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JOGJA, SEPTEMBER 6TH - 8TH, 2013

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YOGYAKARTA - INDONESIA, SEPTEMBER 6TH - 8TH, 2013

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PREFACE

The International Seminar with special focus on "Water Related Disaster Solutions" was implemented successfully from 6th to 8th September 2013 in Yogyakarta attended by experts and professionals from many countries including Indonesian as the host.

The discussions of the Seminar had covered the entire aspects of the water related disaster solutions including its risk management, the innovation in disaster mitigation and adaptation, as well capacity building and community participation aspects, involving highly notified professionals with numerous technical models, state of the arts as well as scientific and empirical deliberations.

The overall presentations, discussions and debates during the Seminar concluded that the outputs will undoubtedly contribute to remarkable concepts, strategies, lessons learned, and sharing of experiences on the water related disaster solutions, particularly on the environmentally sound technologies and sustainable practices on the years to come. Based on this fact, I believe that the proceeding of this Seminar will be valuable document for the implementation of the adaptation and mitigation to the climate change.

I would like to thank the organizing committee, peers and writers, seniors and all members of HATHI for enormous supports to the Seminar. May God bless you all.

Sc., PU-SDA

September, 2013

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THE EFFECTIVENESS OF COASTLINE PROTECTION STRUCTURE AT ESTUARY OF BATANG KAMBANG, WEST SUMATRA

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Abstract

To observe changes of shoreline and the effectiveness of structural coastline protection require the comparison and responses of the coast itself. To identify and to predict the dynamics of the coastline had been analysed by SMS (*Shoreline Modelling System*) and has been developed by CERC (*Coastal Engineering Research Center*), US Army Engineers Waterways Experiment Station. Existing condition simulated to analyse of 10 years record of wave data for the original shoreline and structural to see the effectiveness of protection each year. The original condition of the model had shown the changes of shoreline at estuary affected by the wave and structural designed by groyne and revetment indicated siginificantly protect of shore erosion. Wave transformation model result for wave direction come from southwest and the wave after transformation at groyne is around 2.5 – 3.0 m height and 5.04 m at sea. Shoreline at northern part of estuary Batang Kambang River has been eroded and affected by the groyne construction at southern part. If there are no paralel construction for groyne between the old and the new estuary of Batang Kambang River it will give dramatically impact of erosion. The effectiveness of groyne construction give a new treatment for the shoreline and need special maintenance for sand nourishment if the segment of the shore is not comprehensively constructed.

Keywords: shoreline modelling system, erosion, groyne, revetment

INTRODUCTION

General Background

The changes of shoreline at study area occurred as it relates to flood and the high-tide at the same periode and the new estuary opened at Batang Kambang-Lengayang, Pesisir Selatan District, West Sumatra Province. Structural construction scenario such as revetment and groyne designed for shoreline erosion protection, in this case previously there are no structural protection. The effectiveness structural for shoreline need to be reviewed and it will have an effect on the sedimentation pattern

at the area. Analysis method for the shoreline alteration is SMS (*Shoreline Modelling System*) and has been developed by CERC (*Coastal Engineering Research Center*), US Army Engineers Waterways Experiment Station. Existing condition simulated to analyse of 10 years record of wave data for the original shoreline and structural to see the effectiveness of protection each year.

Literature Study

Final Report Study of Critical of Coastal Area in Pesisir Selatan Sumatera Barat, Balai *Wilayah* Sungai Sumatera V, 2010, support this paper for identification and analysis. Some equation for wave mild-slope 2D has been good accepted as one of the method for gravitational wave at shore (Chang HH, 1987; Berkhoff, 1976; Tsay and Liu, 1983). Formula which is used:

..... (1)

where :

