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Canal Blocking Design as an Effort to Restore Peatlands in East Barito Regency

Agus F Rottie
Student of Master's Degree in Civil Engineering, Swamp Resources Management Department, Faculty of Engineering, Universitas Lambung Mangkurat, Banjarmasin, South Kalimantan, Indonesia
Corresponding Author: Dr. Rony Riduan, ST, MT
Lecturer of Swamp Resources Management Department, Faculty of Engineering, Universitas Lambung Mangkurat, Banjarmasin, South Kalimantan, Indonesia,

ABSTRACT: *One of the ecosystems with important environmental values and services is peat ecosystem as a hydrological controller and regulator, as a sink an as a carbon sequester, as an important source of germplasm and biodiversity as well as other social and economic benefits. Deforestation and peatland degradation lead to disturbed hydrological system, reduced forest cover, peat subsidence, increased fire vulnerability, increased greenhouse gas, loss of biodiversity and other social economic outcomes.*

The present study aimed to identify the existing condition of peatland areas and ground water level around Lubuk Garau River/Canal, map the condition of Lubuk Garau River/Canal and canal blocking construction location plan, and recommend canal blocking design for Lubuk Garau River/Canal to later perform hydraulic modeling to determine the impact of the canal blocking on increased water level elevation.

The research result shows that based on hydraulic modeling, in rainy season the water of Lubuk Garau River flows directly to the estuary so it's not blocked and it can't optimally wet lands around it. Constructing canal blocking in Lubuk Garau Canal/River, East Barito Regency can increase the average Water Level (TMA) by 0.55 m, thus accelerating the rewetting process with larger scope.

Keywords: *Restoration, Canal Blocking, Water Level*

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I. INTRODUCTION

One of the ecosystems with important environmental values and services is peat ecosystem as a hydrological controller and regulator, as a sink an as a carbon sequester, as an important source of germplasm and biodiversity as well as other social and economic benefits.

Peatland is uniquely made of and formed by interaction and unity of substrate (organic soil), water (hydrology) and vegetation wholly and solidly. It's vulnerable against external disturbance, including potentials of deforestation and degradation as regulates of unwise and unsustainable cultivation, management and utilization.

Deforestation and peatland degradation lead to disturbed hydrological system, reduced forest cover, peat subsidence, increased fire vulnerability, increased greenhouse gas, loss of biodiversity and other social economic outcomes.

According to the data and report of Peat Restoration Agency (BRG), in 2015 peatland fires, including in East Barito Regency, have caused thick smog for several months, leading to economic, social, health impacts, and even at certain levels disturbing cooperation with neighboring countries.

One of the ways to solve peatland ecosystem degradation and its effects is performing systematic restoration. BRG is assigned the main task of implementing coordination and facilitation of peatland restoration by performing 3 (three) main approaches, i.e.: Peat Rewetting, Revegetation, and Revitalization of Local Livelihoods.

Peat Rewetting is performed by constructing peat rewetting infrastructure, i.e. canal blocking, performing canal backfilling and constructing deep wells.

Based on the record of peatland fires in East Barito Regency from Peat Restoration Agency (BRG), around Taniran Village, Benua Lima Sub-district, 1.697 Ha areas is a part of Peat Hydrological Unity (KHG) of Utar River – Serapat River.

Based on the data and information, it's found that the direct effect to the community and industry around it was inhibited social and economic activities. In fact, for several months, all human activities were stopped because the smog reached a dangerous level.

Most people in the community left the village while some stayed at home without being able to perform social and economic activities outdoor, so that for a time, Taniran Village and the surrounding area in Benua Lima Sub-district had little activities.

Beside disturbing human activities, smog in 2015 reached neighboring countries, impacting the relations between Indonesia and the neighboring countries, leading to protests from the neighboring countries to the Indonesian Government.

