SEDIMENT YIELD ACCUMULATION AT RESERVOIR (BENGOH DAM)

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To my beloved father and mother, family and friends

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ABSTRAK

Mendapan berlaku dalam tempat penyimpanan bekalan air merupakan satu masalah besar bagi pihak berkuasa yang sememangnya sudah diketahui umum. Pengurangan kapasiti dari segi pembekalan air dan kualiti air merupakan dua perkara penting yang memerlukan perhatian umum. Modified Universal Soil Loss Equation (MUSLE) telah dipilih untuk diaplikasikan dalam kajian ini untuk menganggarkan hasil sedimen di Bengoh Dam, Sarawak. Luas kawasan tadahan adalah 127 km^2 dan hujan telah dianalisa untuk tempoh sepuluh tahun kebelakangan bermula dari 1994 sehingga 2008. Pekali air larian, C untuk kajian ini adalah 0.55. Faktor kebolehakisan, K telah dikira dengan merujuk kepada peta klasifikasi tanah untuk kawasan kajian dan Jadual Klasifikasi Kebolehakisan Tanah. Faktor panjang dan kecerunan cerun, LS dikira menggunakan persamaan LS. Manakala faktor penanaman dan pengurusan, CP pula merujuk kepada Jadual Pengurusan Tanaman dan Amalan Kawalan Hakisan. Nilai parameter yang diperolehi dalam MUSLE adalah nilai faktor K bersamaan dengan 0.613, nilai LS dan CP masing-masing adalah 0.368 dan 0.200. Objektif kedua dalam kajian ini juga dapat dicapai. Nilai maksimum dan minimum hasil mendapan peristiwa yang diperolehi adalah 379,588.79 ton setahun dan 200,586.11 ton setahun. Hubungan di antara hujan dan hasil mendapan adalah $y = 84.114x - 3313.8$ and $R^2 = 0.9982$. Kajian ini adalah penting untuk menggambarkan keadaan hasil mendapan yang berlaku di kawasan kajian dan masalah mendapan yang serius serta untuk mendapat perhatian dari pihak bertanggunjawab amatlah diperlukan. Dengan ini juga, ia dapat meningkatkan kesedaran mengenai penggunaan amalan konservatif tanah untuk mengurangkan masalah hakisan.

ABSTRACT

Sedimentation in water supply reservoirs is a widely recognized problem for water supply authorities, Reduction of reservoir capacity and water quality decline are two of the major concerns. The Modified Universal Soil Loss Equation (MUSLE) was selected for application in this research study to estimate sediment yield at Bengoh Dam, Sarawak. The catchment area is 127 km^2 and the rainfall was analyzed for 10 years beyond, from 1994 until 2008. The runoff coefficient for this study area is 0.55. The soil erodibility factor, K was determined by referring to the research area soil map classification and Table of Soil Erodibility Classification. The slope length and steepness factor, LS was computed using the LS equation. Meanwhile, cover and management factor, CP is referring to the Table of Crop Management and Erosion Control Practice Factor. The obtained parameters in MUSLE are K value of 0.613, LS and CP values are 0.368 and 0.200 respectively. The secondary objective on estimating the sediment yield in Bengoh Dam study area using MUSLE also achieved. The maximum and minimum values of sediment yield are 379,588.79 ton per year and 200,586.11 ton per year. Relationship between rainfall and sediment yield obtained was $y = 84.114x - 3313.8$ and $R^2 = 0.9982$. This research is very important to illustrate the condition of the sediment yield at the study area and showed that sedimentation problem is a serious matter that should have an attention from responsible authority. It also can be used to arise the importance of applying soil conservation practice to minimize the erosion damage.

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NOTATION

doa	Department of Agriculture Malaysia
E	East
GIS	Geographic Information System
govt.	government
i.e	*id est*
Kpg.	Kampung (village)
km	kilometers
km^2	square kilometers
km^3	cubic kilometers
m	metres
mm	millimeters
mm/h	millimeters per hour
m^3	cubic metres
Mha	Mega hectares
Mm^3	Mega cubic metres
N	North
O.M.	Organic Matter

RMK-9	Rancangan Malaysia Ke-9
s	seconds
Sg.	Sungai (river)
sq km	square kilometers
tones/m^2/yr	tones per square metre per year
t/ha/yr	ton per hectare per year
t/yr	tones per year
USDA	US Department of Agriculture
yr	year
°C	Celsius degree
°	degree
%	percent

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CHAPTER 1

INTRODUCTION

1.1 Introduction

All rivers contain sediments and it can be considered a body of flowing sediments. When a river is stilled behind a dam, the sediments contain will sink to the bottom of the reservoir. Dam are built for several purposes such as supplying water from storage to domestic, industrial and agricultural users, generating electric power, navigation and flood control. Construction of dams results in sediment deposition upstream and increased stream erosion downstream.

