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ECOLOGICAL ASPECT OF NON PRODUCTIVE FISHPONDS AT MAHAKAM DELTA AREA: REVITALIZATION WITH SILVOFISHERY SYSTEM

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ABSTRACT: *Mahakam Delta area utilization for various purposes, especially for intensive aquaculture has led to degradation of the land quality and mangrove vegetation both in ecological terms. The research was conducted in the Mahakam Delta to assess the ecological aspect revitalization of non produktive fishponds at Mahakam Delta with silvofishery system which is a combination of fishery and forestry in one unit of land management. The research was conducted by surveys, interviews, laboratory analysis and tracking of secondary data relating to the revitalization activities of fishponds at Mahakam Delta with silvofishery system. The results of the study are: [1] Revitalization of non productive fishponds at Mahakam Delta with silvofishery system was conducted by government and local community, applied Traditional Ditch Fishponds with three types of bakau planting site, i.e.: permanentflooded, periodically flooded and not flooded site. [2] Five major parameters of water quality in the 2 to 8 years ages silvofishery fishponds, (Temperature: 25 to 28℃; Transparency: 40 to 60 cm; pH: 6.7 to 7.36; Salinity: 13 to 20 ppt; Dissolved Oxygen: 3.2 to 5.7 ppm) are relatively stable and meets the quality standard suitability for cultivation of shrimp, milkfish and crabs.*

KEYWORDS: Intensive aquaculture, Revitalization, Fishpond, Mahakam Delta, Silvofishery system.

INTRODUCTION

Mahakam Delta area utilization for various purposes, especially for intensive aquaculture has led to degradation or loss of quality and function of land and mangrove vegetation both ecologically and economically which leads to several problems, among others tread damage, decrease in the carrying capacity of the environment and decrease the productivity of mangrove stands and productivity of farms, which can affect the socio-economic conditions of society.

Syahrudin (2008) stated that the Mahakam Delta conservation area damage caused by uncontrolled land clearing fishponds and not environmentally friendly impact on coastal erosion and decline infarm production. Up to 2008 damage to the Mahakam Delta region reached 95,000 ha or 87.96% of the total area of 152 400ha.

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Revitalization efforts that have been made in the Mahakam Delta region is the management of fishponds with Silvofishery system which is the combination of aquaculture in mangrove planting, which is done by the government, government partnerships with the community and by the community independently. Independently, community fishponds with Silvofishery system in the area has not managed or no longer productive. Extensive farms managed 5-30 hectares, with a variety of mangrove stand age.

In the Mahakam Delta region in the province of East Kalimantan-Indonesia, has conducted various studies, including studies of Land Carrying Capacity for Shrimp Farming in the Mahakam Delta (Sutrisno and Ambarwulan, 2003), withthe results ofthe studyshowedthatwhile thecentral and northern partsinmuara-Mahakamestuaryis expected tosupportthe cultivation ofshrimp. Only thepH ofthe soilandwaterinsomelocationsmaybecome an obstacle tothe success ofthiseffort. The southern parthas aconstraintonthe suspendedmaterialin addition torelativelyhighpH ofthe soilandwater. Observationsimageshowsthe trend expandingfarmstoNyparegion(upstream Mahakam), whichis physicallyless supportive ofshrimp farming.

ZoningPlanResearchandRehabilitationReferralMahakam Delta area, has beencarried outbySuhardiman(2009), based on theinterpretation ofsatellite imagery-based objects, the ratiobetween the area offishpondsandmangroveforestsarestillleft witha variety ofconditionsis60: 40, andthe rate isdirectly proportional tothe level ofcriticality oflandthatreaches±60% of thetotal area. Based on these results, the patternfor therehabilitation of areas already become a fishponds canbe doneusinga modelSilvofisherywithsystemsadjusted to thewishes of the people

Economic Studies Business Model Mangrove Pondinthe Mahakam DeltaRegionalKutai regencyhas been done by Upat(2009), withthe resultsthatthe typeof pondviablebyfish farmersaresilvofiosheryfishpondsmodels, because it providesa great advantagetofarmersfinancially, interest rate per year obtained also satisfiesrateset bythe bank. Study of Public Participationin the Managementof Mangroveshas beendonebyWardaniand Djuhriansyah (2006), providesthe results ofthe level of community participationin the managementof mangroves inMuaraJawaIlirare in thelowcategory. Tocomplementpreviousresearch, this studyisfocusedtodeterminewhether therevitalization ofnon-productive fishpondsinthe Mahakam Delta Silvofisheryecologicalsystemcanimprove thesite andcapacity of the environment, thebenefits of research: [1] as avaluation toolMahakam Deltarevitalization activities[2]add to theirknowledge of themanagementof mangrove areas; [3] into considerationthe MahakamDeltarevitalizationpolicy making.

