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PHYSICAL CHARACTERISTICS AND MANGROVE COMMUNITY IN THE NORTH PART OF MAHAKAM DELTA IN EAST KALIMANTAN – INDONESIA

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ABSTRAK

Delta merupakan bagian dari ekosistem estuari, kondisinya dipengaruhi regim hidrologi dari arus pasang surut dan aliran sungai. Secara berlanjut delta berubah akibat dari pasokan sedimen, mineral dan hara, yang menunjang komunitas vegetasi mangrove didalamnya. Keragaman kondisi cabang-cabang Sungai Mahakam diduga berperan terhadap karakteristik delta dan komunitas mangrovenya. Penelitian ini bertujuan mempelajari pola pasang surut di wilayah delta, pengaruhnya terhadap karakteristik fisik dan komunitas mangrovenya, serta kaitan keduanya. Penelitian dilakukan di Delta Mahakam bagian utara, pada bulan Agustus 2005. Hasil penelitian ini menunjukkan tidak ada perbedaan fluktuasi muka air diantara saluran delta, namun pola fluktuasi salinitas dan kekeruhan airnya bervariasi. Kisaran salinitas adalah 0,04 – 0,59% (Muara Kaeli), 0,01 – 0,37% (Muara Berau), dan 2,18 – 3,17% (Muara Saliki). Tingkat kekeruhan tertinggi di Muara Berau (45,6 – 361,6 NTU), diikuti Muara Kaeli (31,2 – 238,6 NTU), dan terendah di Muara Saliki (12,0 – 36,4 NTU). Komunitas mangrove didominasi kelompok Soneratia *dan* Avicenia *di seluruh stasiun pengamatan, yang menunjukkan komunitas mangrove masih pada tahap muda. Tingkat kerapatan pohon dan semai masih cukup baik, masing-masing 225 – 567 tegakan/ha dan 3867 – 19.600 tegakan/ha, namun kerapatan belta cenderung rendah (183 – 675 tegakan/ha). Komposisi komunitas mangrove dan kerapatan semai meningkat dari Muara Saliki ke Muara Kaeli, menujukkan kondisi di Kaeli lebih baik dari Saliki. Kondisi tersebut tampaknya terkait dengan karakteristik sedimennya dan adanya gangguan manusia.*

Kata kunci: Delta, mangrove, salinitas, sedimen, kekeruhan

ABSTRACT

Delta is a part of estuary ecosystem where the hydrological regime, tidal current and river flow, control its condition. Delta is constantly changing, owing to sediment, mineral and nutrient input. Variation in channel condition of Mahakam river is believed to have large influence on the delta characteristic and consequently to the mangrove community. This research aims to study tidal pattern in delta channel and its associated physical characteristics, mangrove community and relationship between them. The research was conducted in North Part of Mahakam Delta, on August 2005. The results showed no differences on water level fluctuation between channel, but there were significant difference salinity and turbidity fluctuations. Salinity fluctuation on surface water were between 0.04 – 0.59%, 0.01 – 0.37%, and 2.18 – 3.17% in Muara (Mouth) Kaeli, Muara Berau, and Muara Saliki, respectively. Turbidity level in Berau showed the highest fluctuation (45.6 – 361.6 NTU), followed by Kaeli (31.2 – 238.6 NTU), and the lowest was in Saliki (12.0 – 36.4 NTU). The mangrove community was still young, indicating by the domination of Soneratia *and* Avicenia. *Both tree (225 – 567 trunk/ha) and seeding (3867 – 19,600 trunk/ha) densities indicated that all location had good mangrove condition, but belt density was low (183 – 675 trunk/ha). Mangrove composition and seedling density increased from Saliki to Kaili, indicates that Kaili had a better condition. This condition is believed to associate with the sediment characteristic and human disturbances.*

Keywords : Delta, mangrove, salinity, sediment, turbidity.

INTRODUCTION

Delta is a part of estuary ecosys-tem, a very dynamic area that controlled by the hydrological regime, salinity fluctu-ationand water mass movement. The estuarine dynamics reflects their temporal and spatial water regime variability. This temporal variation is associated with short time scale of diurnal tide, and longer time

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scale of the neap and spring tide cycle, aswell as fresh water input from the river flow (Wilson, 1988). Spatial variability exists because of delta system, which enables to form unique water regime pattern on their channels, resulting in variation of material trapping. The different estuary types consequently have different sedimentation regimes (Dyer, 1986).

