ISSN:1991-8178

Australian Journal of Basic and Applied Sciences

Journal home page: www.ajbasweb.com

Case Study of the Use of Morphometry Das Barek Kisi To Predict Watershed Erosion

[1]Hendra Wahyudi, [2]Suhardjono, [3]Mohammad Bisri, [4]Agus Suharyanto

[1]Doctoral Program Civil Engineering (Water Resources) Student Brawijaya University Malang
[2,3,4]Doctoral Program Civil Engineering (Water Resources) Supervisor Brawijaya University Malang

ARTICLE INFO

Article history:
Received 12 March 2015
Accepted 28 April 2015
Available online 5 May 2015

Keywords:
DAS, DAS Morphometry, HSS Gamma I, MUSLE and Erosion.

ABSTRACT

Watershed (DAS) is the main element of an ecosystem that consists of vegetation, soil, water and human beings with all the activities carried out in it (Soerjono, 1978). These elements interact to form a balance of the input from the output in the form of rain and water flow and sediment that reflect an ecosystem condition. One of the activities in the watershed is made reservoirs that collect rain water in the rainy season and releasing it in the dry season, so that water needs can be met throughout the year. In addition to considering the structure of the building, the construction of dams should consider the amount of erosion in the watershed. This is related to the age of the reservoir and operating and maintenance costs. Method to predict erosion aplenty, among other methods MUSLE. This is a development method MUSLE USLE method performed by Williams in 1975 to replace erosivitas rain (R) into erosivitas flow (Rw) (Bisri, 2009). Erosivitas flow (Rw) is the ability to stream which can cause erosion. Erosivitas flow (Rw) is believed to be approximated by Gamma HSS method first developed by Sri Harto (1985) using data from 30 watersheds morphometric parameters in Java. Morphometry watershed is the watershed physical properties that can be used to distinguish one watershed to another watershed. Research on the use of morphometric watershed to predict erosion in the watershed do Barek Kisi located in Blitar, East Java. Barek watershed Grid is subzone lava which is subzone Brantas. The results obtained from this study is the analysis of erosion with MUSLE method requires erosiviats flow value (Rw). Erosivitas flow has been analyzed by using the Rational method (Williams, 1975 in Bisri, 2009). HSS Gamma I developed with the use of data morphometry DAS it can be used to analyze the flow erosivitas (Rw) so morphometry can be used to predict erosion.

© 2015 AENSI Publisher All rights reserved.

To Cite This Article: Hendra Wahyudi, Suhardjono, Mohammad Bisri, Agus Suharyanto., Case Study of The Use of Morphometry Das Barek Kisi To Predict Watershed Erosion. ***Aust. J. Basic & Appl. Sci.,*** *9(11): 256-262, 2015*

INTRODUCTION

Watershed (DAS) is the main element of an ecosystem that consists of vegetation, soil, water and human beings with all the activities carried out in it (Soerjono, 1978). These elements interact to form a balance of the input from the output in the form of rain and water flow and sediment that reflect an ecosystem condition.

Specific conditions watershed during the rainy season, the amount of water that is to be excessive even flooding. While during the dry season the water amount is reduced even happen drought. This condition requires the means to store and distribute water in the form of ponds and reservoirs and all supporting facilities.

Construction of a dam or reservoir in addition to the structural analysis of erosion analysis is also an issue that is in need of attention because it will involve erosion of age reservoir and operational costs.

Model estimates of erosion was first developed by Wischmeier and Smith in the 1960s, known as the model USLE (Universal Soil Loss Equation) to current models to predict erosion has grown by leaps and bounds.

MUSLE method is one method to predict erosion found by Williams (1975) in utomo (1994). MUSLE method is a development method by changing the parameters erosivitas USLE rainfall (R) with parameters erosivitas flow (Rw). Erosivitas flow (Rw) is the ability to stream which can cause erosion. Analysis erosivitas flow (Rw) Rational method using equation (Williams, 1975 in Bisri, 2009).

Synthetic unit hydrograph (HSS) is a method developed to cope with the absence or deficiency of measurement data on a watershed (DAS). Synthetic unit hydrograph has been developed by Snyder (1938), Sri Harto (1985), a senior official (1990) up

Corresponding Author: Hendra Wahyudi, Doctoral Program Civil Engineering (Water Resources) Student Brawijaya University Malang.
E-mail: ayahkukung@Gmail.com

to Limantara (2006) by using morphometric parameters watershed.

HSS Gamma I was one of the methods to analyze the peak discharge developed by Sri Harto (1985) by using the data from 30 watersheds morphometry in Java. While morphometry DAS DAS is a trait that can dipergunkan to distinguish watershed by watershed another one.

The Research Methods:

The research method is a step that is done from the beginning to the end so it can be concluded. The steps can be seen in Figure 1 below.