MATERIALS AND METHODS

Research Location

Field research activitieshave been conductedat locationsfishpondswithSilvofisherysystemin theMahakam DeltainHandil8 villageMuaraJawa District,Kutai Kartanegara. Water quality dataanalysisperformed onHealth Laboratoryof East KalimantanProvincial.

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Scope of Research

The scope ofthis studyis limited tostudiesrelated tothe benefitsofthe ecologicalaspects ofthe revitalization ofunproductivefishpondsinthe Mahakam Deltawith SilvofisherySystem. Thestudy focuses onissuesrelated to thequality of thesitesandenvironmental carrying capacity.

Data Collection Methods

Databiogeophysic: Observationsbiogeophysicdone onaquaculture fishpondsare managedbythe Silvofisherysystem onseveralconditionsanddifferentage of manggrove stands.

Monitoring of water quality: madeinaquaculture Silvofisheryfishpondswhichbecamethe object of research. The observed parameters: temperature, brightness, pH, salinity, DO, BOD, suspended solids, ammonia, nitriteandnitrate. Someof thewaterquality parameterswere observeddirectlyinthe fieldandanalyzedatthe Health Laboratoryof East KalimantanProvincial.

Waterquality parametersandequipment usedforobservation, refer to theequipment usedbyPrasita(2007) is presentedin Table1.

Table1. SomeWaterQualityParametersandMeasure ToolUsed

No.	Parameters	Equipment	
1.	Temperature(ºC)	Thermometers	Direct measurements
2.	Brightness(m)	Secchidisk	Direct measurements
3.	pH	pH meter	Direct measurements
4.	Salinity(ppt)	Salinometer	Direct measurements
5.	Dissolved oxygen(ppm)	DO meter	Direct measurements
6.	BOD (ppm)	sample bottle, BODmeter	Laboratory
7.	DissolvedSolids(mg /l)	spectrophotometer	Laboratory
8.	Ammonia(ppm)	spectrophotometer	Laboratory
9.	Nitrite(ppm)	spectrophotometer	Laboratory
10.	Nitrate(ppm)	spectrophotometer	Laboratory

Source: Prasita(2007)

Secondary Data: Secondary datacollectedthrough a surveyof variousresearchreports, literature, andthe results ofa surveyofvariousinstitutions/ agencies, such as documents, pictures/maps, textandtables, relevantandsupport research, analysis ofresearch data.

LandQualityAnalysis: based on the resultsof thelaboratoryanalysisof water qualitytoprovide a picture ofthe condition ofthe quality of landwhich includeswater qualityin Silvofisheryfishpondswithvariousmangroveplant age, andto analyze thesuitabilityof landforSilvofisherysystem.

RESULT AND DISCUSSION

Formsand Implementation Activities:

Forms ofunproductive fishpondsrevitalization activitiesinthe Mahakam Deltawith Silvofisherysystemhas been implemented in the formof pondmanagementsystem

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changes,thatwere initiallymanagedintensivelyandhasless or unproductive,modifiedwithenvironmentally friendlyfarmmanagementsystemsthatintegrate orcombineaquaculture andforestryin one unitland management.

Implementationbeginswith theinitiationof activitiesandthe introduction of environmentally friendly farm management system by the governmentthatthe Forest Service Kutai Kertanegara, by makingthe Pilot Project farm management system implementation involvesSilvofisherysystem. During theperiod2002 to 2007has beencarried outmangrove plantingarea of819hawithSilvofisherysystem(Sidik,2008). Insubsequent stages, mostfish farmersinthe Mahakam Deltagraduallybegan tomake changesto thesystem ofenvironmentally friendlyfarmmanagementwithSilvofisherysystem.

Community Involvementin Activities:

The results ofthis studyshowedthe public, especiallythefish farmerseither individually orin a groupof farmersfarms, has beenactively involvedandproactive infishpondsrevitalization activitiesinthe Mahakam Deltawith Silvofisherysystem. This is demonstratedby the manyfarmers groupsSilvofisheryfishpondsthat have formedandthe number ofproposalsfor setting up anewSilvofisherypondraised byfarmers groupsto theForest ServiceKutaiKertanegara. Silvofisheryfishpondsfarmer groupsinthe Mahakam Deltaare presentedin Table2.

