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PREFACE

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1. The sicentific manuscript must be received in English, which have been presented for about the last one year on an International Forum either in or outside the countries.
2. Paper should be written at maximum of (10) ten-pages. A4 paper size format using Tahoma 10 pt font letter on a single paragraph.
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   - main champter : introduction, main subject, conclusion (and suggestion);
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CONTENT

ENVIRONMENTAL ISSUES BASED RIVER MANAGEMENT, A SYSTEM TO CONTROL RIVER DAMAGE IN THE SIAK RIVER BASIN

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ABSTRACT

The Siak river basin is very important for the Riau province because of its social, cultural and economic community interaction, even in its relation with foreign countries.

Increase of population and a development have caused some problematic environmental issues of the Siak river basin as the following : (1) Pollution of various sources; (2) Increase of erosion due to land clearing; (3) Reduction of natural forests because of land conversion and floods in downstream Siak; (4) Abrasion of river flood plains caused by river transportation and loss of vegetation cover.

This aim of study shall evaluate the environmental issues causing river damage and the objective to prepare an integrated management concept based on those issues.

The method of study focuses on identification, analysis and preparation of integrated management system.

Pollution content in the Siak River is indicated by the high BOD rate at segment I as upper Siak River : 10 – 30.5 mg/L (Standard of BOD Class 2 is 3 mg/L), and segment II as a middle to downstream Siak river : 20.3 – 38.3 mg/L (Standard of BOD Class 3 is 6 mg/L). Fecal Coliform bacteria content of 1500 Total/100 mL was also detected at segment I (Standard of Fecal Coliform Class 2 is 1,000 Total/100 mL) and a content of 2,400 Total/100 mL at segment II (Standard of Fecal Coliform Class 3 is 2,000 Total/100 mL)

The integrated management programme shall comprise : environment damage control, river water pollution control, water resources productivity, community empowerment and law enforcement.

Keywords : Siak river basin management; environmental issue; Riau province; abrasion.

INTRODUCTION

Background

The Siak river basin in the Riau province has characteristics as such : area 11,327.76 sq.km , total length 572 km, total navigation course 300 km, river width between 75 to 100 m, depth between 5 – 29 m, flow velocity 4 m/sec, and a discharge of 45 – 1700 cu.m/sec.

Population of the area covering Kabupaten Rokan Hulu, Kampar, Bengkalis, Siak and the city Pekanbaru is 1,492,746 people (2005). Since alongside the Siak river, the people have been interacted in social, cultural and economic activities with other regions and even with foreign communities.

At present, the Siak river is providing among other : (1) Clean water for the community residing along the river; (2) Raw water for Pekanbaru PDAM; (3) Raw water for industries; (4) Source of living for fishermen and (5) River transportation.

The increase of population and rapid development in the Siak river basin area has caused problematic environmental issues such as : (1) Pollution of various sources; (2) Erosion due to land clearing; (3) Reduction of natural forests because of conversion and floods in downstream Siak and (4) Abrasion of flood plains as a cause of river transportation and loss of vegetation cover.

Objective and Aim

This study shall evaluate environmental issues in the Siak river basin area that influence the river damage force, in order to come out with an environmental based integrated management concept.

Hypothesis of Research

Growth of economy and development in the area as indicated by the increasing number of industries, plantations, housing areas, office, trade and transportation is assuming to be the reason of various environmental issues problems, such as pollution, erosion, forest conversion, floods, and abrasion of flood plains. Solution to these problems is the provision of an integrated river management system.

Research Methodology

Applied research method shall include the identification and analysis of environmental issues toward existing standards, and the preparation of an integrated management system. One of these issues is the river water quality which has been evaluated at fourteen sampling points and compared to the Siak river water criteria (Decree by the governor of Riau, No. 12/2002)

Scope of Research and Water Quality Monitoring

The identification and analysis of various environmental issues within the Siak river basin covers a study area range between 100° 28' EL – 102° 12' EL, and 0° 20' NL – 1° 16' NL. comprising administratively five area segments (four kabupatens and one city) with total area of 11.327.76 sq.km. Identification of water quality as one of the environmental issues has monitored water quality at following locations :