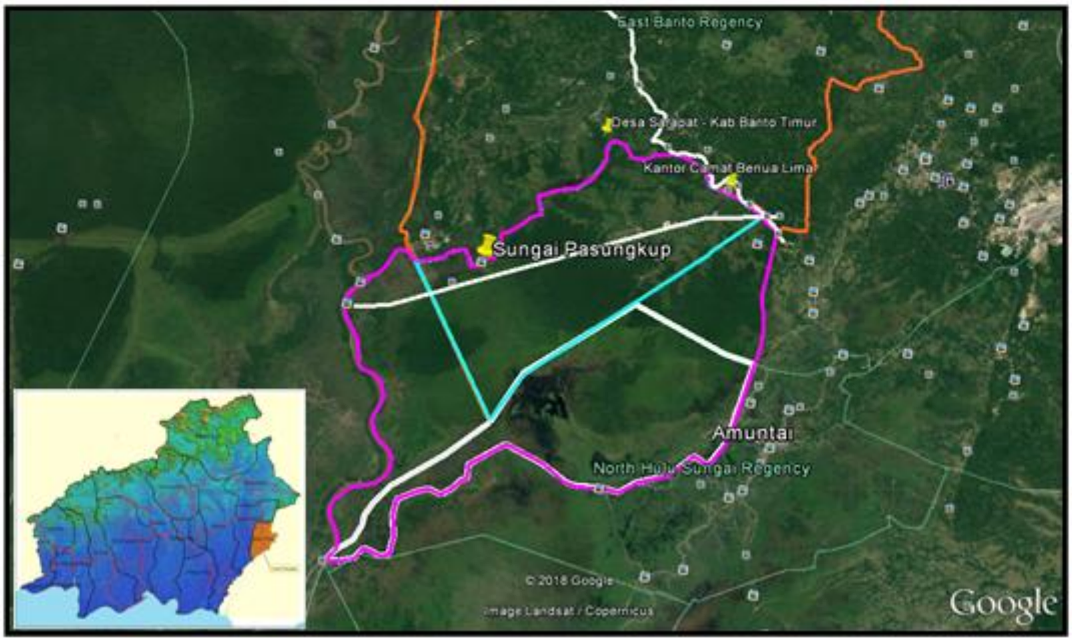


Figure 1. Visualization of Google Satellite Image – Peatland of Taniran Urban Village

Research Method

The present study was divided into several research stages, i.e.:

1. Performing literature study and Desk Study related to the research title;
2. Performing data and information collection from Taniran Village, Benua Lima Sub-district - East Barito Regency;
3. Collecting rainfall record data from rain recording posts around Lubuk Garau River/Canal Watershed (DAS) of Taniran Urban Village with minimum observation period of 10 (ten) years from related agency;
4. Diversifying forest into stream to get the design rainfall data for analysis and modeling consistent with the standard and criteria;
5. Analyzing the design flood discharge (Q2 years, Q5 years, Q10 years, Q20 years, Q25 years, Q50 years) using Nakayasu method;
6. Analyzing river hydraulic modeling using HEC-RAS program with existing river/canal condition without canal blocking and estimating water level and puddle elevation around the River/Canal;
7. Analyzing hydraulic modeling of the river using HEC-RAS program with river/canal condition with several canal blockings and estimating water level and puddle elevation around the River/Canal;
8. Preparing research conclusion based on hydraulic modeling result related to canal blockings which affect water level elevation and river/canal capacity which is predicted to increase peat rewetting and eventually reduce the risk off peatland fire.