$\hat{\eta}(x,y)$ = surface elevation as complex function

σ = wave frequency

$C(x,y)$ = phase velocity = σ / k

$C_g(x,y)$ = group velocity = $\partial\sigma / \partial k = nC$, with

$$n = \frac{1}{2}\left(1 + \frac{2kd}{\sinh 2kd}\right) \quad \text{..... (2)}$$

$k\,(x, y)$ = wave number (=2π/*L*), depend on the depth $d\,(x, y)$ with corelation of disperse linier :

$$\sigma^2 = gk \tanh(kd) \quad \text{..... (3)}$$

Equation (1) as refraction simulation, diffraction and wave reflection refleksi at the model area. Equation of mild-slope modify as follow for friction effect enclose, dissipation and breakwave:

$$\nabla.\left(CC_g \nabla\hat{\eta}\right) + \left(\frac{C_g}{C}\sigma^2 + i\sigma w + iC_g\sigma\gamma\right)\hat{\eta} = 0 \quad \text{..... (4)}$$

where w is friction factor and g are breakwaver parameter. Friction factor which is used by CGWAVE :

$$w = \left(\frac{2n\sigma}{k} \right) \left[\frac{2 f_r}{3\pi} \frac{ak^2}{\left(2kd + \sinh 2kd\right) \sinh kd} \right] \quad \text{.....(5)}$$

Where a = (H/2) as wave amplitude dan f_r is friction coefficient based on Reynolds and basic roughness by Madsen (1976) dan Dalrymple et.al. (1984). The value of f_r is the same with the range for Manning coefficient dissipation. The function of f_r as (x,y) so that can be formulated as the loss of wave energy. For breakwave parameter γ, used :

$$\gamma = \frac{\chi}{d} \left(1 - \frac{\Gamma^2 d^2}{4a^2} \right) \quad \text{.....(6)}$$

where χ is constant and G empiric constant.

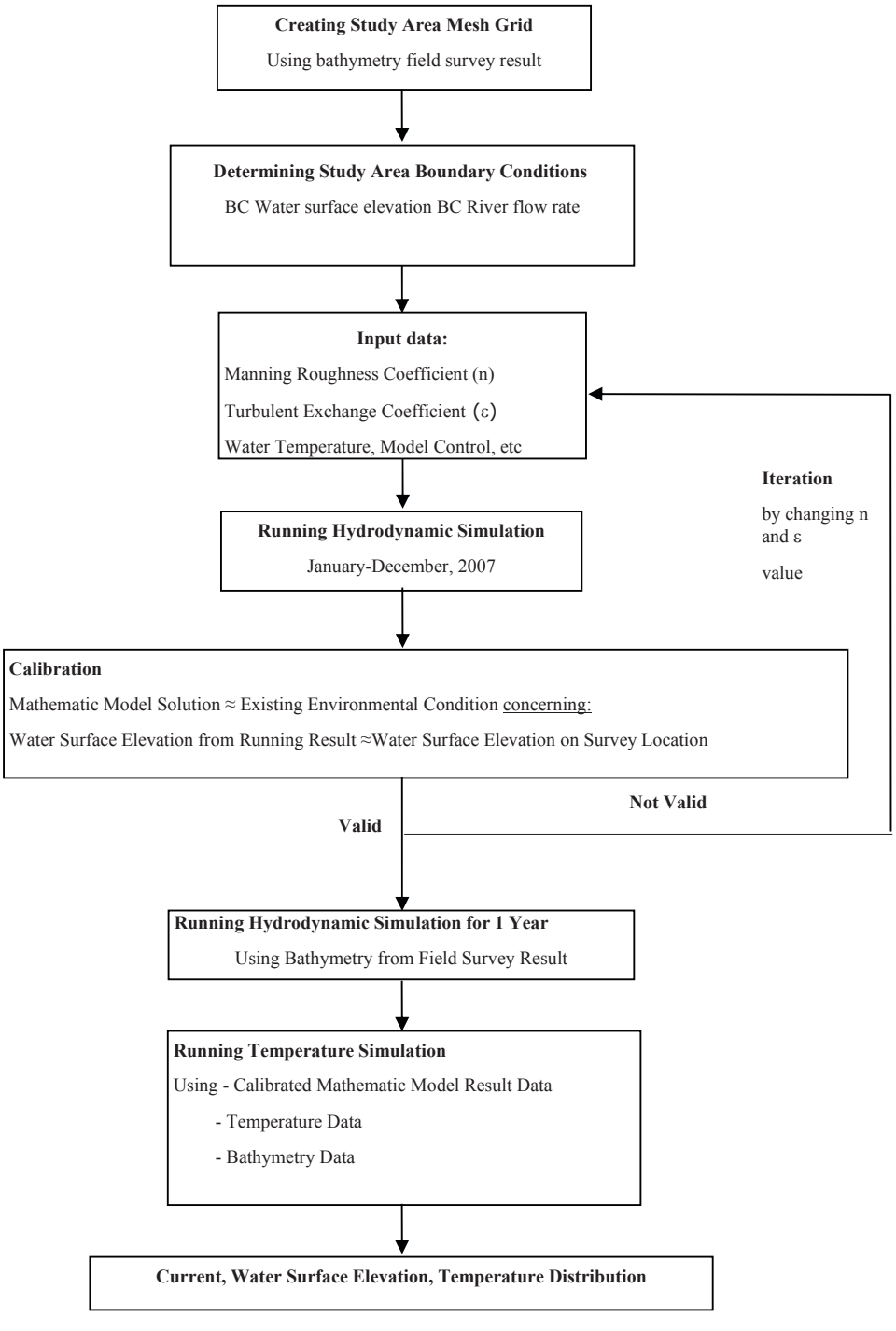
Corelation of nonlinear disperse used equation (2) :