Table 1. Administrative area and location of water quality monitoring

Segment	Administrative Area	Sq km	%	No	Location of Water Quality Monitoring
Segmen I	Kabupaten Rokan Hulu	1,480.33	13.1%	1	S.Tapung Kiri di Tapung
				2	S.Tapung Kiri di Tandun
Segmen II	Kabupaten Kampar	3,298.62	29.1%	3	S.Tapung Kiri di Petapahan
				4	S.Tapung Kanan di Sikijang
				5	S.Tapung Kanan di Kota Garo
Segmen III	Kabupaten Bengkalis	923.55	8.2%		
Segmen IV	Kota Pekanbaru	4,968.72	43.9%	6	S.Siak di Jembatan Siak II
				7	S.Siak di Jembatan Siak I
				8	S.Siak di Pelabuhan Pelita Pantai
				9	S.Siak di Pelabuhan Sei Duku
Segmen V	Kabupaten Siak	656.54	5.8%	10	S.Siak,Penyebrangan Ferry Perawang
				11	S.Siak, 100 m Hilir Pelabuhan IKPP
				12	S.Siak, Dermaga PT.Pertiwi
				13	S.Siak, Dermaga PT.Kampar Wood
				14	S.Siak Sri Indrapura
Total		**11,327.76**	**100 %**	-	

Sumber : Master Plan Pemulihan Kualitas Air S.Siak Provinsi Riau 2007 -2011, Meneg LH 2006.

RESULTS AND DISCUSSION

Environmental Issues

The environmental issues, such as pollution, erosion, forest conversion and abrasion are explained in following table

Table 2. Environmental issues in administrative area

Segment	Administrative Area	Environmental Issues						
		Pollution				Erosion	Forest Conversion	Abrasion as River Border
		I	P	A	D			
I	Kabupaten Rokan Hulu	--	v	--	--	v	v	v
II	Kabupaten Kampar	v	v	v	--	--	v	v
III	Kabupaten Bengkalis	v	v	v	--	--	v	v
IV	Kota Pekanbaru	v	--	--	v	--	--	v
V	Kabupaten Siak	v	v	v	v	--	v	v

Remarks I : Industry; P : Plantation; A : Agriculture; D : Domestic

Source of pollution come from industrial activity (timber, glue, palm oil) and other activities such as plantation; agriculture and domestic. Disposal of liquid waste has decreased water quality of the Siak River. Identification of domestic waste is the detection of Fecal Coli form bacteria. River transportation contributes to pollution by oil spilling and thrash when ships or oil tankers are cleaned.

Location and Water Quality Monitoring Parameters

Water quality monitoring of the Siak River is carried out several times in a year by Bapedal Riau,as the regional environmental board. Monitoring is done at fourteen sampling points covering areas from upper to downstream Siak River including a number of kabupatens and cities except Kabupaten Bengkalis (Table 1).Measurements consist of thirty six parameters : (1) Physics – four parameters (Temperature,Dissolved Solid, Suspended Solid and Conductivity); (2) Anorganic Chemistry – twenty seven parameters (Ammonia, Mercury, Arsenic, Iron, Sulphur H_2S, Boron, BOD, COD, Do, Fluorine, Total Phosphate, Choride, Free Chlorine, Cadmium, Cobalt, Chromium, Manganese, Nitrate, Nitrite, pH, Cyanide, Sulphate, Selenium, Zinc, Copper, Lead and Nickel); (3) Microbiology (Fecal Coliform and total Coliform) and (4) Organic Chemistry (Grease and oil, detergent and Phenol)

Water Quality Status

The water quality status of the Siak River shall indicate polluted or suitable water quality when water quality measurement results are compared with the Siak River water allocation and quality criteria.