Secondary Data Collection

Secondary data collection in the present study covered the following data:

1. The condition of peatland which was caught fire in 2015 around Taniran Urban Village, Benua Lima Sub-district - East Barito Regency

2. Rainfall record data collection from rain posts around Lubuk Garau River in Taniran Urban Village - Benua Lima Sub-district with minimum observation period of 10 (ten) years through related agency;
3. Google Earth satellite image visualization data of peatland condition in Taniran Urban Village, Benua Lima Sub-district - East Barito Regency, by:
a. Entering Google Earth satellite image application;
b. Displaying in Lubuk Garau River location coordinate layer;
c. Displaying in Lubuk Garau River Watershed boundary layer;
d. After finding the boundary of Lubuk Garau River, showing "Show historical imagery" menu;
e. Setting "Show historical imagery" menu for visualization peatland area condition around Lubuk Garau River before 2015 (before peatland fire)
f. Setting "Show historical imagery" menu for visualization peatland area condition around Lubuk Garau River soon after the 2015 fire;
g. Saving canal blocking construction image as a picture file (jpg.)

II. RESULT AND DISCUSSION

1. Hydrological Data Collection

Hydrological data collection was performed by coordinating with the Hydrological section of the Department of Public Works and Spatial Planning (Department of PUPR) of Central Kalimantan Province, Program Planning Commitment Maker Official of Central Kalimantan Province of Kalimantan River Area Center II, Department of Public Works and Spatial Planning of East Barito Regency.

Table 1. Rainfall Data in the Research Location (Source: Department of PU of Central Kalimantan Province, 2017)

No	Data Type	Source	Data Period
1	Rain Data	Tampa Rain Post	2006 - 2017

2. Design Flood Analysis

Sub-DAS / DAS : Lubuk Garau
Area of DAS : 40.09 km^2
River length (L) : 13.89 km
a. Concentration time
Tg (for river length (L) < 15 km)
Tg = 0.21 * (L0.7) = 0.00 hour
Tg (for river length (L) > 15 km)
Tg = 0.4 + 0.058L = 1.21 hour
b. Time unit of rainfall
Tr = (0.5 - 1) * Tg
Derives
Tr = 0.75 * Tg = 0.90 hour
c. Time of start of flood to peak flood hydrography
Tp = Tg + 0.8*Tr = 1.93 hour
Time from peak flood hydrography to 0.3 peak flood discharge
T0.3 = α.tg
T0.3 = 2*tg (for normal DAS)
T0.3 = 2.41 hour
T0.9 = 1.5* T0,3
T0.9 = 3.62 hour
d. Peak flood discharge

$$Q_p = \frac{A * R_o}{3.6(0.3T_p + T_{0.3})}$$

Qp = 3.72 m3/second
Upslope section
Interval = 0 ≤ t ≤ Tp
0 ≤ t ≤ 1.93
QA = Qp (t/Tp)2,4
Downslope section
Interval = Tp ≤ t ≤ (Tp + T0.3)
Qd1 = Qp x (0,3)(t-Tp)/(T0,3)

Qd2 = Qp x 0,3(t-Tp+(0,5.T0,3))/(1,5T0,3)
Qd3 = Qp x 0,3(t-Tp+1,5T0,3)/(2T0,[3])

Table 2. Lubuk Garau River Flood Design – Nakayasu (Source: Analysis Result, 2018)

Nakayasu	Q2th	Q5th	Q10th	Q20th	Q25th	Q50th	Q100th
Q	64.47	85.11	107.19	112.73	132.85	136.04	137.77

From table 2 above, a graph of the design flood discharge was made according to Lubuk Garau Watershed reproduction using HSS Nakayasu method as shown below.

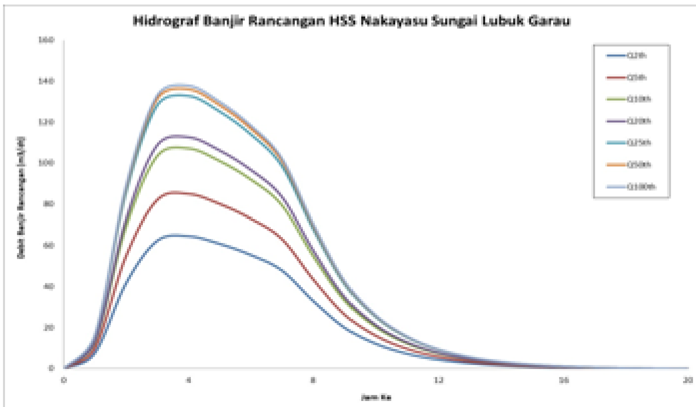


Figure 2. DAS Lubuk Garau Design Flood

Hidrograf banjir…: Hydrograph of Design Flood by HSS Nakayasu of Lubuk Garau River Debit banjir rancangan: Design flood discharge