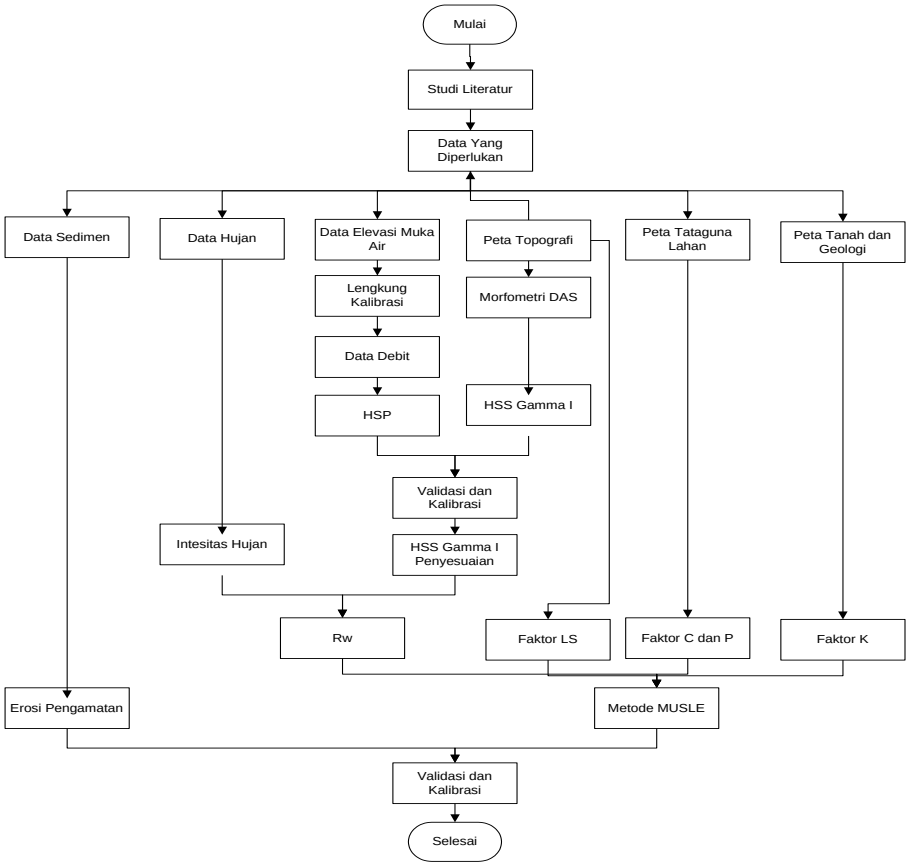

Fig. 1: Research Flowchart

RESULTS AND DISCUSSION

Results of measurements that have been made to the watershed morphometry Barek Grid can be seen in Table 1.

Table 1: Morphometry Barek watershed Grid.

NO	Nama Parameter	Morfometri DAS Barek Kisi
1	Luas DAS (dalam km^2)	16.51
2	Bentuk DAS	Lonjong
3	Panjang Sungai Utama (L)(km)	16.33
4	Kerapatan Drainase (DD)	3.609
5	Kemiringan Sungai Utama	0.0445
6	Nisbah Percabangan (Rb)	1.81
7	Faktor Sumber (SR)	0.48
8	Frekuensi Sumber (SN)	0.51
9	Jumlah Pertemuan Sungai (JN)	28
10	Faktor Lebar (WF)	0.81
11	Luas Relatif DAS Sebelah Hulu (RUA)	0.56
12	Faktor Simetri (SIM)	0.45

This watershed morphometric measurement results further analysis of synthetic unit hydrograph (HSS) Gamma I by using equation (6), (7) and (8). Parameter analysis results synthetic unit hydrograph (HSS) Gamma I can be seen in Table 2. and Figure 7. Here.

Tabel 2: Hydrograph Synthetic Unit Parameters (HSS) Gamma I.

No	DAS Name	Synthetic Unit Hydrograph Gamma I			
		TP	TB	QP	K
1	Barek Kisi	1.76	21.21	0.11	1.50