Siak River Water Allocation and Quality Criteria

The river water allocation and quality criteria is determined by Decree No 12/002 issued by the governor of Riau for two segments with each allocation as such :

- **Segment I : Allocation Class 2,** starting at upstream Tapung Kiri River (0° 45' 40" NL – 100° 41' 20" EL), including Tapung Kanan River (0° 38' 00" NL – 100° 41' 20" EL) at Bukit Suliki, Desa and Kecamatan Tandun, Kabupaten Rokan Hulu up to Jembatan Siak II (0° 33' 13" NL – 101° 24' 01" EL), including Kelurahan and Kecamatan Tampan Pekanbaru.
  Water allocation Class 2 : raw drinking water for treatment according to standard technology, water recreation facilities, fresh water fish cultivation, animal husbandry, irrigation, and or other allocation with water quality qualifications equaling its water use.
- **Segment II : Allocation Class 3**, starting at Jembatan Siak II (0° 33' 13" NL – 101° 24' 01" EL), including Kelurahan and Kecamatan Tampan, Kota Pekanbaru up to the Siak River estuary (1° 14' 12" NL – 102° 10' 00" EL) at Desa and Kecamatan Sungai Apit, Kabupaten Siak.
  Water Allocation Class 3:raw drinking water for treatment according to appropriate technology, fresh water fish cultivation, animal husbandry, irrigation and or other allocation with water quality qualifications equaling its water use.

Condition of Water Quality Status Siak River

Water Quality Status(WQS) of the Siak River is determined by the comparison of water quality measurement results (June 2006) with the Siak Water Criteria (Decree No. 12/2002) which showed some unsuitable parameters such as SS (Suspended Solid), BOD, COD, DO, Fecal and Total Coli form.

SS content in the Siak River basin ranges between 21 – 126 mg/L (Figure 1); except for location 1 and 6, almost all measurement location at segment I, unsuitable with class 2 standard indicating a range between 66 – 126 mg/L (Standard of SS, class 2 is 50 mg/L), whereas in segment II all sampling points did fulfill the standard for class 3 although SS qualification is much higher, namely 200 mg/L.

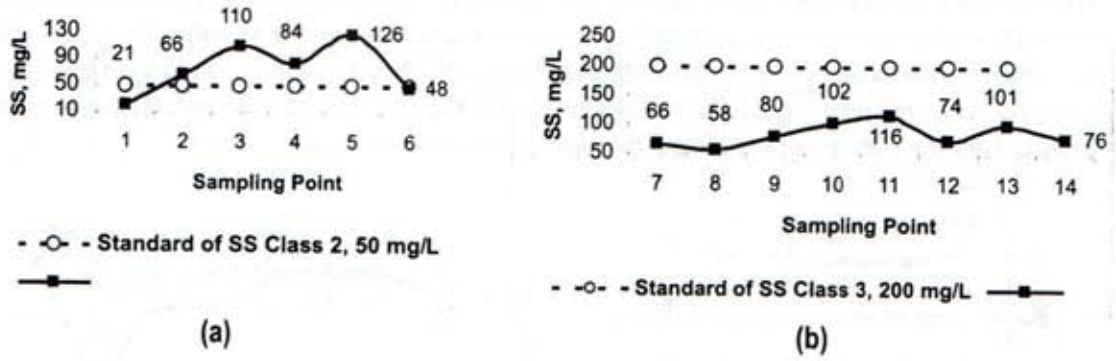

Figure 1. *SS at Siak River : (a). Segment I; (b).Segment II*

BOD content along the Siak River indicated a rate of 1.2 – 38.3 mg/L (Figure 2); nearly all locations at segment I, unsuitable with the class 2 standard showing a BOD content rate between 10 – 30.5 mg/L (Standard of BOD Class 2 is 3 mg/L) except for location 1. Similar conditions are encountered at segment II, where almost all conditions did not fulfill standard class 3 (Standard of BOD Class 3 is 6 mg/L) showing a BOD range between 20.3–38.3 mg/L. Only location 9 did meet the standard of class 3.