Table2. DataFarmers Groupinthe Mahakam DeltaSilvofisheryFishponds

No.	Farmers Group	Number of Member	Location	Activity
1.	Silvofishery Rintisan	29 Persons	Muara Jawa Ilir	Extensionfisheries andnursery toplantingmangroves.
2.	Pesona Mangrove	7 Persons	Muara Jawa Tengah	
3.	Windu Jaya	6 Persons	BujitIsland, Benakang, Anggana, Sepatin	
4.	Tanjung Lestari	9 Persons	Tanjung Sembilang	
5.	Theraphy Mangrove	9 Persons	Pulau Pemerung, Anggana	
6.	Maju Jaya	8 Persons	Muara Sembilang	

Results Achieved:

The resultsthat have beenachievedfrom therevitalization activitiesinthe Mahakam Deltaregionin particularSilvofisherysystemmanagedindependentlyby the communityare presentedin Table3.

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Table3. Activities Revitalization Unproductive Fishpondswith Silvofishery Systeminthe Mahakam Delta Region

No.	Fishponds Manager	Area (ha)	Locationof Fishponds
1.	Farmers GroupSilvofisheryRintisan Chairman: H.Shukri, Spi.;Members: 29Persons	267,5	Muara Jawa Ilir (Handil 7, 8, 9)
2.	Farmers GroupPesona Mangrove Chairman: Nurdin; Members: 7 Persons	47,5	Muara Jawa Tengah (Handil 6, 7)
3.	Farmers GroupWinduJaya Chairman: M.Ishak; Members: 6Persons	100	BujitIsland, Benakang, Anggana, Sepatin.
4.	Farmers GroupTanjung Lestari Chairman: Mulyadi; Members: 9Persons	45	Tanjung Sembilang
5.	Farmers GroupTherapyMangrove Chairman: H.Arsyad; Members: 9 Persons	35	Pulau Pemerung, Anggana
6.	Farmers Group Maju Jaya Chairman: Aldi; Members: 8Persons	50	Muara Sembilang

SustainabilityActivities:

Farmmanagement activitieswith Silvofisherysystemonthe locationof researchhas beencarried outfor abouttenyearsandis stillwell-managed anddevelopedwith the creation of new aquaculture with Silvofishery fishponds. This canbe seenby age Silvofishery fishponds varied from age 2 to 8years. Guaranteethe sustainability of activitiesis also demonstratedby theseriousnessof thefarmer groupsin procurement activitiesmangroveseedlingswerecarried out continuouslytomeet the needs ofgoodseedsforplantingandforreplanting.

Ecologicalaspect:

The results ofthe studyof ecologicalaspectsin particularwater quality Silvofishery fishponds with differentmangrovestand age, based on theclasscategorysuitabilityfor5mainparametersare presentedin Table4.

Table 4. Suitability Class Five Main Parameter Water Quality Silvofishery Pond with Different Age of mangroves stands

No.	Parameters	Age stands / Test Results / Measurement				Suitability Class
		2 years	5 years	6 years	8 years	
1.	Temperature (°C)	25-28	25-28	25-28	25-28	S1 (28-30)
2.	Brightness (cm)	40-60	40-60	40-60	40-60	S1 (30-40)
3.	pH	7	6.7	6.7	6.9	S2 (6-7.5)
4.	Salinity (ppt)	13-20	13-20	13-20	13-20	S1 (12-20)
5.	Dissolved Oxygen (ppm)	5.5	3.2	3.4	4.3	S1 (>5) dan S2 (3-5)

Five major water quality parameters (temperature brightness pH salinity dissolved oxygen) Silvofishery fishponds, with different age of mangrove stand meet the criteria of suitability classes S1 and S2 for aquaculture.

The comparison5mainparametersof waterquality(temperature, brightness, pH, salinityanddissolved oxygen) inSilvofishery fishpondswiththe requirementsforthe cultivation ofseveraltypes offisherycommodities, are presentedin Table5.