3. River Modeling Analysis

HEC-RAS software was one of the programs used for one-dimensional hydraulic modeling and calculation. Hydraulic analysis which can be performed using HEC-RAS is water surface profile calculation at steady flow. HEC-RAS is designed to be used in calculating natural channel network and artificial channel. An important factor in HEC-RAS modeling is using representation of geometric data and geometric calculation, as well as repeated hydraulic calculation.

In using HEC-RAS, there is calculation procedure which is commonly used based on the solution of a one dimensional energy conservation equation. Energy loss can be evaluated using friction (Manning equation) and contraction as well as expansion. Momentum equation is used in situations where water surface profile changes quickly. The situation includes mixed flow area calculation, calculation on a hydraulic structure and evaluation of a profile on connected river or river with branches.

The stages of HECRAS modeling analysis for Lubuk Garau River are:
1. Making new project
2. Imitating the geometry of Lubuk Garau River
3. Inputting cross section data of Lubuk Garau River
4. Imitating the hydraulic of Lubuk Garau River
5. Calculating the hydraulic of Lubuk Garau River flow
6. Displaying Elongated cross section of Lubuk Garau River
7. Displaying cross section of Lubuk Garau River

4. Canal Blocking Design

1. Types of Canal Blocking Design Based on Construction Age

a. Short-Term (Temporary)

Sometimes blocking construction is constructed for short term and temporary duration to maintain water level in surrounding canals. Usually, short-term blocking is constructed to anticipate long dry season and/or constructed during sudden forest and peatland fire. Other considerations for building temporary blocking are limited budget, land ownership issue, and difficult accessibility for mobilization of materials and equipment in short time (Ng Kok Seng, 2011). Examples of blocking constructed at short time are compacted peat blocking, single layer wooden blocking, earth sack blocking, etc.

b. Medium Term (Semi-Permanent)

Semi-permanent blocking is designed for construction age of 2-5 years. Blocking construction material for medium term could be strong and long lasting wood (categories 1-2) which is waterproof with high acidity, such as red balau (Shorea belangiran), cajuput (Melaleuca kajuputi), pelawan (Tristaniopsis sp), resak (Vatica wallichii), rengas (Gluta renghas), bangkirai (Shorea laevis), etc. Blocking structure made of hardwood combined with mineral earth sacks or mature peat (saprik) could last 2-5 years. Meanwhile, rock material is arranged loosely and stacked and bound/wrapped with bronjong/wires (gabions) consistent with necessary blocking height and size. The rock structure is usually covered with waterproof layer (geotextile) to reduce seepage through blocking (Ng Kok Seng, 2011). Example of semi-permanent blocking is two layers wooden blocking, bronjong blocking, etc..

c. Long Term (Permanent)

Durable materials such as reinforced concrete, cast-in-situ or pre-cast, are used for permanent blocking structure. As a structure, concrete is relatively more durable than other materials, considering the structure could easily last longer than 5 years without repair (Ng Kok Seng, 2011). Examples of long-term blocking are concrete, pre-cast, three layers of more wooden blocking, etc..

2. Canal Blocking Building in Lubuk Garau River

Based on the criteria above, the canal blocking design in Lubuk Garau River was decided to be canal blocking with reinforced concrete structure.