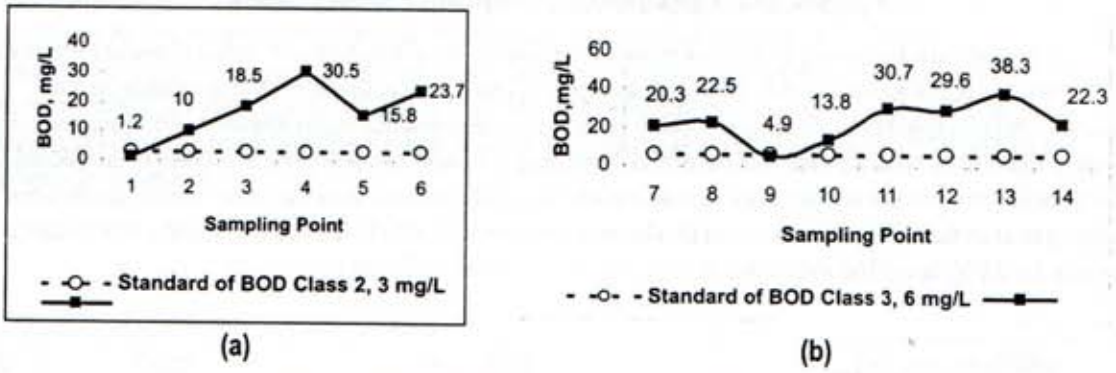

Figure 2. *BOD at Siak River : (a). Segment I; (b).Segment II*

COD content along the Siak showed a rate between 4.8-90.7 mg/L (Figure 3) where almost all sampling points at segment I did not comply to standard class 2 showing a COD rate of 47.7-85.9 mg/L (Standard of COD class 2 = 25 mg/L) except for point 1 and 2. Similarly are the conditions at segment II with almost all locations unsuitable with the class 3 standard, showing a rate of 57.2–90.7 mg/L (Standard of COD class 3 = 50 mg/L). Only point 9 and 10 are showing appropriate class 3 standard qualifications.

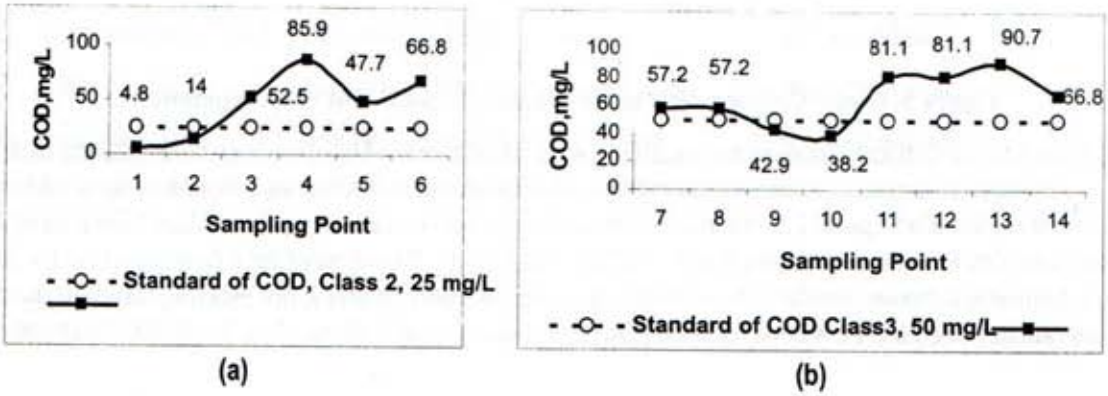

Figure 3. *COD at Siak River : (a). Segment I; (b).Segment II*

DO content along the Siak is showing a rate between 0.01 -6.51 mg/L (Figure 4). Conditions at segment I, related to DO content are relatively acceptable because rates **are meeting the standard** class 2 except for point 6 which showed a DO content of 2.6 mg/L (Standard of DO class 2 = 4 mg/L). At segment II, nearly all sampling points are not meeting standard class 3 showing a DO content of 0.01-2.9 mg/L (Standard of DO class 3 = 3 mg/L). Only sampling point 14 fulfilled the qualification of criteria class 3.

