International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-2, July 2019

The Hydraulic Modelling on Sediments Ponds in Binanga Aron River, North Sumatera Indonesia

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Abstract*: The development of dams and sediments ponds which is the hydrological planning to improve the aspect of irrigation, river engineering, foundations, soil mechanics, environmental engineering, hydrology and hydraulics. The management difficulty for a decision maker of environmental impacts which is the river's condition does not change for the better in direct response to reduction in nutrient concentration. The aims of this study to evaluate the design of reservoirs building and analysing the water flow and volume of sediment storage in the Binanga Aron River, Samosir, North Sumatera Indonesia. The hydraulic modelling on sediments ponds will ensuring the availability of sufficient volume of water, river flows and water quality status. The primary channel building is equipped with a door to prevent the rinsing water flow back to the primary channel and prevent the entry of rinsing water containing sediment into the canal. Then, the insufficient water availability from the river that is used as a water source in the irrigation area, then the irrigation area is still possible to supply water from nearby water sources. From the result, the volume of water recorded 1,977 ltr/s/ha with simultaneously delivery system. It is necessary to adjust the position of the dam, where the channel flow depth in the sedimentary bag building at least 0.236 m, the discharge ranges from 0.078 - 0.263 m^3/sec. The water availability planned of water sources into artificial reservoirs in the Binanga Aron River to maintain the water supply.

***Index Terms*: hydrology; hydraulics modelling; sediments ponds; sedimentary; Binanga Aron River**

I. INTRODUCTION

Water is one of the important things for living, among others, for the needs of agricultural businesses, fisheries plantations and livestock. Besides that, water plays an important role in the evaporation process specifically in plant ecosystems to maintain the temperature and water acts as drinking sources. Rivers and streams, however, can be subjected to regulation by well-established practices through the use of dams, storage reservoirs, and diversions. It is mainly through these controls that efforts are made to make the most efficient usage of water as a resource [1]-[4]. The role of rivers within the global hydrologic cycle or hydrological system depends for their very existence upon a balance between their many sources of water and the losses that they experience. This called water budget of lakes is important enough to have warranted considerable study throughout the world, with each lake or lake system possessing its own hydrologic system. These may include restrictions on water utilization especially during wet season and dry season to enhance water-quantity and water-quality management activities. To predicted imbalances in the hydrologic budget, it is usually difficult to influence the basic natural factors that cause the imbalances. Precipitation and evaporation, for the most part, are uncontrollable, although some advances have been made in evaporation suppression from small lakes through the use of monomolecular surface films. Groundwater flow is not controllable, except where highly restricted flow can be tapped. Rivers and streams, however, can be subjected to regulation by well-established practices through the use of dams, storage reservoirs, and diversions. It is mainly through these controls that efforts are made to make the most efficient usage of water as a resource [5]-[9]. Technically, river bank erosion can be occurring due to several factors that become contributor to the erosion to happen. Among the factors are the loss of soil particles on river bank due to stream flow, land slide due to the increment of bank slope, erosion due to turbulence of the stream flow and finally the side erosion that cause the structure of the bank collapsed. River geometry includes a cross section for minimum geometry (width, depth, cross-section and meander length) and hydraulic variable includes river bank slope, minimum friction and minimum stream flow that affect the bed erosion and sedimentation. At the end, the shape of river geometry profile can be elaborate as a physical shape of a river whether it is plain or groove due to the pressure of the bed surface transverse flow that led to erosion and sedimentation [10]-[14]. In maintaining the water quality status, this study deal with the problem factors by providing sedimentary basin for each of rivers' channel at a certain distance along the Binanga Aron river network. The plan to build the sediment building are complementary buildings or parts of the main building that function to avoid the basic and elevated sediments, especially the sand fraction and the larger ones to enter the irrigation channels which is built at downstream part of Lake Toba. The sediment pond is located in downstream part of the building with certain distance between the sediment basins until Toba Lake.

Revised Manuscript Received on 30 July 2019.

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In the upstream part, construction functioned as control for both annual flood and drought, as well as raise the water level to be flowed for irrigation. The configuration of the plan for the area determined to be the total area will be divided into the plan area of the river flow into a system of network and irrigation systems from

Binanga Aron River. The dam will increase the water level that will be tapped and flows into the retrieval channel. The improper operation and maintenance of buildings reduce efficiency sediment basin which is a few buildings cannot work optimally. In some cases it was also found that due to poor design concepts resulted in buildings being difficult to operate and requiring high maintenance costs. The sediment basins is a best management practice used on projects involving earth disturbance activities to minimize the amount of sediment leaving a site and entering receiving waters [15]. Sediment basins are impoundment structures designed to receive sediment of storm water runoff and provide an opportunities for the removal of Total Suspended Sediment (TSS). This process is achieved by detaining the water long enough for the TSS to settle from the water under the influence of gravity before the water is discharged to the uncontrolled environment [16]-[20].