Concrete blocking type was used for large/wide canal (>15 meters) in the location with thin-medium peat depth and mineral underground layer of peat (alluvial), where the carrying capacity of the land is relatively strong enough to bear the weight of the concrete structure. Concrete blocking/concrete dam aims to hold relatively big water flow and discharge and maintain water level maximally.

Concrete blocking could be equipped with water level regulator in the forms of boiler or without boiler. Concrete blocking was suggested to be constructed in canals close to each other which end in river or beach. Concrete blocking has relatively long age and strong construction durability compared with wooden or compacted peat blocking. However, concrete blocking construction is relatively expensive and the construction is more complicated and takes longer.

Lubuk Garau River in the rainy season often has runoffs on either side of the canal. Meanwhile, in the dry season, the water flow in the canal is relatively small. In the middle section to the estuary, the water flow is very small to dry. This causes the land condition around the canal to be dry and flammable.

Considering the condition, rewetting infrastructure planning in Canal Km 40.5 of Lubuk Garau River was expected to help maintaining canal water level elevation, especially in the season, with canal blockings which serve to hold water at certain height to maintain water level elevation in surrounding lands, thus rewetting lands around it and reducing the risk of forest fire.

Skema jaringan sekat kanal: scheme of canal blocking network Jembatan (eksisting): bridge (exiting) Ke…: To… Eksisting: existing Bendung irigasi: irrigation dam Bangunan sekat kanal: canal blocking building Gorong-gorong jalan: street sewer

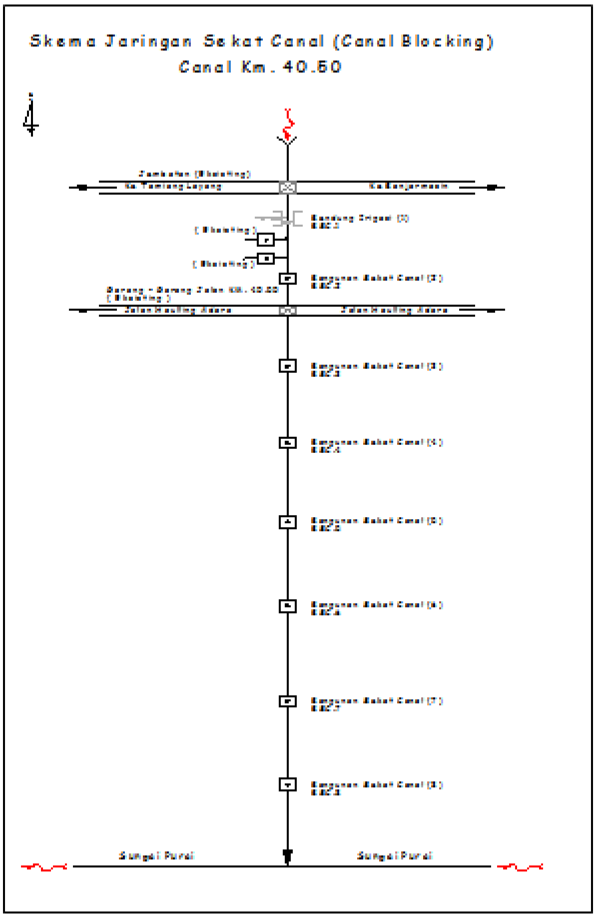
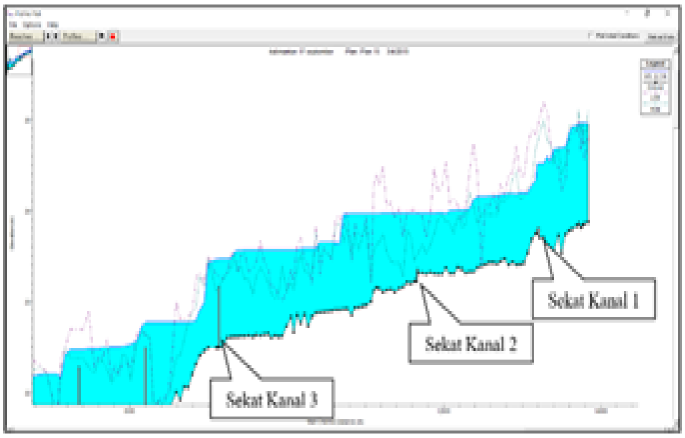