In East Kalimantan – Indonesia, Mahakam Delta has been being extended to Makasar Straits, spread from the north of Muara (Mouth) Berau, to the south of Muara (Mouth) Jawa. Mangrove commu-nity has developed on those areas, where various environmental conditions have in-fluence to their growth. According to Luk-man *et al* (2004), there was a variation in the mangrove conditions between both mouths. Domination of pioneer species such as *Soneratia* and *Avicenia* indicates that the mangrove community was on the succession stage, in which a better developmental condition was observed in Muara Berau (representation of North part Mahakam Delta) than that in the Muara Jawa. Accordingly, Muara Berau (in this research as North part Mahakam Delta) was chosen for this study area.

According to Thom (1967) micro-topographic is the most important ecological factors that control over mangrove distribution in deltaic environment. Consequently, the natural condition variation in delta channel of Mahakam River is believed to have influence on the mang-rove community. This research aims to study tidal pattern in delta channel and its associated physical characteristics and mangrove community as well as the relationship between them.

METHODOLOGY

The research was conducted on three sampling sites, Muara Saliki, Muara Berau, and Muara Kaeli (Table 1; Fig.1) on August 2005. Water regime was derived from the salinity temporal pattern and wa-ter fluctuation on delta channel for 24 hours, base on three-hour periodically observation. The surface water (0 – 50 cm) salinity was measured using WQC (*Water Quality Checker*) HORIBA U-10, temporal vertical salinity distribution was measured by data logger YSI 6000. Water fluctu-ation was measured using stick manually and compared to tide table in Sungai Kutei (P. Nubi) (Geo-graphical Position: 00°7'S and 117°5'E) (Dinas Hidro-Oseanografi, 2005). In delta area, sediment was sampled by coring for determining vertical distribu-tion of sediment fraction. Fraction of sedi-ment was analyzed using *test sieve* and pipette methods (Hidayat, 1988) for sepa-rating and grading sediment fraction.

Table 1. Location and Coordinate of Sampling Sation in North Part of Mahakam Delta

Station	Location	Sampling	Coordinat
IA	Muara Saliki	Vegetation; Sediment	0°20'45,0" S 117°27'04,1" E
IB	Muara Saliki	Vegetation	0°19'52,2" S 117°28'22,5" E
II	Muara Berau	Vegetation; Sediment	0°21'01,9" S 117°31'02,1" E
III	Muara Kaeli	Vegetation; Sediment	0°24'47,3" S 117°32'25,7" E
IV	Muara Saliki	Tidal pattern	0°26'30,1" S 117°26'48,3" E
V	Muara Berau	Tidal pattern	0°28'22,7" S 117°26'57,7" E
VI	Muara Kaeli	Tidal pattern	0°29'47,1" S 117°27'50,2" E