II LITERATURE REVIEW

River flow is a water building network, which is planning and implementation involves in variety of supporting disciplines, such as hydrology, hydraulics, foundations, soil mechanics, irrigation and river engineering [13], [20]. The environmental engineering focus to the environmental impacts due to network development of Binanga Aron channel in Samosir district. Every single river drainage area has a different characteristic, this requires accuracy in applying a suitable theory to the relevant drainage area. Therefore, before starting the dam construction plan, it is necessary to refer to existing specifications according to the characteristics of the river basin. For example topographic location, watershed area, climatology data, and environmental conditions. In this study it is intended to briefly describe the basics of basin planning theory be used in the calculation of construction and complementary buildings [2], [22], [23]. The hydrological data is a collection of information or facts regarding hydrological phenomenon such as rainfall intensity, temperature, evaporation, duration of solar radiation, wind speed, river discharge, river water level, velocity of flows, river's sediments concentration [1], [5]-[10]. In planning the flows of dam, the most important hydrological and hydraulic analysis to make is determining the planned flood discharge. The steps in planning the discharge analysis are as follows:

Synthetic Hydrology Unit (SHU) Gama I

Synthetic Unit Hydrograph (SHU) is commonly used to measure flood discharge with parameters accordance with the conditions in Indonesia Source Frequency Parameters (SN), which is a comparison between the number shares of One-Level River and Total Share of Rivers Level. The Network drainage density (D) is the ratio of the sum of the lengths of all rivers in the watershed unit area. Then, the Symmetry factors (SIM), which is the product of the factor width (WF) with the area of the upstream watershed. The area of the upstream watershed (RUA) is the ratio between the watershed area measured in the upstream line drawn perpendicular to the hydrometric station and the point closest to the watershed centre of gravity. The Source factor (SF) is a comparison between the lengths of the first level river with the length of rivers of all levels. Besides that, the Width factor (WF) is the ratio between the widths of the watershed measured at the river point within 0.75L with the watershed width measured at the point of the river within 0.25L from the hydrometric station. Unit of hydrolysis is given into four main variables such as the rising time (TR), peak discharge (QP), base time (TB) and storage coefficient (k) (Equation 1) [24], [25].

$$Qt = Qpxe\text{-}^{t/k}\ (m^3/dtk)$$
$$TR = 0{,}43(L/100SF)^3 + 1{,}0665SIM + 1{,}2775(hour)$$
$$QP = 0{,}1836A^{0{,}5886}TR^{-0{,}4008}JN^{0{,}2381}(m^3/dtk)$$
$$RB = 27{,}4132TR^{0{,}1457}S^{-0{,}0986}SN^{07344}RUA^{0{,}2574}\ (hour)$$
$$k = 0{,}5617A^{0{,}1798}S^{-0{,}1446}SF^{-1{,}0897}D^{0{,}0452} \quad (1)$$

Other factors to be considered in this methods:

1. Determination of rainwater intensity to evaluate the hydrographs depends on the influence of watershed parameters:

$$\Phi = 10{,}4903 — 3{,}859.10^{-6}A^2 + 1{,}6985.10^{-13M}\ (A/SN)^4 \quad (2)$$

2. Estimation of the base flow:

$$QB = 0{,}4751{,}A^{—0\ 1491}\ D^{0{,}9430}\ (m^3dtk) \quad (3)$$

3. Determination of the average rainfall with proper methods available. Another analysis is recommended which is to multiply the rain point with the rain reduction factor

$$B = 1{,}5518A^{—0{,}491}N^{-0{,}2725}SIM^{-0{,}0259}S^{-0{,}0733} \quad (4)$$

Based on the above considerations, the amount of flood discharge per hour can be determined by following

$$Qp = (01*Re) + QB\ (m^3 / sec) \quad (5)$$

Qp = flood discharge per hour (m^3/sec)
Qt = unit discharge per hour (m^3/sec)
Re = effective rainfall (mm/ hr)

Determination of Flood Debit Plan and Regional Rainfall

The selection of flood plans for water buildings is a problem that mostly contributed in the statistical analysis of the sequence of flood events in the rain distribution. The selection of flood determination analysis technique plan depends on the available data and the type of water building. The common method used to measure the prediction of flood debit is rational method and unit hydrograph method. Moreover, rational method is the most common applied. The prediction debit level can be calculated by rational method is the large of flow area is less than 30 ha. Meanwhile, for area which more than 500 ha, the unit hydrograph method can be applied (Equation 6).

Rational method formulation (6)

QP = 0,002778 .C .I .A

Where:

QP = Prediction debit (m3 / sec)
C = Flow coefficient
I = Rain intensity (mm / hour)
A = large of flow area (km3)

The rainfall intensity distribution and river discharge data are the most fundamental data in planning the construction of dam.

The determination in choosing the location and equipment both rainfall and discharge is a factor determines the quality of the data obtained. Rainfall data analysis is intended to obtain the amount of rainfall, while statistical analysis taken into account in calculating the flood discharge. The rainfall data used for calculating flood discharge and watershed at the same time. The rainfall required for the preparation of a water utilization design and flood control design is the average rainfall throughout the disputed area rather than through certain point area. This rainfall is expressed in mm [26]. In obtaining the rainfall data, we need a tool to measure the rain level. Rainfall data taken from stations around the dam site where the rain station is included in the watershed.

Hydraulics Analysis of weir and Complementary Buildings

Hydraulic analysis of weir includes the body of the dam itself and complementary buildings in accordance the purpose of the dam. The calculation of dam structure begins with the analysis of the channel, range from the trunk / primary, sediment basin channel, drainage channel for sediment basin and canals. From these channel, the elevation of the water level is determined, where this elevation is used as a reference in determining the height of the sluice gate.