$$\sigma^2 = gk \left[1 + \left(ka\right)^2 F_1 \tanh^5 kd \right] \tanh \left\{ kd + kaF_2 \right\} \quad \text{.....(7)}$$

Where:

$$\left.\begin{aligned} F_1 &= \frac{\cosh\left(4kd\right) - 2\tanh^2\left(kd\right)}{8\sinh^4\left(kd\right)} \\ F_2 &= \left(\frac{kd}{\sinh\left(kd\right)} \right)^4 \end{aligned}\right\} \quad \text{.....(8)}$$

Methodology of Study



First step was hydrodynamics simulation estimated by SMS to make some grid on bahtymetric map and designed by CAD software. Beside that, GFGEN (*Geometri File Generation*) is a program in SMS to make geometry and mesh file as the data input to SMS model in ASCII file format.

Second step, shoreline analysis compared the two different images (topographical map and satellite image), even the scale of the map is only 1:50,000, but the shoreline and the estruary can be analysed significantly, where the sand of the shore eroded.

RESULTS AND DISCUSSION

Result of Wave Analysis

Transformation wave model from south west at study area is shown in Figure 1 and vector direction creeping and vector of the wave are shown in Figure 2 and 3. Based on the model for wave after transformation estimated around 2.5 - 3.0 meters for the height of structural coastline protection and the model for wave height at sea was around 5.04 m.