Figure 3. Scheme of Canal Blocking Building of Lubuk Garau River

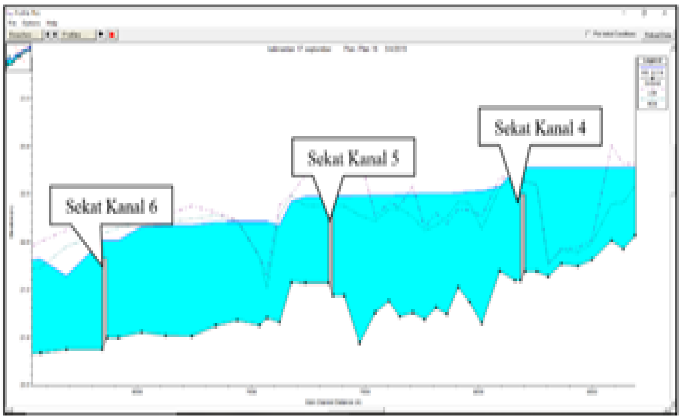
5. Result of Simulation of Canal Blocking Building Placement

One of the purposes of constructing canal blocking in Lubuk Garau River is water level in Lubuk Garau River was expected to be held longer to maintain wetness level of the surrounding peatlands to reduce peatland fire potential.



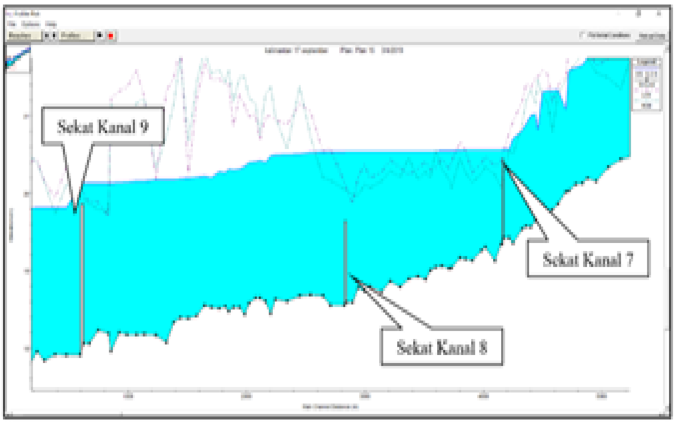
Sekat kanal: canal blocking

Figure 4. Simulation Result of Canal Blocking Buildings 1, 2 an 3



Sekat kanal: canal blocking

Figure 5. Simulation Result of Canal Blocking Buildings 4, 5 and 6



Sekat kanal: canal blocking

Figure 6. Simulation Result of Canal Blocking Buildings 7, 8 and 9

Based on the simulation results of canal blocking building placements above, it was found that with canal blockings, water level in Lubuk Garau River rose by an average of 0.55 m and could be held longer, so that the areas on either side of the river could be wet longer with larger scope, eventually reducing the potential of drying in the lands around Lubuk Garau River which potentially causes land fire, especially in the dry season.

III. CONCLUSION

The data analysis performed in the present study produced the following conclusions:

1. Based on the research result using hydraulic modeling on Lubuk Garau River, it's found that during the rainy season water flows directly to the estuary, so it's not held and can't optimally wet the lands around it;
2. Canal blocking is a building which is suitable for the condition of Lubuk Garau River with average distance of 1 km serves to hold water longer during the dry season, increasing the peat rewetting process around it;
3. Canal blockings in Lubuk Garau canal/River, East Barito Regency could increase average Water Level (TMA) by 0.55 m, so it's expected to accelerate rewetting process with larger scope.

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