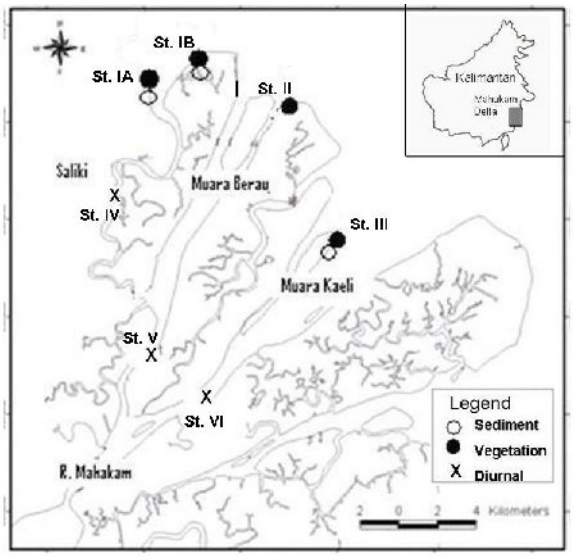


Fig 1. Map of Observation Sites in Mahakam Delta

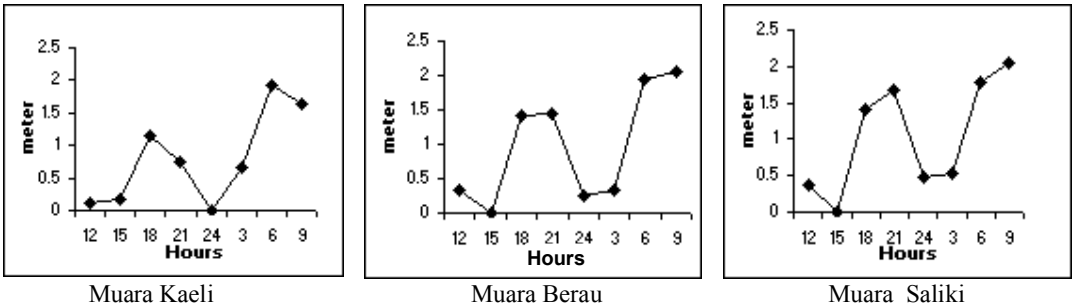
Mangrove community observation was carried out by means of tree density and propagation rate parameters. The mangrove density was counted by line transects method (Cox, 1967), and the standing divided by density of tree (∅ trunk > 10 cm), belt (∅ trunk between 2 - 10 cm) and seedling (∅ trunk < 2 cm) (Pudjoarinto, 1982). Propagation rate was evaluated from distribution of the belt and the seedling.

RESULT AND DISCUSSION

Physical Characteristic of Delta Channel

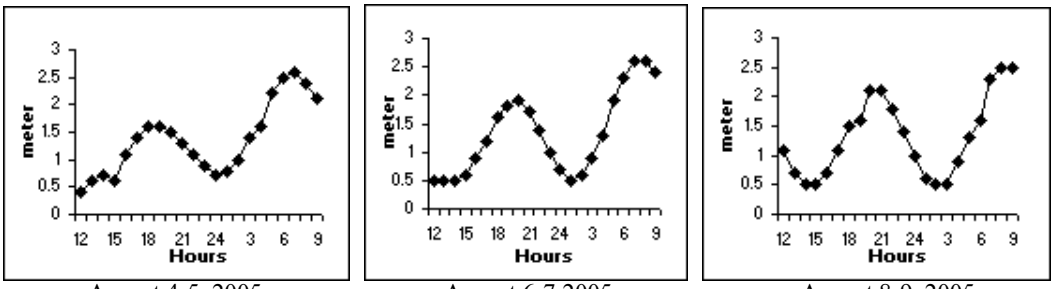
Maximum diurnal water level fluctuation on three delta channels was ± 2 meters (Fig 2), and influenced by the tidal pattern (Fig 3). There were no differences on water level fluctuation pattern among the delta channels. Neither channel physical condition nor river discharge influence the water level fluctuation.

Despite the similarity in the water level fluctuation pattern, the surface water salinity fluctuation in these three delta channels were diverse (Fig 4). The salinity fluctuation were between 0.04 – 0.59%, 0.01 – 0.37%, and 2.18 – 3.17% in Muara Kaeli, Muara Berau, and Saliki, respectively. Lower salinity in Muara Berau and Muara Kaeli are attributed to the position of those channels as the main channels of northern part of Delta Mahakam which are largely influenced by freshwater come from the river. In contrast, Saliki is a tidal river so that it was characterised by higher salinity.



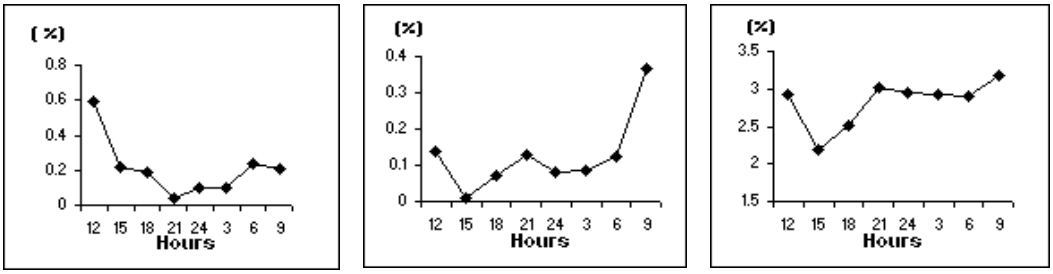
Muara Kaeli Muara Berau Muara Saliki

Fig 2. Diurnal Water Fluctuation in North Part of Delta Mahakam.