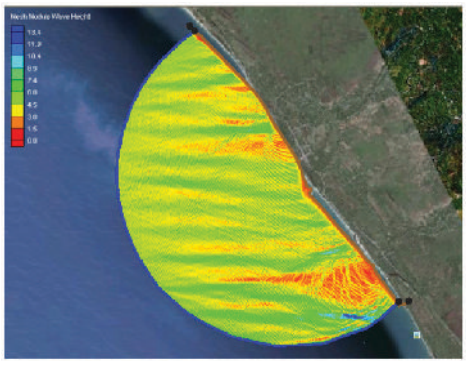


Figure 1. Mesh Module Wave Height

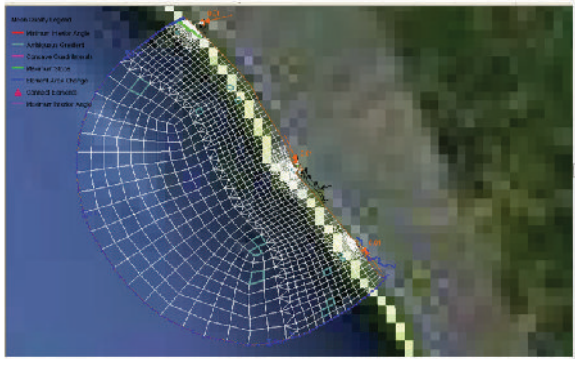


Figure 2. Mesh Area Model Location

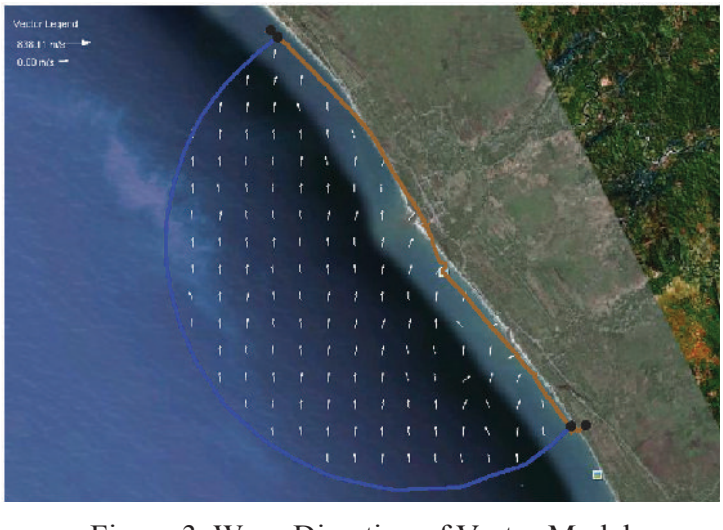


Figure 3. Wave Direction of Vector Model

Result of Shoreline Analysis

The original condition of the model had shown the changes of shoreline at estuary affected by the wave (Figure 5. Structural designed by groyne indicated siginificantly eroded.