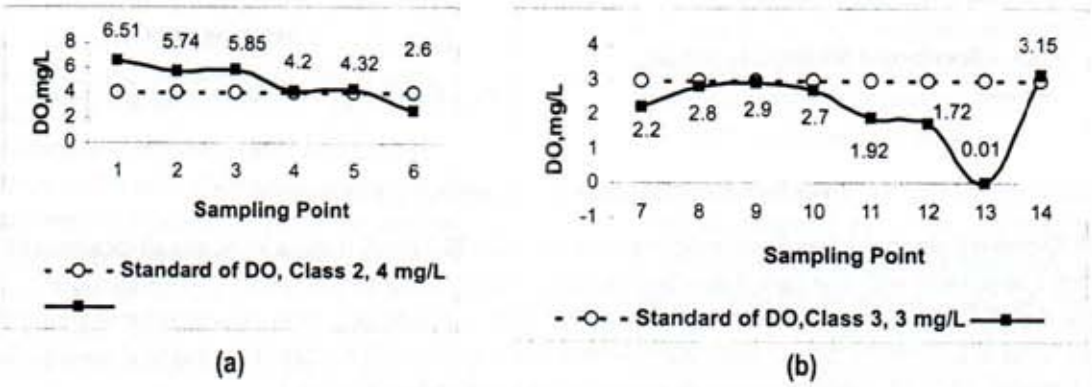

Figure 4. DO at Siak River : (a). Segment I; (b).Segment II

Micro-biological parameters of the Siak River showed, as generally detected in other rivers of Indonesia, a high content of Fecal and Total Coli form bacteria (Figure 5 and 6). Fecal Coli form bacteria detected in segment I, is relatively acceptable, only sampling point 3 showed conditions not relevant with standard class 2 because a 1,500 Total /100 mL rate was detected (Standard of Fecal Coli form class 2 = 1,000 Total/100 mL). Similar conditions were encountered at segment II where only location 7 showed irrelevant conditions not complying to standard class 3. Detected at this location is a rate of 2,400 Total/100mL (Standard of Fecal Coli form class 3 = 2,000 Total/100 mL)

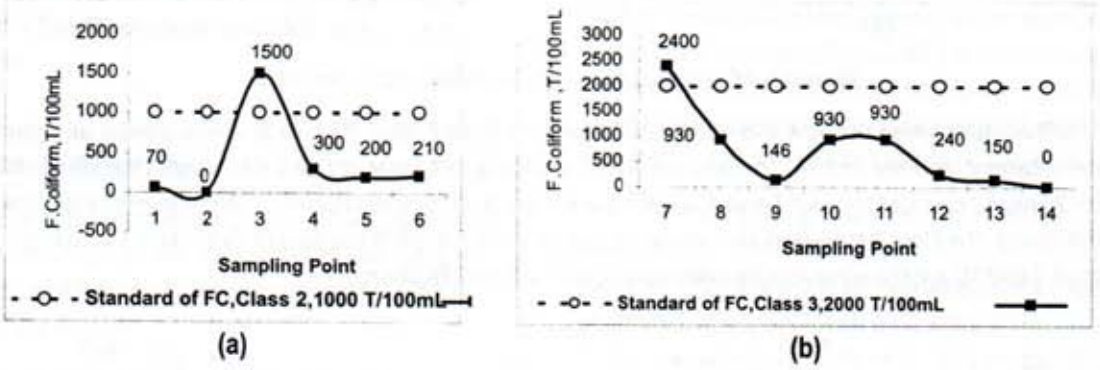

Figure 5. Faecal Coliform (FC) at Siak River : (a). Segment I; (b).Segment II

Referring to the Coli form Total bacteria content, water quality in the Siak River is classified as very bad because a number of sampling points are not meeting the standard criteria of class 2 as well as class 3. At segment I, three locations (point 2,3 and 6) showed conditions not relevant to standard class 2 because of detected Total Coli form rate indicating 9,300 – 12,200 Total/100 mL (Standard of Total Coliform class 2 = 5,000 Total/mL. Segment II showed similarly three sampling points (location 7,8 and 9) not meeting standard class 3. Detected rate has been 24,000-46,000 Total/100 mL (Standard of Total Coliform class 3 = 10,000 Total/100 m L.