August 4-5, 2005 August 6-7,2005 August 8-9, 2005

Fig 3. Diurnal Water Level Fluctuation at Different Time in Mahakam Delta (Dinas Hidro-Oseanografi, 2005).



Muara Kaeli Muara Berau Muara Saliki

Fig 4. Diurnal Salinity Fluctuation on Surface Water in Muara Kaeli, Muara Berau, and Muara Saliki

Variation in salinity fluctuation pattern in three delta channels indicates the ecological diversity of the estuarine water. According to Pritchard (1965) *in* Schubel & Kennedy (1984) mixing sequence between fresh water and salt water forms density gradient and resulting in different estuarine circulation patterns. In Muara Kaeli, the fluctuation of salinity was not associated with thewater level fluctuation. Therefore, Muara Kaeli belong to the type B estuary, in which the water mass mixing is partially attributed to the balance between the water river discharge and the tidal flow. When the tidal flow come, the salt water flows to the bottom part of the channel, meanwhile freshwater from the river tend to be lifted up to the surface (Fig 5).

Salinity fluctuation and water level fluctuation in Muara Berau have the same pattern as that in Muara Kaeli, but the high tide in Muara Berau do not increase the water salinity. Accordingly, Muara Berau is an estuary of type A, where the river water discharge was more dominant and higher than the tidal flow. In this type ver-tical mixing of water mass was very limited so that the water is clearly strati-fied (Fig 6). It was indicated that the fresh water discharge in this channel was higher than that in Muara Kaeli, however, the well mixing of freshwater and the sea water was occurred when high tide came on 21.00 (09.00 pm).

In Muara Saliki, tide influences the salinity fluctuation. Accordingly, Muara Saliki is categorised as a type C estuarine. This type of estuarine is characterised by a vertically homogeneous water mass, indicated by the continuous high level of surface water salinity (Fig 7).