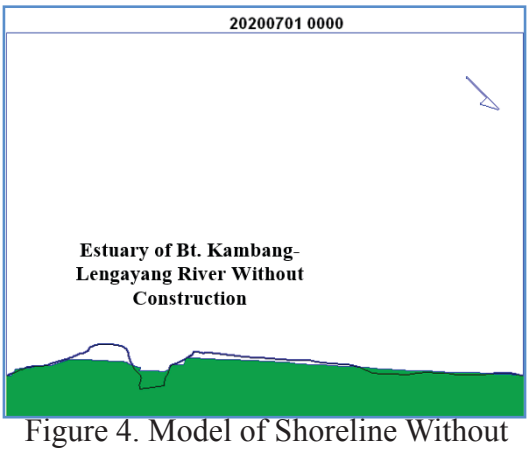


Figure 4. Model of Shoreline Without Protection

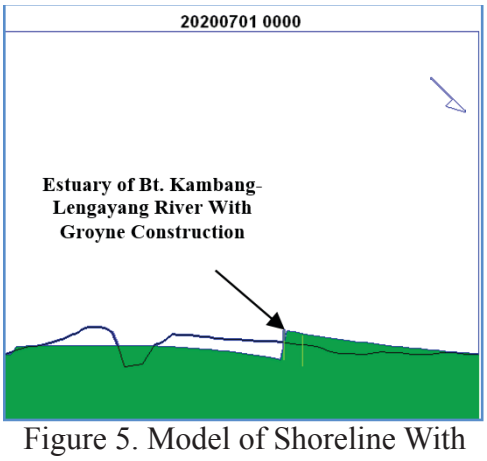


Figure 5. Model of Shoreline With Protection

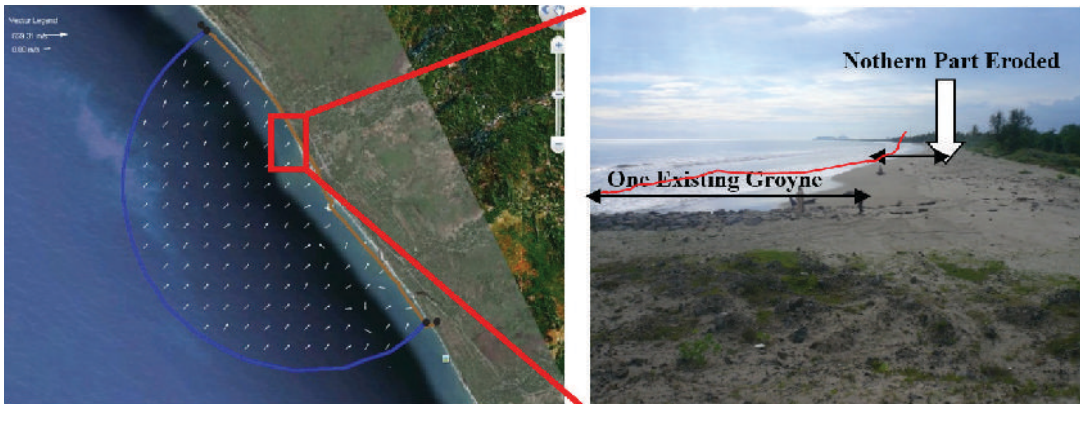


Figure 6. Location of estuary of Kambang and the shoreline before paralel structural protection at nothern part

Comparison Layout Map Situation Before and After Structural Protection at The Estuary of Kambang River

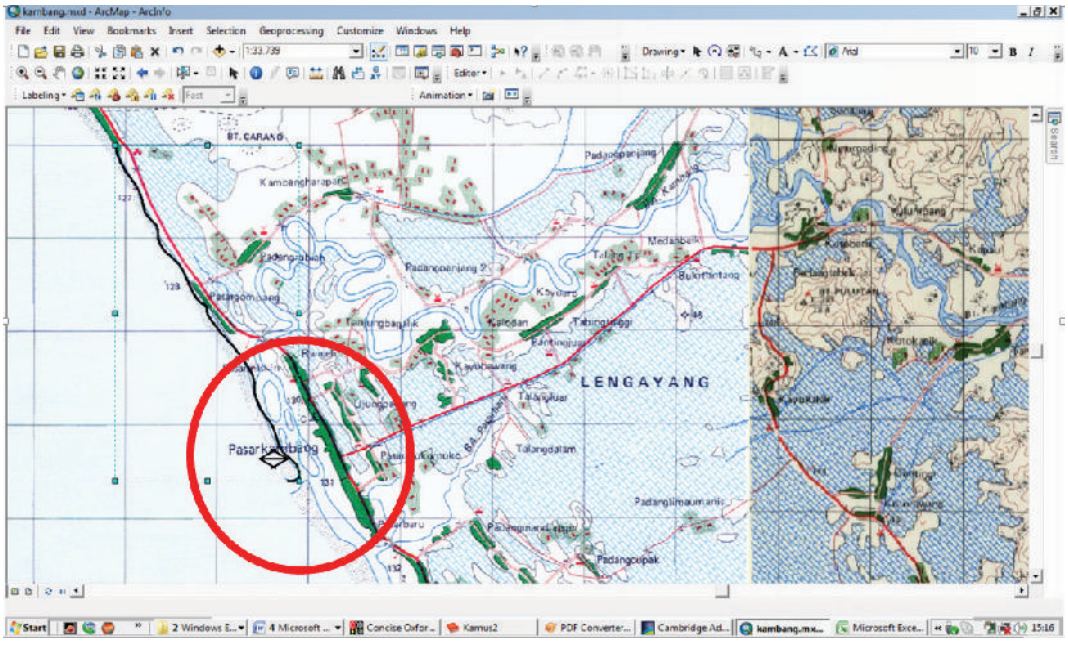


Figure 7. Topographical Map 1990, Analysis for Shoreline Identification at Kambang Before Construction