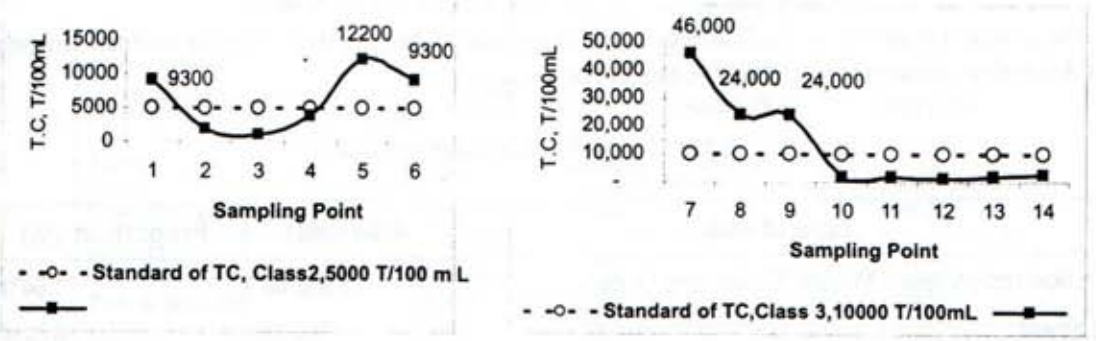

Figure 6. Total Coliform (TC) at Siak River : (a). Segment I; (b).Segment II

Pollution in the Siak river basin

The decrease of water quality in the Siak River has lead to same cases of river water pollution and fish dead as explained in Table 3 which illustrates the case of dead fish as a cause of industrial waste disposal and industrial waste water quality irrelevant to Industrial Liquid Waste Standard Criteria (ILWSC). Such was proven by a rubber industry in Kabupaten Kampar. Waste of this industry did not meet the set condition of ILWSC for parameters like Total Nitrogen and Total Ammonia. Fifteen palm oil industries were found operating without considering ILWSC for the parameters BOD and COD. Conditions can be described as 73% industries not fulfilling ILWSC for the parameter Total Nitrogen, 60% for parameter Total Suspended Solid and 13% for parameter Total Ammonia.

Table 3. Pollution cases in Siak river basin

No	Time	Case	Source of waste
1	February, 2002	Fish dead, at Sei Sibambam	Palm oil industry
2	May,27 2002	Fish dead, at Desa S. Gasip	Paper mill
3	November,10,2002	Pollution at Siak River	Paper mill
4	October,30, 2002	Pollution at Tapung River	Palm oil industry (Kampar)
5	December,8,2002	Fish dead, at Siak River (Perawang)	Paper mill
6	December,11,2002	Fish dead, at Tapung River	Palm oil industry
7	March , 2003	Pollution at Mempura River	Gas & oil industry
8	Februari 2004	Pollution at estuary of Siak River	Gas & oil industry
Sumber : Anonymous, Pengendalian Kerusakan DAS Siak, 2006			

Increase of erosion in Siak river basin_

The problem of erosion in the Siak river basin is very much related with the type of soil found in the area. The table below shows the type of soil and extent of area.

Table 4. Type of soil in Siak river basin

Type of soil	Area (Ha)	Proportion (%)
Yellow red complex Podzol, Litosol, and Latosol	21,992.09	1.94%
Latosol	201.74	0.02%
Organosol and Glei Humus	569,269.97	50.20%
Yellow red Podzol on sedimentary and igneous rock	299,077.10	26.37%
Yellow red Podzol on alluvium	12,924.93	1.14%
Yellow red Podzol on alluvium	229,310.48	20.22%
No data	1,311.16	0.12%
Total	**1,134,087.47**	**100 %**

Source : Peta tanah tinjau BPN,2006

Table 4 shows that soil type in Siak river basin is dominated by *Organosol and Glei Humus* (50.20%) and *yellow red Podzol* (47.73%). These types of soil are very vulnerable to erosion and cause an increase of sedimentation in river basin, although sand mining upstream the Siak River and abrasion of flood plains are contributing to the condition.

The latter also causes shallowing of the river part in the area surrounding Pekanbaru into downstream direction to Desa Pedada, Kabupaten Siak. In a span of eight years (1996-2004) river shallowing at Kuala Gasip reached 10 meters

Change of Land Use

A drastic land decrease occurred in the Siak river basin in last fifteen years. For illustration, in 1990 forest in the river basin covered an area of 636,202 ha (57.32 % of total); in 2005 remaining forest covered an area of only 172,648 ha (16.72% of total). A forest area of 463,554 ha was converted in the span of time indicating a land conversion rate of 2,575 ha per month. Change of land use is shown on Table 5.