Selection of Weir and Pond Type

A few factors must be consider in selecting the weir types such as the watersheds condition, the maximum flood water level reached, the nature and strength of subgrade, type of material transported by river flow, the ease of maintenance and exploitation and the efficiency of implementation cost. Based on the topographic location in the hilly area, we can determine the weir that is suitable for Binanga Aron River. The fixed dam expected to drain various types of material transported. Moreover, the costs of dam maintenance, exploitation and implementation are relatively cheaper compared to rubber dam. The fixed dam is a water building across the river with a fixed building construction that enable to raise the river water level to be used to irrigate the highest rice fields in the irrigation areas (Figure 1).

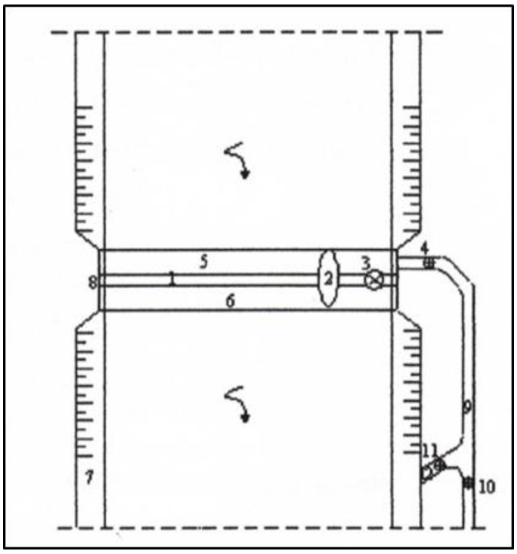

Fig.1: The Fixed Dam Scheme and Intake Left with Sediment pond [26]

Selection of Weir and Sediment Pond Location

The determining factors in choosing the weir and the sediment basin location based on the placement of the weir location is precisely seen in terms of hydraulics and sediment discharging to avoid the interference of sediment discharging. To ensure a smooth flow, the weir must be located on the outer bend or in a straight section of the river.The placement of dams in the inner bend of the stream should be avoid. Besides that, the dam should be located in stable foundation and the topography of the area will be irrigated in whole area of the plan can be irrigated [27].

Primary Channels

In determining the dimensions of the primary channel, the first thing to consider is the primary channel elevation. The water elevation in the primary canal is determined as follows the elevation of the farthest and highest fields that will be irrigated (Equation 7 and Figure 2). The amount energy lost depends on the lowest tertiary channel, the secondary channels to tertiary, and the primary secondary channel, due to the slope of the channel and in retrieval channels or tapping.

$$Q = V*A$$
$$A = (b+m.h)h$$
$$P = b+2*h\, m^2 + V= k*R^{2/3}*I^{1/2}$$
$$R = \sqrt{AP} \qquad (7)$$

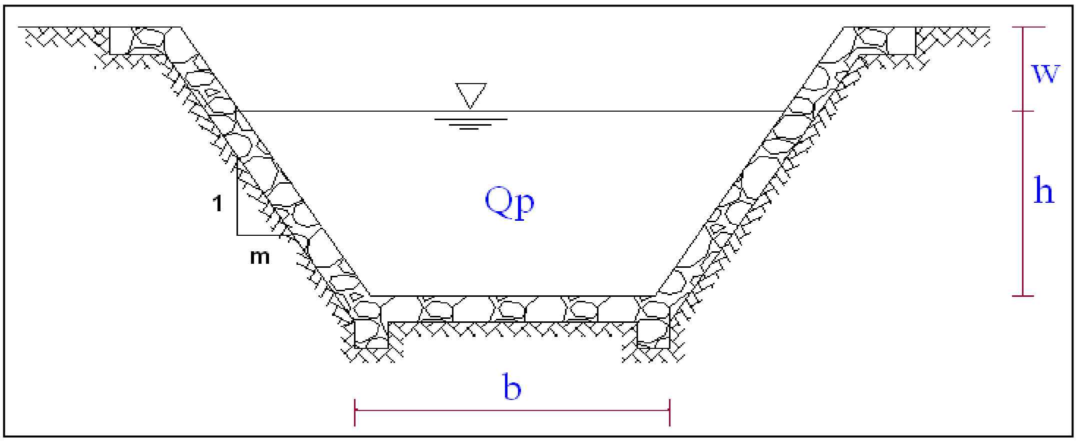

Fig. 2: Cross Section of Primary Channel Dimensions [27]

Debit Gauge and Romijn Measuring Instrument

The parameters in determining the selection of a discharge meter such as suitable with local conditions and acceptable, the simple and precise discharge formula, the easy exploitation and reading, the easy and inexpensive maintenance, the suitability of buildings for discharge measurement purposes and the accuracy of measurements in the area. This measuring instrument is used in front of the building intake channel. This measurement also functions to regulate and measure the discharge as well as the door of the primary channel (Table 1).

Table 1: The measurement of discharge as well as the door of the primary channel

	ROMIJN STANDARD TYPE					
	I	II	III	IV	V	VI
Width (m)	0,5	0,5	0,75	1	1,25	1,5
Maximum depth of flow on the planned water level	0,33	0,5	0,5	0,5	0,5	0,5
Maximum discharge on planned water level	160	300	450	600	750	900
Dissipated energy	0,08	0,11	0,11	0,11	0,11	0,11
Base elevation below the planned water level	0,81+V	1,15+V	1,15+V	1,15+V	1,15+V	1,15+V
V=Varians =0,18x Hmax						

Source: [24]-[27]

Sediment Drain Door

The sediment basin drain door should not interfere during rinsing, the flow on the drain door should not to be sink. Decreasing on flow velocity reduced the sediment discharging capacity. Therefore, in increasing the flow, the velocity should not be reduced. In order to increase the speed of flow, the slope of the channel is made that allows for ease of sediment discharge.