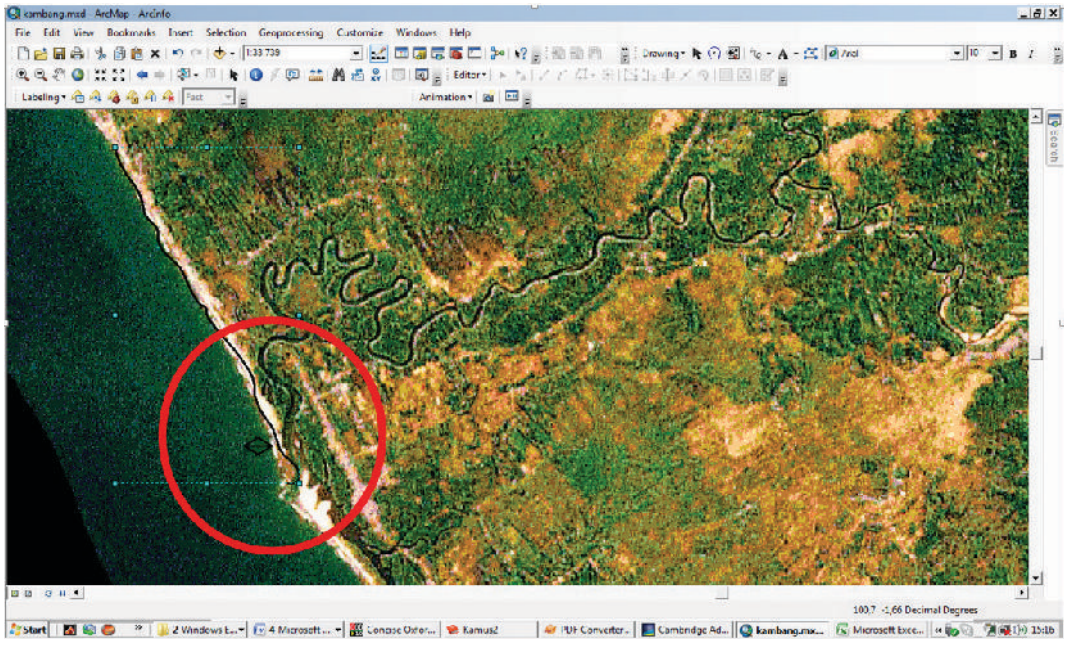


Figure 8. Satellite Image 2002, Analysis for Shoreline Indentification at Kambang Before Construction

Comparison at two different images between topographical map 1990 and satellite 2002 show that coastline at Kambang sedimentation is very dynamics, where the forward and backward movement of sedimentation analysed around 140 m to the main land.

Comparison Shoreline after Structural Construction (Groyne and Revetment) between Model and Real Condition on Field