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Table 5. Comparison 5 Main Parameters of Water Quality in Silvofishery Fishponds with Requirements for Cultivation of Several Types of Fishery Commodities

No.	Parameters	Results[1)]	Cultivation Requirements Specification						Remarks	
			Shrimp [2)]		Milkfish[3)]		Crab[4)]			
I	Fishponds age of 2 years								Source:	
1.	Temperature (°C)	25-28	29-30	E	21-32	E	25-30	E	1)	Primary data
2.	Brightness (cm)	40-60	≥60	E	>5	E	-	-	2)	Sutrisno & Ambarwulan (2003)
3.	pH	7	8.0-8.5	Ne	6.5-8.5	E	7-8	E	3)	Prasita (2007)
4.	Salinity (ppt)	13-20	15-25	E	5 - 35	E	15-30	E	4)	Susanto, G.N.(2006)
5.	Dissolved Oxygen (ppm)	5,5	≥3,0	E	>3	E	>3	E		
II	Fishponds age of 5 years								Cultivation requirements:	
1.	Temperature (° C)	25-28	29-30	E	21-32	E	25-30	E	E	:: Eligible
2.	Brightness (cm)	40-60	≥60	E	>5	E	-	-	Ne	:: Not eligible
3.	pH	6.7	8.0-8.5	Ne	6.5-8.5	E	7-8	E		
4.	Salinity (ppt)	13-20	15-25	E	5 - 35	E	15-30	E		
5.	Dissolved Oxygen (ppm)	3.2	≥3.0	E	>3	E	>3	E		
III	Fishponds age of 6 years									
1.	Temperature (°C)	25-28	29-30	E	21-32	E	25-30	E		
2.	Brightness (cm)	40-60	≥60	E	>5	E	-	-		
3.	pH	6.7	8.0-8.5	Ne	6.5-8.5	E	7-8	E		
4.	Salinity (ppt)	13-20	15-25	E	5 - 35	E	15-30	E		
5.	Dissolved Oxygen (ppm)	3.4	≥3.0	E	>3	E	>3	E		
IV	Fishponds age of 8 years									
1.	Temperature (°C)	25-28	29-30	E	21-32	E	25-30	E		
2.	Brightness (cm)	40-60	≥60	E	>5	E	-			
3.	pH	6.9	8.0-8.5	Ne	6.5-8.5	E	7-8	E		
4.	Salinity (ppt)	13-20	15-25	E	5 - 35	E	15-30	E		
5.	Dissolved Oxygen (ppm)	4.3	≥3.0	E	>3	E	>3	E		

The comparison showed that the 5 main parameters of water quality (temperature, brightness, pH, salinity and dissolved oxygen) in Silvofishery fishponds ages 2 to 8 years largely eligible for shrimp farming, milkfish and crab. Only the pH of water that do not eligible for shrimp farming.

Productivity improvement stread relationship with fishponds and stands of mangroves

Descriptively, treadrepairrelationswithfarmproductivityandincreasemangrovestands, can be described:

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AgainstIncreased ProductivityPond:water qualityconditionsin thepondSilvofisherypondcan supportincreased productivitythroughthe efforts ofdiversificationanddiversification offisherycommoditiesby selectingthe mostprofitablebusinessesandselectingfisherycommoditiesthathave thehighesteconomic value.

Mangrove Stands Against Productivity Improvement: Improved tread on aquaculture with Silvofishery system is also very supportive for the intensive cultivation of mangroves, with the planting of the type and age of the uniform and regular spacing and silvicultural treatments can increase of productivity of mangrove stands.

Site Repair Relationshipwith Improved Environmental Carrying Capacity

Indescriptive relationship site simprovement with increasedcarrying capacity of the environment: [1] Site repairinpondaquaculturewithSilvofisherysystemcanimprovethe utilizationrate ofland suitabilityof landforcultivationsomoreefficiently. Implementation inan increase inthe carrying capacity ofthe environmentistheland's use foraquacultureis moreefficientto reducethe level ofdamage tothe environmentso as toincrease theavailability ofland resourcesthatcanbe utilized; [2] In addition tothe increased availability oflandthatcanbe used, improvedtreadonaquacultureinfishpondsSilvofisherysystemalso workswellforseed productionforest commodity(mangrove) andfisherycommodities(crab), so as to supportthe needs of seed for subsequent cultivation; [3] at the silvofishery fishpondsvarioustypes oforganismsthatcanbe used asnatural foodforfish farminghave also begun toexist, sometypes of shell fish and fish (trash fish) that live naturallyin fishpondscanalsobe used asfeedsilvofisherysoft-shelled crabsare culturedwitha systemof cagesin silvofisheryfishponds. The presence ofvarioustypes ofbiotain Silvofisheryfishpondscanincreasethe carrying capacity ofthe environment throughthe role ofmaintaining the stability ofthe aquatic environmentso that it canbean ideal environmentforthe cultivation ofa variety offisherycommodities.