Table 5. Change of land use in Siak river basin (1990-2005)

Type of land	Year		Decrease	Increase
	1990	2005		
Forest	636,202	172,648	463,554	--
Developed area	4,934	23,647	--	18,713
Water body	4,969	7,110	--	2,141
Palm oil plantation	73,243	263,148	--	189,905
Rubber plantation	65,083	67,014	--	1,931
Open farm land	46,203	93,568	--	47,365
Shrubbery	144,853	97,890	46,963	
Estate	97,492	152,651	--	55,159
Farm agricultural land	36,967	155,194	--	118,227
Total	**1,109,946**	**1,032,870**	**510,517**	**433,441**

Analysis on change of land against flood and erosion in downstream Siak

Change of land from forest into plantation or other land types has caused the increase of run off in upstream Siak and floods on the downstream. Floods and erosion in upstream area are race about by the following factors, are :

(1) Shape of river basin

Shape of downstream Siak sub-river basin is determined by the calculation of the ratio of circulation (Rc) and ratio of elongation (Re) values which have great influence on the concentration time of the flood peak. A longer shaped river basin will produce a longer concentration time. Following table shows the indexes of upper Siak river basin

Table 6. Shape and description of downstream Siak sub-river basin

Sub-river basin	Rc*)	Re**)	Deskription **)	
Tapung Kiri				
S.Talangkah	0.63	0.67	Rc approaching circle	(Rc approaching 1)
S.Tapung Kiri Hulu	0.53	0.49	Rc approaching oval shape	(Rc approaching 0,50)
S. Tapung Kiri Hilir	0.66	0.41	Rc approaching circle	(Rc approaching 1)
Tapung Kanan				
S.Tapung Kanan Hulu	0.53	0.56	Rc approaching oval shape	(Rc approaching 0,50)
S.Tapung Kanan Hilir	0.64	0.52	Rc approaching circle	(Rc approaching 1)
S.Kiras	0.47	1.34	Rc approaching long shape	(Rc<0.5)

Remark :*) Source Departemen Kehutanan, 2006; **). Pocessed from Data *)

Based on Table 6, length of run-off to river basin outlet is divided into three classifications : (1) **Short**, observed in three rivers (Telangkah,Downstream Tapung Kiri,and Downstream Tapung Kanan); (2) **Moderate,** observed in two rivers (Upper Tapung Kiri and Upper Tapung Kanan); (3) **Long,** observed in one river (Kiras). With such condition, run-off tends to intensify in Upper Siak river basin causing floods in downstream Siak river basin.

(2) Elevation and flow direction

In general, Upper Siak sub-river basin has a elevation of 25-525 m with an eastward flow direction. Details are shown in following table.

Table 7. Different of height and flow direction in Upper Sub River Basin

Sub River Basin	Min Height, (m)	Max Height, (m)	Different of Height (m)	Flow Direction
Tapung Kiri				
S.Talangkah	50	489	439	North
S.Tapung Kiri Hulu	25	125	100	East
S. Tapung Kiri Hilir	50	525	475	East
Tapung Kanan				
S.Tapung Kanan Hulu	25	150	125	East
S.Tapung Kanan Hilir	25	100	75	Southeast
S.Kiras	25	75	50	South
Source : Departemen Kehutanan, 2006				

Table 7 shows that the difference of height in each sub-river basin is relatively high compared to the flat surface at downstream Siak river basin.This difference, and an east and south flow direction tends to increase the run-off causing floods in downstream Siak river basin.

(3) Climate and rainfall in Siak river basin

Climate condition and intensive rainfall in the river basin increases the run-off entering the Siak River.This condition is supported by the *Koppen* classification that states that the Siak river basin is influenced by a wet tropical climate with a yearly evenly spread rainfall and a relatively short dry season. Whereas, according to *Schmidt Ferguson*, area in the vicinity of the river Tapung Kiri can be classified as the wet climate type. Areas at Tapung Kanan, the city Pekanbaru, and downstream Siak River are influenced by very wet weather. The yearly rainfall rate in the area is relatively high showing a range between 1,805 – 2,470 mm with an intensity of 13.9 – 19.2 mm/day.