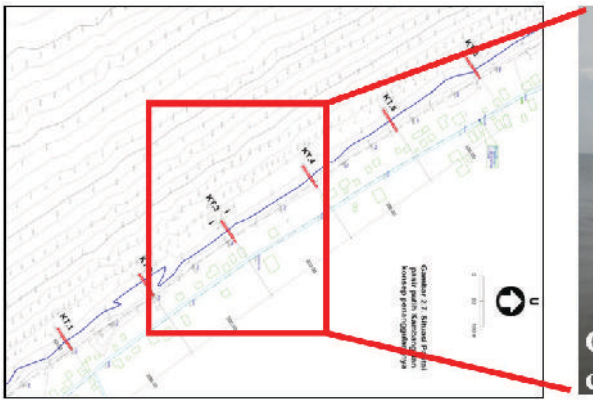


Figure 9. Model Layout Real Condition

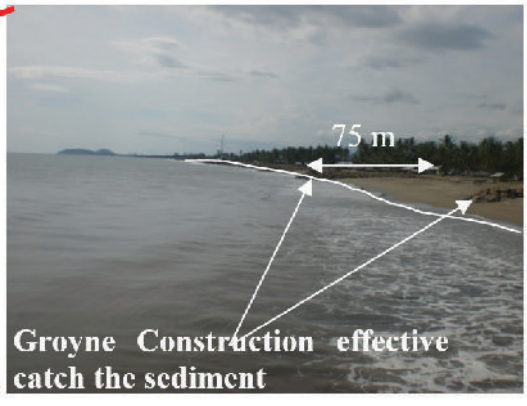


Figure 10. Groyne Construction, 30 April 2013

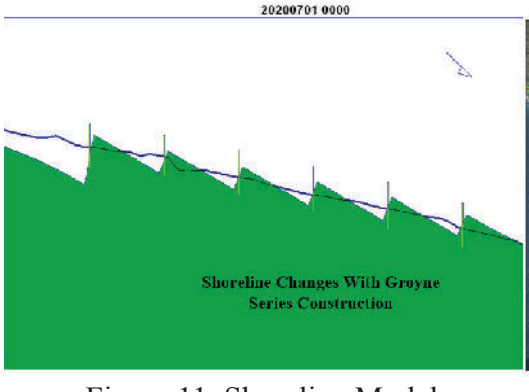


Figure 11. Shoreline Model

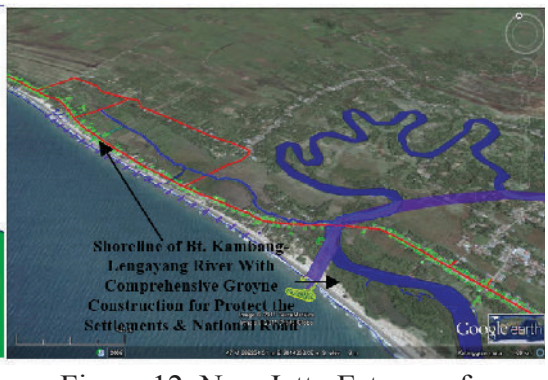


Figure 12. New Jetty Estuary of Kambang

One year after shoreline protection combination with groyne and revetment have adequate effective, but it is not the same with the model. Incremental of shoreline significantly move forward around 75 m to the sea (Figure 10).

CONCLUSION AND RECOMMENDATION

Shoreline at northern part of estuary Batang Kambang River was eroded and affected by one groyne construction at southern part. If there are no paralel construction for groyne between the old and the new estuary of Batang Kambang River it will give dramatically impact of erosion. The effectiveness of groyne construction give a new treatment for the shoreline and need special maintenance for sand nourishment. In addition, other location of shoreline at northern part eroded significantly so that it need the comprehensive structural construction alongside around 14 km. Groyne construction interupt the changes of natural shoreline but give the effective protection

for settlements and national road. The writer is still observing the dynamics of the movement of the coast for the next 10 years to see the changes and the impact both at the estuary and the coast.

One year after shoreline protection combination with groyne and revetment have adequate effective, but it is not the same with the model. Incremental of shoreline significantly move forward around 75 m to the sea.

ACKNOWLEDGEMENTS

This paper based on final report study of critical coastal in Pesisir Selatan District of West Sumatra, 2010 funded by APBN through Balai Wilayah Sungai Sumatera V, before the physical construction were build in February - August 2012. In this case the writer would like to know and compare the analysis of model of the wave, the shoreline and the structural approach to the real condition after the groyne and revetment constructed. This paper would like to find out the effectiveness of structural coastline protection to catch sediment and give more line of the coast forward to the sea for the next time eventhough in decade or century.

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