The presence ofvarioustypes ofbiotain Silvofisheryfishpondswhichincreasethe carrying capacity ofthe environment throughthe role ofmaintaining the stability ofthe aquatic environmentso that it canbean ideal environmentforthe cultivation ofa variety offisherycommodities, economicallycanreduce theinputof controlandincreaseproduction, so as toreduce production costsandincreaserevenuesociety.

CONCLUSION

1. Revitalization of unproductive aquaculture fishponds in the area of the Mahakam Delta with Silvofishery system, has been implemented by the government and society using traditional ditch pond with three mangrove site conditions: permanent flooded, periodically flooded and not flooded,.
1. 2. Five major water quality parameters (temperature brightness pH salinity dissolved oxygen) Silvofishery fishponds, with different age of mangrove stand meet the criteria of suitability classes S1 and S2 for aquaculture.
2. Water quality parameters in 5, 6, and 8 years ages of Silvofishery fishponds, with three different mangrove site planting conditions for the major water quality parameters: temperature (25-28°C) brightness (40-60 cm) pH (6.7 to 7.36) salinity (13-20 ppt) dissolved oxygen (3.2 to 5.5 ppm) in 5, 6, and 8 years ages of

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Silvofishery fishponds, relatively stable meet the quality standards suitability for cultivation of shrimp, milkfish and crabs.

SUGGESTIONS

1. Based on the consideration of ecological aspects, revitalizing fishponds unproductive in the Mahakam Delta with Silvofishery system is suggested to use a traditional ditch pattern design with a pond where the mangroves sites planting flooded periodically.
2. For further aquaculture with Silvofishery system requires a relatively long cycle businesses, advised the government establishes the certainty of land status to support sustainability efforts.
3. To explore other benefits beyond commodity production forestry and fisheries, there should be a potential valuation of environmental services Silvofishery fishponds system.
4. For the development of Silvofishery fishponds, need input Silvofishery technological innovation, supported by research and development of other types of forestry and fishery commodities with high economic value.

REFERENCES

Abubakar, A. , A.M. Lahjie dan Ichiro Hongo. 2012. Economic Analysis of Brackish Water Pond Cultivation Models in Kutai Kartanegara East Kalimantan. Regional Research Institute of Agricultural Production (RRIAP) Publication No. 26.

Allen, G.P. and J.L.C. Chambers. 1998. *Sedimentation in The Modern And Miocene Delta*. Indonesian Petroleum Association. Jakarta.

Allen, G.P.; D. Laurier and J. Thouvenin. 1976. "Sediment Distribution Pattern in Modern Mahakam Delta" . *Proceeding Indonesian Petroleoum Association*, 5th Annual Convention. Jakarta.

Anwar, C.andH.Gunawan. 2006.Role ofEcologicalandEconomicalSocialMangrove Forestinthe Coastal AreaDevelopmentSupport. MainPapersonExposureResearch Results: ConservationandRehabilitation ofForest Resources. Padang, 20 September 2006. (in Indonesian)

Bengen, D.G.2009.The integrationKnittingCoastal Managementas the Basis forSustainableEnvironmentalDevelopmentCornerstone. WorkshopPapersNGO Forum-TOTAL E&PSamarinda26 to 27 October2009.24p. (in Indonesian)

Gunarto. 2004.Conservation ofBiologicalResources SupportMangroveasCoastalFisheries. Journal ofAgricultural Research, 23(1), 2004.(in Indonesian)

Gunawan, W.andNoorhidayah. 2007.FunctionsandBenefits ofBiological Resourcesin theMangrove EcosystemPerspective ofEcologicalandEconomical(Bio Resource Functionand Benefit of the Mangrove Ecosystemin Ecological and EconomicalPerspective). InfoForestVol. IVNo.6Year 2007: 595-604.(in Indonesian)

Harahab, N.2010. Economic Assessmentof Mangrove Forest Ecosystemand Its Applicationin Coastal Planning. GrahaScience. Yogyakarta.251p.(in Indonesian)

Karminarsih, E. 2007. Utilization of Mangrove Ecosystems to Minimize Impact of Disastersin Coastal Region (The Use of Ecosytem Mangroveinminimalize Disaster Impactin Beach Area). JMHTVol. XIII(3): 182-187, December 2007.