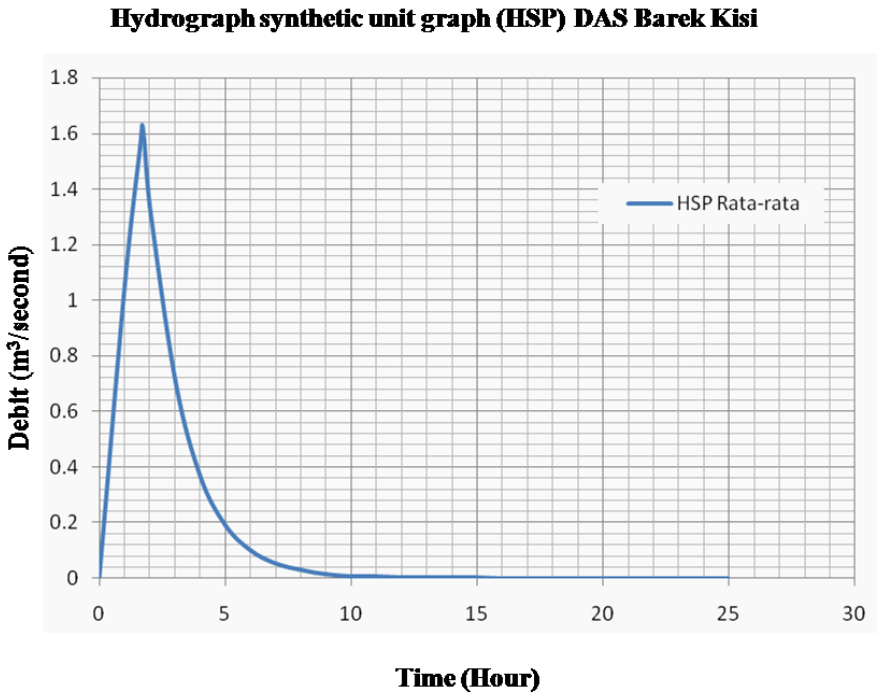

Fig. 2: Hydrograph Synthetic Unit Graph (HSS) Gamma I

Analysis Grid Barek watershed arc calibration is done because measuring devices installed in the watershed Barek AWLR Grid is a tool that needs to be changed to discharge. Elevation changes become necessary discharge arc calibration chart. Curved calibration DAS Barek Grid can be seen in Figure that can be used for calibration. The results can be seen in Figure 3 below

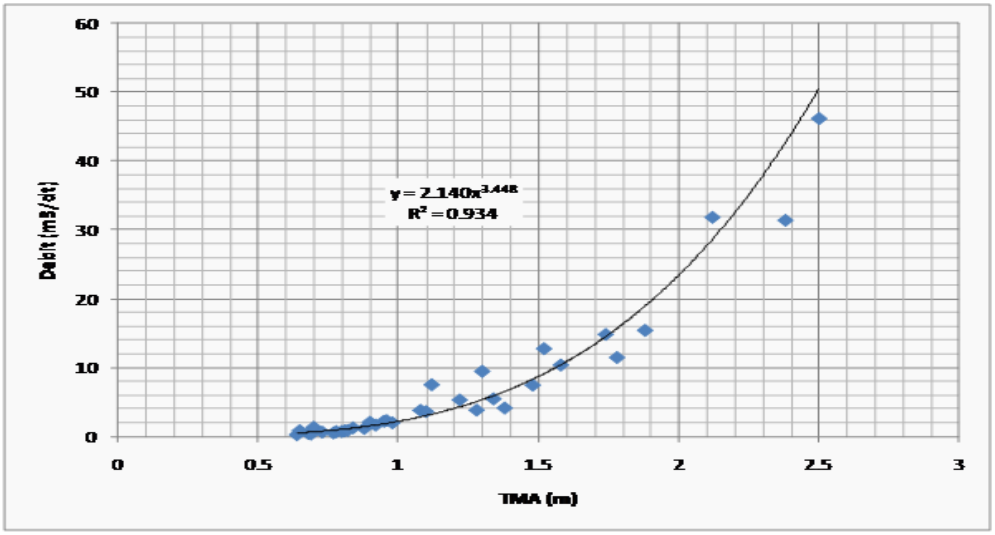

Fig. 3: Calibration Curves Graph Grid Barek watershed.

Measurement unit hydrograph (HSP) are selected from observations during 2007 to 2013 can be seen in Figure 4 below.