Intake Building

Intake building is a building in the form of a sluice located on the right or left side of the dam. The function of this building is to divert the desired amount of water flows for irrigation. The rinsing in the picking building equipped with a door and the front part is open to avoid a high water level during flooding. The size of the door opening depends on the desired flow rate. This speed depends on the size of the grain being discharge. The elevation of the intake floor is taken at least one meter above from the upstream floor of the dam to accommodate the sand and gravel discharge. In this situation, the higher the floor from the riverbed, the better is prevention of discharging basic sediments. The term of the intake floor is too high, the water discharge that is tapped becomes less, so it is necessary to set wider intake. In ensuring the fulfillment of water tapping and preventing the sediment from entering the intake, it is necessary to take a certain comparison between the width and the height of the openings (Refer Equation 8).

Formula: Qn = 1,2*Q.

$$Qn = \mu.a.b.\sqrt{2.g.z} \quad (8)$$

Description:

Qn = planned discharge (m^3/sec)
Q = water needs in the field (m^3/sec)
μ = discharge coefficient
a = opening height (m)
b = opening widt (m)
g = gravitation = 9,81 m/sec^2
z = high loss of energy between the openings

0,15 – 0,30 m

Sediment Pond Channel

The sediment basin are enlargement of cross sections of a channel to a certain length to reduce flow velocity and enable the sediment. In accommodate the sediment deposits, the bottom of the channel section is deepened and widened. This reservoir is cleaned periodically by rinsing the sediment back into the river with critical flow. Sediment ponds are placed at the beginning of the primary duct (Figure 3).