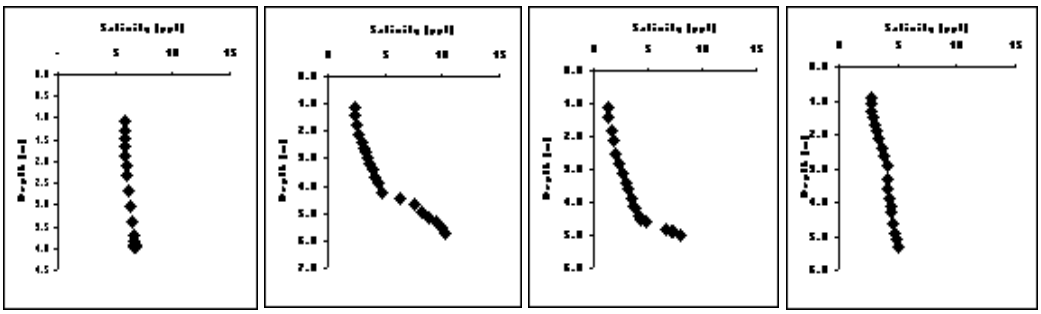


Fig 5 Daily Vertical Distribution of Salinity in Muara Kaeli

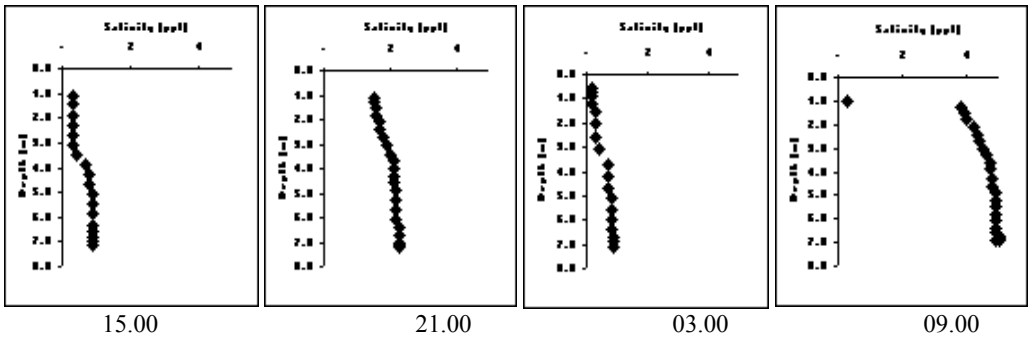


Fig 6. Daily Vertical Distribution of Salinity in Muara Berau

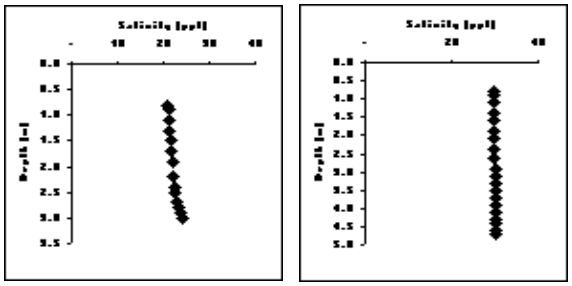
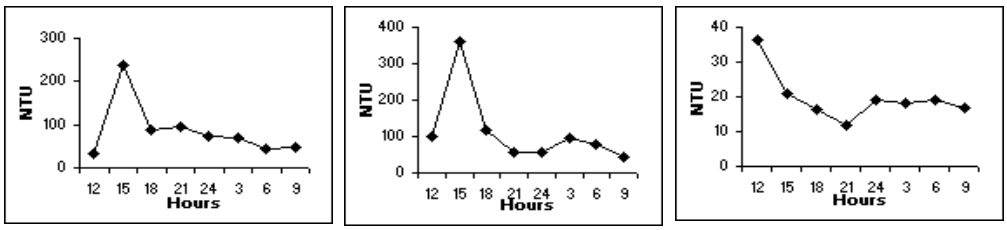


Fig 7. Vertical Distribution of Salinity at Different Tidal Time in Muara Saliki

Muara Berau and Muara Kaeli had similar pattern of water turbidity fluctuation, but the pattern in Muara Saliki was different (Fig 8). It was observed that the highest turbidity fluctuation was in Muara Berau (45.6 – 361.6 NTU), followed by Muara Kaeli (31.2 – 238.6 NTU), and the lowest was in Muara Saliki (12.0 – 36.4 NTU). Maximum turbidity in Muara Berau and Muara Kaeli were occurred in the first tidal movement and it decreased afterward. In Muara Berau, this phenomenon is associated with the large river water mass, so that when the tidal water flew rapidly to the channel the mixing processes occurred intensively. In Muara Saliki, water mass mixing is not occurred as the river water mass was remarkably lower. According to Lin & Kuo (2003) estuarine turbidity is mainly generated from bottom resuspension by tidal pumping.



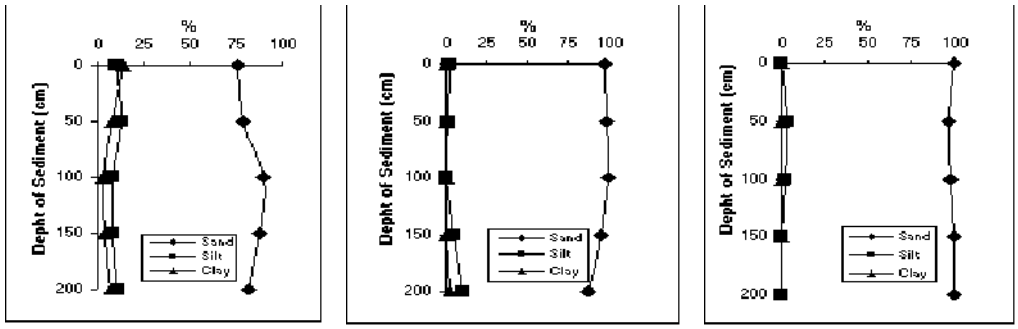
Muara Kaeli Muara Berau Muara Saliki

Fig 8. Diurnal Turbidity Fluctuation in Muara Kaeli, Muara Berau and Muara Saliki

Sediment characteristic in three sampling locations represent the channel delta condition (Fig 9). Sand was the dominant fraction in all channels, but silt and clay fraction tend to increase from Muara Saliki to Muara Kaeli. Lower river water flow in Muara Saliki generates lower turbidity level and consequently also lower fraction of silt and clay. More effective silt and clay trapping was occurred in Muara Kaeli, even compared to that in Muara Berau, as indicated by higher con-tent of silt and clay fraction. This pheno-menon is associated with the condition of Muara Kaeli channel that has a lower river flow than Muara Berau.