ISSN 2053-5805(Print), ISSN 2053-5813(Online)

Kusmana, C.; Istomo; C. Wibowo; S.W. Budi, R.; I.Z. Siregar; T.Triyana; S. Sukardjo. 2008. Manual of Mangrove Silviculture in Indonesia. Published by: Directorate General of Land Rehabilitation and Social Forestry, Ministry of Forestry and Korea International Coorpiration Agency (KOICA) The Rehabilitation Mangrove Forest and Coastal Area Damaged by Tsunami in Aceh Project. Jakarta. 217 p.

Lahjie, A.M.2003.Forest UtilizationApproachtoAgroforestrySystems. Mulawarman. Samarinda. 378p.(in Indonesian)

Mustafa, A .;M.PAENA; Tarunamulia and J.Sammut. 2008. Relationship between Environmental Conditions and Productivity Factors Pond to Refine Land SuitabilityCriteria: 2.Soil Quality. AquacultureResearchJournalVol. 3No.1Year 2008: 105-121. (in Indonesian)

Prasita, V.D.2007. Analysisand Optimization of Environmental Carrying Capacity Utilization for Coastalaquaculturein the District Coarse sand.Dissertation.Graduate School ofBogor Agricultural University.Bogor.147p. (in Indonesian)

Sidik, A. S. 2008. The Changes of Mangrove Ecosystem in Mahakam Delta, Indonesia : A Complex Social-Environmental Pattern of Linkages in Resources Utilization. Paper Presented at The South China Sea Conference 2008. The South China Sea: Sustaining Ocean Productivities, Maritime Communities and the Climate. Kuantan, Malaysia, 25-29 November 2008.22 p.

Suhardiman, A. 2009.Zonation Plan and Rehabilitation Direction for Mahakam Delta area.Thesis Master Program of Forestry.Graduate Program Mulawarman University.Samarinda. 139 p. (in Indonesian)

Susanto, G.N.and S.Muwarni. 2006. Analysis In Ecological Farming Land Transferon Potential Areas forHabitatMangrovecrab(Scylla sp.). 2006NationalSeminar PapersLimnologyLIPIJakartaGrahaWidya5 September 2006.(in Indonesian)

Sutrisno, D. And Wiwin Ambarwulan. 2003.Assessmentof LandCarrying CapacityforShrimpFarminginthe MahakamDelta. MarineNatural ResourceSurvey Center. Coordinating Agency for SurveysandMapping Agency. Cibinong-Indonesia. 40p.(in Indonesian)

Suyatna, I. 2011. Demersal Fish Species Distribution Study Around Mangrove Mahakam Delta Region. Doctoral Dissertation. Doctoral Program of Forestry, Graduate Program Mulawarman University. Samarinda.177 p. (in Indonesian)

Syahrudin. 2008. Damage Apprehensive of Mahakam Delta. Research and Development of East Kalimantan Province. (in Indonesian)

Upat,A.M.2009.Economic StudiesBusiness ModelMangrovePondinthe Mahakam DeltaRegionKutai Kartanegara Regency.Thesis. Master ofEnvironmentalScienceGraduate ProgramMulawarman University. Samarinda. 113p. (in Indonesian)

Wardani, A.andDjuhriansyah. 2008.Study ofPublic Participationin the Managementof MangrovesinMuaraJawaIlirMuaraJawaKutai Kartanegara Regency.Journal ofResearchandSocio-EconomicAssessmentof Forestrytheoretical. Vol.1, No.2, December2008:95-108. (in Indonesian)

Zwieten, van P.A.M.; A.S. Sidik; Noryadi; I. Suyatna, Abdunnur. 2006. Aquatic Food Production in The Coastal Zone: Data based perception on the trade-off between mariculture and fisheries production of the Mahakam Delta and Estuary, East Kalimantan, Indonesia. In CAB International 2006. Environment and Livelihoods in Tropical Coastal Zones (es. C.T. Hoanh, T.P. Tuong, J.W. Cowing and B. Hardy) Comprehensive Assessment of Water Management in Agriculture Series, p. 219 – 236.

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