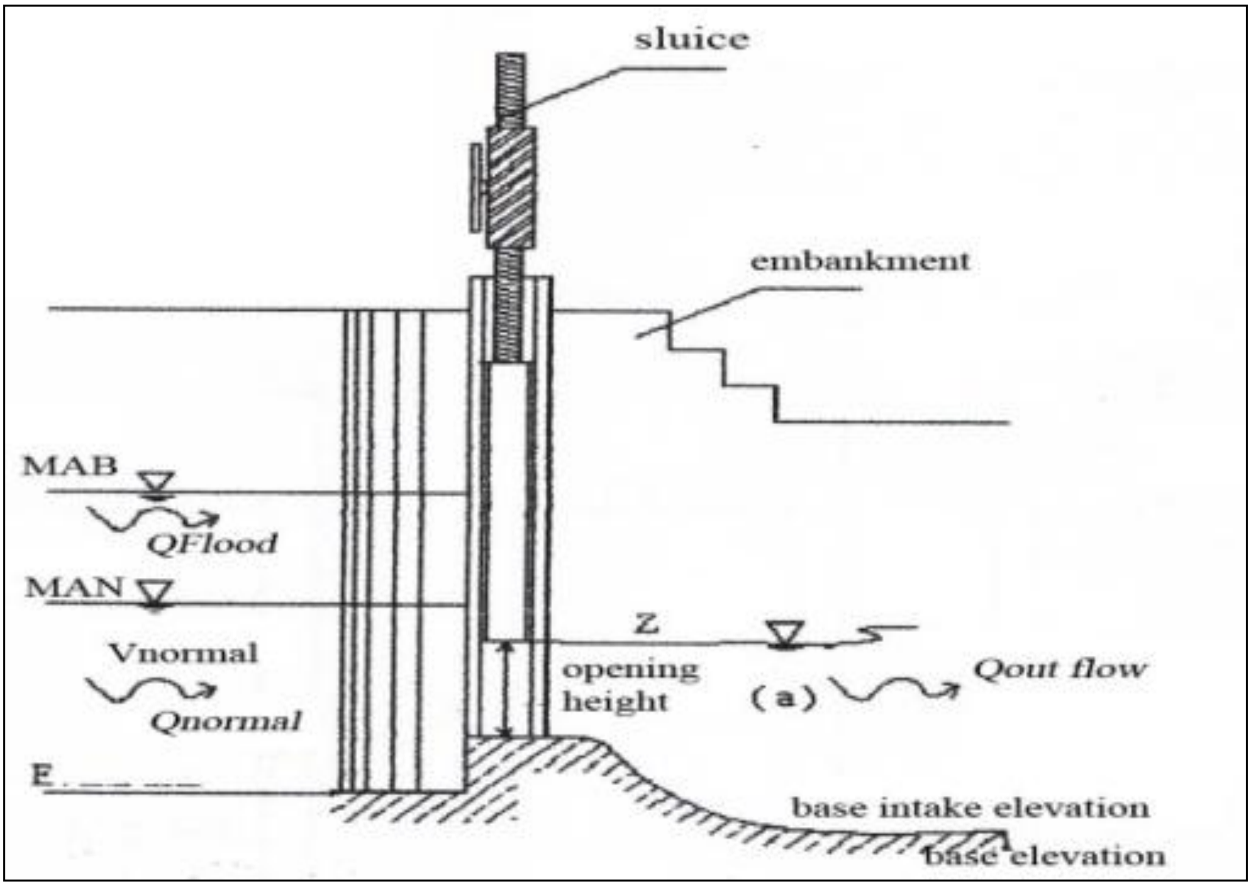

Fig. 3: Cross Section of Intake Building

Weir Width

Weir width is the distance between the base (abutment) and equal to the average width of the river in a stable part. In the lower section of the river, the average width can be taken at full bank discharge, while at the top of the river it is difficult to determine full discharge. The maximum weir width should not more than 1.2 times the average width of the river in a stable groove. Total of weir width is not entirely used to pass the water discharge due to the existence of pillars and drainage structures, therefore the useful width of the dam to pass the discharge is called the effective width (Be), which is affected by the thickness of the pillar and contraction coefficient of the pillar and dam. In determining the effective width, it is necessary to know about the exploitation of dams where flood occures, the drain and the taking doors must be closed. This is intended to prevent the entry of objects transported by floods that may cloging on the drain door when the door is open (Figure 4).

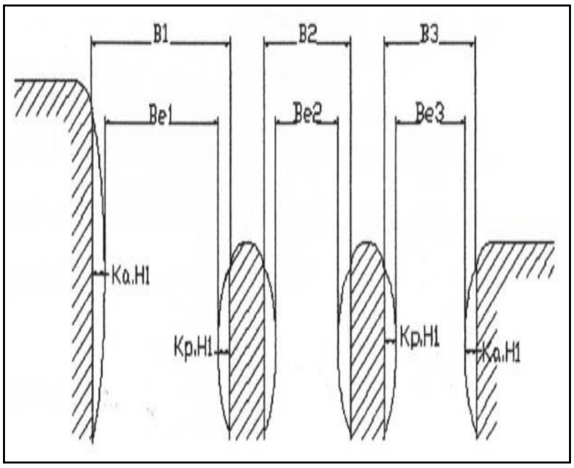

Fig. 4: The sketching of effective dam width
Source: [24]-[27]

Fig. 5: The study area of Binanga Aron River, Samosir, North Sumatera Indonesia

III. STUDY AREA

The area of study is situated in the sub district of Panguruan, Samosir Regency, North Sumatra Province. The location situated from 2^o 32 – 2^o 45', North Latitude until 98^o 42' – 98^o 47, East Longitude. The areas of Pangururan District recorded 121.43, km^2. The site is about 199.1 km from Medan, and can be reached approximately for 3 hours and 36 minutes by road-trip. The water quality and water quantity status affected to the cultivation of fishery, agricultural, plantation, and tourism industries in quality management aspects at Samosir Regency, North Sumatera Province. Binanga Aron River, Samosir chosen as research location because this is one of place which is the popular tourism site in North Sumatera (Figure 5). This location faced the water quality deterioration, drainage channel problems, drought, and landslide problems. In general, the most predominant source of nonpoint pollution are the agricultural, urban and urbanising areas. These activities include plantation, construction or renovation activities, transportation, gardening, solid waste handling and accidental spills. The first flush has been regarded as one of the important issues in the management of water quality and water quantity status, this phenomenon due to the shock loadings of pollutants into the water ways such as the pollutant mass or the pollutant concentration. Lake Toba is very susceptible to human activities in terms of quantity and quality of water status. This is because of the very mall ratio of total catchment area to the lake surface area and the leakage of untreated sewage from domestic and agricultural waste. It has been reported that the water level of Lake Toba has declined 3-5 m below its normal level during the year 1984-1987. The purpose of this study to evaluate the changes of Binanga Aron River flows after drought phenomenon, to analyse the amount of sediment production and sediment storage volume and to determine the process which are take place after sediment rising and flow passes through the river basin.

IV DISCUSSION

The physical characteristic recapitulation of sediment ponds

Based on Table 2, Table 3, Table 4, Table 5 and Table 6 showed the overall data of physical characteristic recapitulation of sediment ponds in Binanga Aron River, Samosir, North Sumatera, Indonesia, from 2015 until 2018. The overall analysing of physical characteristic recapitulation of sediment ponds such as water depth rises from riverbed (m), depth of water drops from the riverbed (m), width of the water rises (m) and so on (Refer the Table 2 until Table 6) proved that, there are only small changes for January, April, July and October every year from 2015 until 2018. From the specification of physical characteristic recapitulation of sediment ponds which is planning, designing, and implementing appropriate control practices for construction activities to control the sediment production along the Binanga Aron River Basin. The sediments ponds is one of the method will be required to prepare and implement an erosion and sediment control plan before construction begins [28], [29]. Sediment, which results from the excessive erosion of disturbed soils, is the primary pollutant of concern. The bare erosion slopes and drains choked with sediment can often be observed at construction sites in developing areas such as agricultural, industrial and tourism areas [10]-[14], [30]. The sedimentation problems is the build-up (aggradation) of sediment on the land surface or the bed of a watercourse. The sediment production in drainage systems and in river leads will be rising the bed levels and caused the flash floods phenomenon during heavy rainstorms [18]-[20], [31],[32]. The physical characteristic recapitulation of sediment ponds below is a dynamic process and is dependent upon the geomorphic and hydraulic characteristics of the drainage system. The deposited sediment tends to remain in place for short periods of time and depends on the on the flow characteristics of the drainage systems [33], [34].