Mangrove Community Characteristic

Domination of *Sonneratia* and *Avicenia* in Muara Saliki, Muara Berau, and Muara Kaeli (Table 2) indicates that the mangrove communities in those area were still in their young stage development. There were found *S. alba* (Station IA, IA, II, III), S. *caseolaris* (Station III), *A. marina* (Station II, III), and th e others grained sediment, and rapid deposition and accumulation of flocculate material is associated with areas of decreased bottom stress. It can explain how silt and clay effectively trapped in Station Kaeli, more than in Station Saliki even in Berau.



Station Kaeli Station Berau Station Saliki

Fig 9. Vertical Distribution of Sediment in Three Location of Delta

According to Blake *et al.* (2002) the transport and trapping of fine-grained sediment are controlled by tidal dynamic, rivers discharge, salinity stratification, flow pattern and particle dynamics throughout the estuarine system. Milligan (2002) explained that base on observation in ACE Basin, South Carolina, flocculation processes may play a significant role in trapping of fine-

species was *Bruguiera parviflora* (Station III).

According to Sukardjo (1984) *S. caseolaris*, *A. marina* and A. *alba* are pioneer species and grow on soft mud of coastal edge or delta. The lower salinity level in Muara Kaeli is suitable for *B. parviflora*. *Bruguiera* is able to grow in water with salinity level up to 25 ‰

(Sukardjo, 1984). Mangrove composition tend to increase from Muara Saliki to Muara Kaeli, indicates that Muara Kaeli had a better condition than Muara Saliki.

Base on the tree and seeding density all the study area in Mahakam Delta were observed in a good condition of mangrove community. The tree and seedling densities were 225 – 567 trunk/ha and 3867 – 19600 trunk/ha, respectively, but the belt density was low (183 – 675 trunk/ha) (Table 3). According to Wou-thuyzen *et al* (2002), in good mangrove ecosystem, the minimum density of tree, belt and seedling are 260 trunk/ha, 2,516 trunk/ha, and 3116 trunk/ha, respectively.

An observation in Cimanuk Delta, Indonesia, showed that seedling of *A. alba* and *A. marina* were commonly occurred, supported by unstable condition of sediment due to a high rate of mud sedimentation (Sukardjo, 1982). Both kind of mangrove have root system which support adaptation for unstable bottom and extreme salinity fluctuation.

The mangrove condition also indicates that ecosystem disturbance in Muara Kaeli was low while in Muara Saliki was high. Muara Saliki is near to Muara Badak City where human activities are high. Besides that, in Saliki Village, in upper part of IA and IB station, there also a construction activity of gas port was going on.

Tabel 2**.** Mangrove Species in the Research Location

Delta Channel	Station	Dominant species	Others species
Muara Saliki	IA	*S. alba*	*Nypa sp.*
	IB	*S. alba*	
Muara Berau	II	*S. alba, A. marina*	
Muara Kaeli	III	*S. alba, S. caseolaris, A. marina*	*B. parviflora*

Table 3**.** Characteristic of Mangrove Community Density, in Delta Mahakam.

Area	**Station**	**Trunk Density**		
		Tree (trunk/ha)	**Belt** (trunk/ha)	**Seeding** (trunk/ha)
Muara Saliki	IA	567	183	3.867
Muara Saliki	IB	458	617	2.133
Muara Berau	II	258	425	10.933
Muara Kaeli	III	225	250	19.600

Although revegetation level still high, which was marked by high seedling density, but the low belt density indicates degradation of the mangrove regeneration rate. The worst condition was observed in station IA and IB where the seeding density was the lowest. Characteristic of sediment might influence the revegetation rate, as clay and silt content were high in Kaeli, it was suitable for mangrove seeding to grow.

CONCLUSION

There were no differences in the water level fluctuation pattern among three channels in the north part of Mahakam Delta. The salinity and turbidity fluctuation, however, were remarkably dif-

ferent. Domination of *Soneratia* and *Avicenia* in the study area indicates that the mangrove communities was still in the young stage of development. The tree and seeding density shows that the study area had a good mangrove condition. Mangro-ve composition and seed density increased from Muara Saliki to Muara Kaeli, indicates that Muara Kaeli had a better environmental condition. This environmental condition is associated with the sediment characteristic of the channels and the human disturbances.

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