Land erosion involves detachment, transport and subsequently deposition of solid practices can be defined as sediments. The sediment yield from land erosion along with materials from gully and stream bank erosion is transported by stream flow either in suspension or by rolling and sliding along the bed.

Sediment is deposited, starting with the larger particles and aggregates. Smaller particles and aggregates are carried further downslope, resulting in an enrichment of fines. Therefore, the size distribution of erodes sediments has a major impact on soil erosion-deposition process. In general, the coarser, heavier sediments, the gravel and sand, tend to settle out at the upper end of reservoir, forming a “backwater” delta which gradually advances toward the dam. The lighter sediments, the silt and clay, tend to be deposited near the dam.

The rate of reservoir sedimentation depends mainly on the size of a reservoir relative to the amount of sediment flowing into it: a small reservoir on an extremely muddy river will rapidly lose capacity; a large reservoir on a very clear river may take times to lose an appreciable amount of storage.

Apart from rapidly filing the reservoirs, sediment-filled rivers also can cause an abrasion of turbines and other dam component. The efficiency of a turbine is largely dependent upon the hydraulic properties of its blades. The erosion and cracking of the tips of turbines blades by water-borne sand and silts considerably reduces their generating efficiency and can require expensive repairs.

1.2 Problem of Statement

Every reservoir loses storage of water due to sedimentation. Sedimentation affects both the useful life of a reservoir for such important purposes as flood control, water supply and its aesthetic quality. Changes in sediment yield can change in many elements of the river ecosystem, including rates of weathering and erosion, climate and human activity.

It also affects the rates of soil development and influences the discovery of disturbed surfaces down slope from source areas in watershed. Sediments yield is mostly affected by surficial materials, topography, rainfall seasonality and vegetation

cover and will be increased by soil disturbance, which often occurs as the result of land use.

Sedimentation could be occurred because of mismanagement of land resources of soil erosion such as soil loss from pollution, human settlement, decrease in fertility and erosion. Human activities that disturb vegetation, such as logging, mining, agriculture, and construction, may greatly increase the land erosion.

In addition, when sediment builds up behind the dam, it will reduce the hydraulic head available for power production. Sediment can enter the inlets to the hydroelectric power plant, causing damage to the turbines. On the downstream side of the dam, the reduction of sediment in the water flow can result in erosion as the natural replenishment of sediment is eliminated.

For example, the Three Gorges Dam on China's Yangtze River. According to CYJN (CIPM Yangtze Joint Venture) report, total sediment discharge at Yichang is 530 millions tons/yr, equivalent in volume to about 0.43 km^3 per year, compared to the total normal reservoir power pool volume of 26 km^3.

The capture of sediment in the reservoir will cause significant degradation of the river bed for hundreds of kilometers downstream, eroding flood control embankments, undermining bridge crossings and changing the hydrologic regime of the river on which millions of people depend (William P.B., 1993). There is also significant risk that sediment captured in the reservoir would accelerate coastal erosion.

Therefore, it is necessary to take serious action about the factors and effects of sedimentation towards the reservoir. Collecting data such as rainfall data and type of soil distribution of the study area is very important in calculating the sediment yield accumulation. It can be calculate by applying the MUSLE method. This study is important as awareness for the dam industry while constructing dam in the future.

1.3 Objectives

The objectives of the study are as follow:

i. To calculate the sediment yield accumulation at Bengoh Dam reservoir using MUSLE (Modified Universal Soil Loss Equation).

ii. To calculate the accumulated sediment yield for 15 years beyond from 1994 until 2008.

1.4 Study of Area

Presently in Sarawak, there are five existing hydroelectric dams which are the Batang Ai Dam, Baleh Dam, Murum Dam, Pelagus Dam and Bakun Dam. All these dams are aims to supply electricity throughout Sarawak State either now or in future. The study area of this study is the proposed Bengoh Dam.

The Bengoh Dam is proposed to be constructed on Sungai Bengoh, which joins with Sungai Semadang to form the upstream end of Sungai Sarawak Kiri. The