The suspended sediment produce is one of the empirically indicator of sediment delivery into the drainage system or watercourse from the land during land clearance and earthwork or anthropogenic activities along the river basin [35]-[37].

Table 2: Data of physical characteristic recapitulation of sediment ponds in Binanga Aron River, Samosir, North Sumatera, Indonesia, 2015

No	Description	Month				Average
		Jan	Apr	July	Oct	
1	Water depth rises from riverbed (m)	0.82	1.02	1.05	1.10	1.00
2	The depth of water drops from the riverbed (m)	0.52	0.48	0.47	0.51	0.50
3	The width of the water rises (m)	19.70	20.00	20.10	20.20	20.00
4	Water width down (m)	4.80	4.95	5.00	5.20	4.99
5	Area of water rises (m)	16,650.00	16,725.00	16,880.00	16,945.00	16,800.00
6	Area of water down (m^2)	4,180.00	4,210.00	4,185.00	4,225.00	4,200.00
7	Perimeter of rising water (m^2)	110.30	110.60	111.10	112.00	111.00
8	Perimeter of descending water (M)	102.45	102.85	103.26	103.45	103.00
9	Fingers (M)	3.645	3.648	3.652	3.656	3.650
10	Slope					
	Upstream	0.001000	0.001000	0.001000	0.001000	0.001000
	The middle	0.000714	0.000714	0.000714	0.000714	0.000714
	Downstream	0.002500	0.002500	0.002500	0.002500	0.002500
11	Long river from the bridge to Lake Toba	840.00	840.00	840.00	840.00	840.00
12	The length of the river from the bridge to the hills	16,198.00	16,198.00	16,198.00	16,198.00	16,198.00
13	Sample point every 300 meters					

Table 3: Data of physical characteristic recapitulation of sediment ponds in Binanga Aron River, Samosir, North Sumatera, Indonesia, 2016

No	Description	Month				Average
		Jan	Apr	July	Oct	
1	Water depth rises from riverbed (m)	1.06	1.08	1.12	1.15	1.10
2	The depth of water drops from the riverbed (m)	0.48	0.49	0.50	0.51	0.50
3	The width of the water rises (m)	18.87	19.00	19.02	19.10	19.00
4	Water width down (m)	4.00	4.00	4.00	4.00	4.00
5	Area of water rises (m)	15,930.00	15,955.00	15,975.00	15,980.00	15,960.00
6	Area of water down (m^2)	3,359.10	3,360.00	3,360.20	3,360.70	3,360.00

7	Perimeter of rising water (m^2)	109.60	109.80	110.20	110.40	110.00
8	Perimeter of descending water (M)	100.40	100.70	101.20	101.40	100.93
9	Fingers (M)	3.652	3.669	3.678	3.679	3.670
10	Slope					
	Upstream	0.001000	0.001000	0.001000	0.001000	0.001000
	The middle	0.000714	0.000714	0.000714	0.000714	0.000714
	Downstream	0.002500	0.002500	0.002500	0.002500	0.002500
11	Long river from the bridge to Lake Toba	840.00	840.00	840.00	840.00	840.00
12	The length of the river from the bridge to the hills	16,198.00	16,198.00	16,198.00	16,198.00	16,198.00
13	Sample point every 300 meters					

Table 4: Data of physical characteristic recapitulation of sediment ponds in Binanga Aron River, Samosir, North Sumatera, Indonesia, 2017

No	Description	Month				Average
		Jan	Apr	July	Oct	
1	Water depth rises from riverbed (m)	1.19	1.20	1.21	1.21	1.20
2	The depth of water drops from the riverbed (m)	0.48	0.49	0.51	0.53	0.50
3	The width of the water rises (m)	17.80	17.90	18.10	18.20	18.00
4	Water width down (m)	4.49	4.50	4.51	4.52	4.50
5	Area of water rises (m)	15,100.00	15,110.00	15,130.00	15,140.00	15,120.00
6	Area of water down (m^2)	3,780.00	3,780.00	3,782.00	3,786.00	3,782.00
7	Perimeter of rising water (m^2)	109.70	109.90	110.10	110.30	110.00
8	Perimeter of descending water (M ')	99.70	99.90	100.10	100.30	100.00
9	Fingers (M)	3.600	3.630	3.650	3.680	3.640
10	Slope					
	Upstream	0.001000	0.001000	0.001000	0.001000	0.001000
	The middle	0.000714	0.000714	0.000714	0.000714	0.000714
	Downstream	0.002500	0.002500	0.002500	0.002500	0.002500
11	Long river from the bridge to Lake Toba	840.00	840.00	840.00	840.00	840.00
12	The length of the river from the bridge to the hills	16,198.00	16,198.00	16,198.00	16,198.00	16,198.00
13	Sample point every 300 meters					

Table 5: Data of physical characteristic recapitulation of sediment ponds in Binanga Aron River, Samosir, North Sumatera, Indonesia, 2018