Abrasion of flood plains caused by river transportation

Based on its geographical location, the Siak River is regarded as having strategic value as ship transportation course and inline with the Asean Free Trade Agreement (AFTA) forms an international economic route for regional cooperation between Singapore, Johar and Riau.

The Siak River is the trade navigation route for ships going to or coming from the harbours at Pekanbaru, Perawang and other regions with natural resources potential as palm oil; oil and gas; and a commodity export like a paper and pulp as to produce a foreign exchange of country and Riau provinsi.

Ships of various type and size are daily passing the river and causing wave swells which sometimes are reaching a height of 5 – 100 cm if ships are going at a speed of 25 knots at a 50 m distance range from river bank.The average abrasion rate is 3.3 cm/day as caused by all types of ship going at a speed of 25- 27 knots (M.Efendi Saputra et al. 2002)

CONCEPT FOR THE SIAK RIVER BASIN MANAGEMENT BASED ON ENVIRONMENTAL ISSUES

ENVIRONMENTAL ISSUES

ENVIRONMENTAL ISSUES
(1). Pollution of in dustrial activities, plantations, farming and the community ; (2). Erosion; (3). Forest conversion yielding floods in downstream Siak river basin; (4).Abrasion of flood plains due to river transportation and loss of cover vegetation.
SIAK RIVER BASIN MANAGEMENT CONCEPT
1 SPATIAL PLANNING Preparation of a general spatial plan for the Siak river basin. Implementation, monitoring and evaluation of spatial use at Siak River Basin Implementation of forest preservation. Control of illegal logging, forest fires and forest clearing. Reforestation and forest rehabilitation; and conservation of preserved area. Development of green open areas.
2 CONTROL OF ENVIRONMENTAL DAMAGE Rehabilitation of land in critical condition Dissemination of soil and water conservation methods Dissemination of balanced fertilizing methods and integrated pest control Construction and maintenance of land and water conservation structure
3 RIVER WATER POLLUTION CONTROL Development of community based domestic Waste Water Treatment Installation (WWTI) and rural sanitary facilities Training of community on environment management Development of an integrated solid waste treatment plant Improving performance of industrial WWTI;developing small and medium scaled integrated industrial WWTI Development and application of clean production methods for industries Control of liquid waste and sludge produced by mining activities Evaluating and perfecting on-going water quality monitoring methods Routine monitoring of liquid waste quality Development of an environmental information system Development of water quality and liquid waste facilities and accredited laboratory equipment Control and evaluation of Siak river basin water standard criteria and of programme
4 WATER RESOURCES UTILITY Construction of retaining walls Development of a water front city concept Implementing regulations on water transportation, speed limitation and navigation control signs to prevent river bank abrasion Structuring settlement on flood plain Structuring and controlling of mining and industrial activities or other public facilities. Structuring location used for fish cultivation Construction of canal/drain structures and flood control facilities; and Construction of river flow observation station facilities Control of infiltration and preservation areas
5 EMPOWERMENT OF COMMUNITY Training of government officials on preparing management programmes for Siak river basin Training of government officials on monitoring, evaluating and controlling the Siak river basin env ironment and improving knowledge of the functional staff Training of stake holders on a community based planning and participation management for Siak river basin Development of alternatives in the use of natural resources and community based productive economy for Siak river basin Development of local institutions and community based organizations on management and control of the Siak River Basin
6 LAW ENFORCEMENT Socialization of law and regulations related with environmental aspects Inventory of permits and reorganizing the issuing of liquid waste discharge permits/license Application of administrative sanction (building construction license) Application of administrative sanction (industrial and mining waste) Application of law and order sanction (criminal)

CONCLUSION AND SUGGESTION

Conclusion

1. The Siak river basin, a national and international water transportation course of frequent use, is of great use and potential for increase of the economy in Riau
2. The management concept is a phased implemented programme

Suggestion

1. A coordinated management is to be applied at local governments of regions/area crossed through the Siak River. Law should be enforced and rewards or sanctions be given to industries **meeting or not meeting the set standard criteria**
2. Application of a "polluters pay principle" forcing industries to pay contribution fee for the disposal of industrial waste water in water sources

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