No	Description	Month				Average
		Jan	Apr	July	Oct	
1	Water depth rises from riverbed (m)	1.10	1.21	1.22	1.25	1.20
2	The depth of water drops from the riverbed (m)	0.54	0.52	0.55	0.57	0.55
3	The width of the water rises (m)	20.60	20.80	21.00	21.70	21.03
4	Water width down (m)	5.25	5.38	5.33	5.22	5.30
5	Area of water rises (m)	17,610.00	17,640.00	17,642.50	17,667.50	17,640.00
6	Area of water down (m^2)	4,452.00	4,452.00	4,452.00	4,452.00	4,452.00
7	Perimeter of rising water (m^2)	111.33	111.80	112.35	112.50	112.00
8	Perimeter of descending water (M)	103.15	103.35	103.65	103.84	103.50
9	Fingers (M)	3.688	3.690	3.691	3.692	3.690
10	Slope					
	Upstream	0.001000	0.001000	0.001000	0.001000	0.001000
	The middle	0.000714	0.000714	0.000714	0.000714	0.000714
	Downstream	0.002500	0.002500	0.002500	0.002500	0.002500
11	Long river from the bridge to Lake Toba	840.00	840.00	840.00	840.00	840.00
12	The length of the river from the bridge to the hills	16,198.00	16,198.00	16,198.00	16,198.00	16,198.00
13	Sample point every 300 meters					

Table 6: The average data of physical characteristic recapitulation of sediment ponds in Binanga Aron River, Samosir, North Sumatera, Indonesia, from 2015 until 2018

No	Description	Month				Average
		2015	2016	2017	2018	
1	Water depth rises from riverbed (m)	1.00	1.10	1.20	1.20	1.13
2	The depth of water drops from the riverbed (m)	0.50	0.50	0.50	0.55	0.51
3	The width of the water rises (m)	20.00	19.00	18.00	21.00	19.50
4	Water width down (m)	5.00	4.00	4.50	5.30	4.70
5	Area of water rises (m)	16,800.00	15,960.00	15,120.00	17,640.00	16,380.00
6	Area of water down (m^2)	4,200.00	3,360.00	3,780.00	4,452.00	3,948.00
7	Perimeter of rising water (m^2)	111.00	110.00	110.00	112.00	110.75
8	Perimeter of descending water (M)	103.00	101.00	100.00	103.50	101.88

9	Fingers (M)	3.650	3.670	3.640	3.690	3.663
10	Slope					
	Upstream			0.001		
	The middle			0.000714286		
	Downstream			0.0025		
11	Long river from the bridge to Lake Toba			840		
12	The length of the river from the bridge to the hills			16.198		
13	Sample point every 300 meters					

Analysis of sediment basin

The sedimentation and the losing of capacity in sediment basins is the main problems in the dam areas. The permanent storm water drains built to control the runoff during development along the river basin. The structure connected to the sediment basins until stabilisation of graded areas is achieved. Temporary interceptor ditches and berms with filters in inlets should be constructed to direct runoff from the development areas into any sediment basin. A few suitable physical characteristic to build the sediment basin in Binanga Aron River, Samosir, and North Sumatera Indonesia.

Sediment Volume

Sediment basins located in a sub-catchment to maximise its overall sediment trapping capabilities. The avoided river contains 0.5% sediment deposited in the mud bag. Meanwhile, the accurate values of sediment is 85,579 mm^3 or 85.6 m^3 (Equation 9). The consideration of the design a sediment basin before the provision of adequate storage. This predicted volume based on the accumulated sediment which is estimated from regular monitoring of sediment levels with a measuring post and reference against the top water level.

V_d = 0,0005 x Q_n x T. Where T is the time of rinsing in second

If rinsing is done once a week and Q_n is 0.283 m^3/s

Thus, the sediment volume is

Vd = 0,0005 x 0,283 x 7 x 24 x 3600

Vd = 85,579 mm^3 or 85.6 m^3 (9)

Average surface area

The Average surface area of a sediment basin defined from Equation 10. The design of sediment basins including a permanent pool to reduce flow velocities and provide storage of sediment. The permanent pool reduces flow velocities in the sediment basin structure and increases the detention times. The outlet structure which is located above the bed sediment basin, it is also not necessary for sediment particles to settle all in the bed of the basin to be effectively retained. The sediment velocity recorded for this study at a water

the flow velocity for rinsing as 1 m/s.

Long mud bag

temperature of 20°C and diameter value is 7 gm or 0.07 mm, the sediment velocity ω= 0.004 m/s.

For L / B> 8, it can be calculated:

L > 8B
8B2 = 70,75
B = 2,974 (or 3,0 m)
L > 8 B
L = 8 x 3,0 =24 (10)

The average channel flow depth (hp)

The hydrological theory applied in this study to estimate the design of average channel flow depth (hp). The typical catchment areas being relatively small. For the sediment basins with large catchments (> 50 ha), a runoff routing model should be used to estimate design flows. Figure 6 showed the theoretical of the average channel flow depth. For this study V_n as 0.40 m/s. The ks value as 35. In determining I_n, the area must be estimated. Then the h_n= 0.236 m (this is the average depth) (Refer Figure 6).

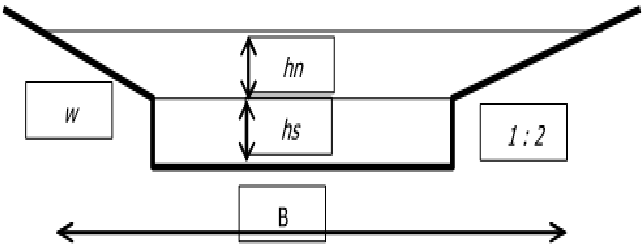

Fig. 6: The theoretical of the average channel flow depth

Determination of I_n (normal exploitation, mud bag almost full)

The calculations including the real b with h_n. Look = 0.236 m. The rinse slope is (flushing, empty mud bag). The sediment in the bag is in the form of coarse sand. For the initial assumption in determining I_s,

The determination the length of the bag of mud as L2 = 42 m which is the longest bag of mud.
Given L / B> 8, the calculation is:

$L > 8B$
$8B2 = 70{,}75$
$B = 2{,}974$ (or 3,0 m)
$L > 8\,B$
$L = 8 \times 3{,}0 = 24$

Mud bag length (L2) = 24 m

Froude number

In order to carried out proper rinsing, the flow velocity must be kept subcritical or Fr <1. The particles smaller than 50 mm will be rinsed

Thus:

$\tau = \rho g h_s I_s$
$\tau = 1000 \times 9,\ 81 \times 0{,}123 \times 0{,}013$
$\tau = 17{,}436\ N/m^2$

Efficiency of the mud bag length (L)

Efficiency of the the mud bag length (L) = 42 m and the planned water depth (hn) = 0.236 m and speed (Vn) = 0.4 m/sec, the plan sediment speed (ap) = 0.004 m/sec.

$$\frac{h_n}{\varpi_0} = \underline{L}$$

ω_0 = the proper diameter d_0 = 0,06 mm

The plan fraction of 0.06 mm with sediment velocity 0.004 m /sec. Fraction depositional efficiency 0.06 mm is calculated as follows:

$\omega = 0{,}004$ m/sec
$\omega_0 = 0,\ 0022$
m/sec $V_n = 0{,}4$ m/sec

$$\frac{\varpi}{\varpi_0} = \frac{0{,}004}{0{,}0022} = 1{,}818$$

$$\frac{\varpi}{V_n} = \frac{0{,}004}{0{,}04} = 0{,}01$$

Rinse building

The total width of the rinsing building will be taken the same as the width of the base of the bag. The depth of rinse water is *hs* = 0.123 m at the discharge rinse plan *Qs* = 0.339 m^3/s,

$(b)\ (h_s) = (bnf)$
(hf)

Where:
B = bag base widt
h_s = rinse water depth
B_{nf} = rinse opening net
if we plan the rinse door using 2 openings with a width of 1/2 x 2.76 = 1.38 m 1.4 m.

$b_{nf} = 2 \times (1{,}4) = 2{,}8$ in
$2.76 \times 0{,}123 = 2.8 \times h_f$
$hf = 0.1212$m

Rinse channel

Rinse channel length valued as 12 m. River base elevation +999,86, the slope planned for rinsing buildings is 1: 20. The dimensions of the rinse planned will be same as the dimensions of the slurry bag. The waterfront plan in the downstream rinsing door becomes +999.86 + (12)(0,01212) = +1001,3. Then, the river base elevation intersection is +1001.3 - 0.123 = +1001,177, so the river recorded a plunge building and a high fall: +1001,177 - 1,40 = +999,777 m.

Primary channel retrieval building

The primary channel building is equipped with a door to prevent the rinsing water flow back to the primary channel and prevent the entry of rinsing water containing sediment into the canal.
The taking threshold in the primary channel is 0.10 m above the frontage of the sediment pond in full condition (+999,877).
The frontage of water upstream is = 1001.96+ 0.123 = +1002,098
Supposedly the energy loss is 0.10 m above the take. Thus, we can calculate the dimensions of the taking building:

$$Qn = \mu\, h_i\, b_1 \sqrt{2gz}$$

$$0.283 = (0.9)\ (0.137)\ b\ \sqrt{(9.81)\ (0.10)}$$

b_i = 1,638 m, taken 2.0 m (taken building net width).
By using 2 openings, 1.25 m each, 1 pillar is needed, with 1.0 m,
Thus total Bi = 2 (1.25) + 1 (1.0) = 3.5 m.

V. CONCLUSION

Indeed the major challenge in achieving the sustainability of environmental management to direct the government guideline in the world has been identified to be relatively fragmented approach on the part of authorities and stakeholders. The guidelines should be prepared tfor the development in areas adjoining river reserve. These guideline will serve to protect the river reserve from encroachment. The upstream of Binanga Aron River need to be more explored to study effected by the deforestation which results in erosion sedimentation problems. Besides that, the river monitoring and conservation effort generally need a lot of resource in terms of manpower and finance. Engaging local communities would be an ideal way to provide the necessary manpower and reduce the cost. Therefore capacity building among the locals would not only provide the needed manpower but also will create much awareness among the public and increase the participation for river conservation effort. The simple monitoring programs and physical evaluation of the river can be used to supplement the existing comprehensive monitoring programs of relevant agencies. Input from the local authorities in terms of pollution event could be vital in addressing the environmental problems effecting the river effectively.

VI. ACKNOWLEDGMENT

The author would like to thank KPM for providing financial sup-port for this research on the SRGS: Development of Environmental Flow Assessment (EFA) Model at Kenyir Lake, Hulu Terengganu, Terengganu (UniSZA/2017/SRGS/17) – R0019-R017, Potential Effects of Climate Change on Streamflow, based on the occurrence of severe floods in East and West Coasts of Malaysia Peninsular River Basins- FRGS RR222 and Department of Irrigation and Drain-age Malaysia for the secondary data and East Coast Environmental Research Institute (ESERI), Universiti Sultan Zainal Abidin (UNISZA) give permission to use re-search facilities and supporting in this research.

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