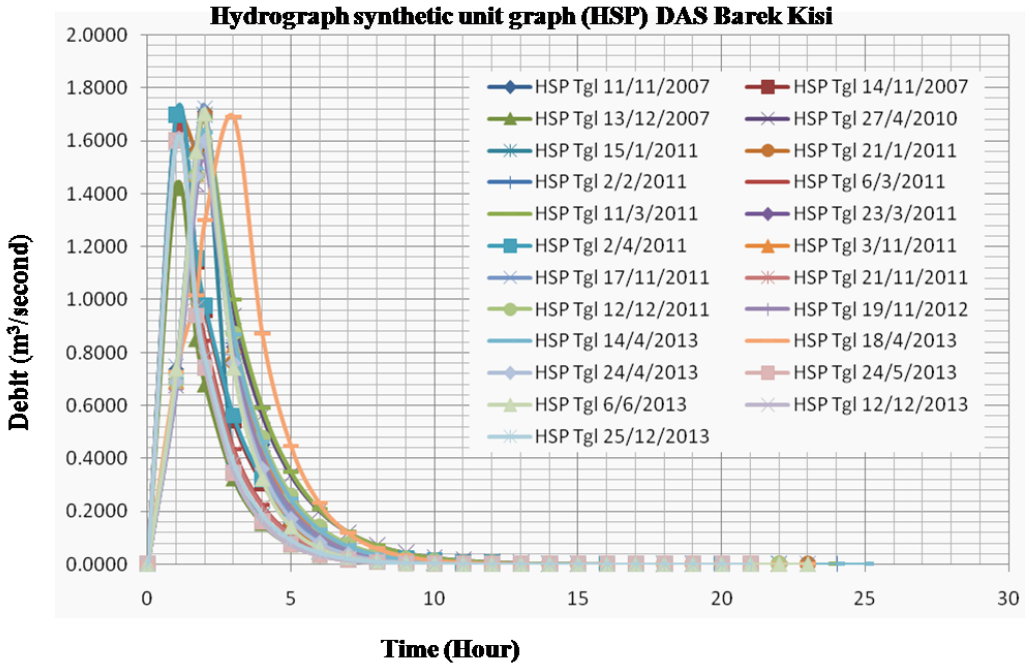

Fig. 4: Graph Measurement Unit Hydrograph (HSP) Barek watershed Grid.

HSS Gamma I of the analysis of the equation (6), (7) and (8) calibrated using measurement unit hydrograph average. The result can be seen in Table 3 and Figure 5 below

Table 3: Results of analysis of HSP with HSS Gamma test I

No	QP	QG	QG - QP	(QG - QP)^2	QG - QP rat	(QG - QP rat)^2
1	0	0	0	0	-0.252172829	0.063591136
2	1.061988043	0.959053685	-0.102934358	0.010595482	0.706880856	0.499680545
3	1.628886957	1.625595996	-0.00329096	1.08304E-05	1.373423168	1.886291197
4	1.550085346	1.6864	0.136314654	0.018581685	1.434227171	2.057007579
5	1.341222971	1.435919775	0.094696804	0.008967485	1.183746946	1.401256833
6	0.709573916	0.738069049	0.028495133	0.000811973	0.48589622	0.236095137
7	0.36631247	0.379370722	0.013058251	0.000170518	0.127197893	0.016179304
8	0.190396702	0.194998211	0.004601509	2.11739E-05	-0.057174618	0.003268937
9	0.099636181	0.100229934	0.000593753	3.52542E-07	-0.151942895	0.023086643
10	0.052494303	0.051518625	-0.000975678	9.51948E-07	-0.200654204	0.04026211
11	0.02784342	0.026480799	-0.001362621	1.85674E-06	-0.22569203	0.050936892
12	0.014866736	0.013611246	-0.00125549	1.57625E-06	-0.238561582	0.056911629
13	0.007990013	0.00699624	-0.000993773	9.87585E-07	-0.245176589	0.06011156
14	0.004321781	0.003596098	-0.000725683	5.26615E-07	-0.248576731	0.061790391
15	0.002352307	0.00184841	-0.000503897	2.53912E-07	-0.250324419	0.062662315
16	0.001288139	0.000950091	-0.000338048	1.14277E-07	-0.251222738	0.063112864
17	0.000709544	0.000488351	-0.000221193	4.89264E-08	-0.251684478	0.063345076
18	0.000393047	0.000251014	-0.000142032	2.01732E-08	-0.251921814	0.063464601
19	0.000218902	0.000129023	-8.98795E-05	8.07832E-09	-0.252043806	0.06352608
20	0.000122541	6.63182E-05	-5.62227E-05	3.16099E-09	-0.252106511	0.063557693
21	6.89315E-05	3.40878E-05	-3.48436E-05	1.21408E-09	-0.252138741	0.063573945
22	3.86365E-05	1.75213E-05	-2.11152E-05	4.45852E-10	-0.252155308	0.063582299
23	1.8543E-05	9.00602E-06	-9.53697E-06	9.09538E-11	-0.252163823	0.063586594
24	5.72551E-06	4.62913E-06	-1.09637E-06	1.20204E-12	-0.2521682	0.063588801
25	2.62277E-06	2.37939E-06	-2.4337E-07	5.92291E-14	-0.252170449	0.063589936
26	1.36401E-06	1.22302E-06	-1.40992E-07	1.98787E-14	-0.252171606	0.063590519
27	6.38438E-08	6.28637E-07	5.64793E-07	3.18992E-13	-0.2521722	0.063590819
28	0	0	0	0	-0.252172829	0.063591136
	7.060839206			0.039165849		7.344832567
	0.252172829				F	0.994667564

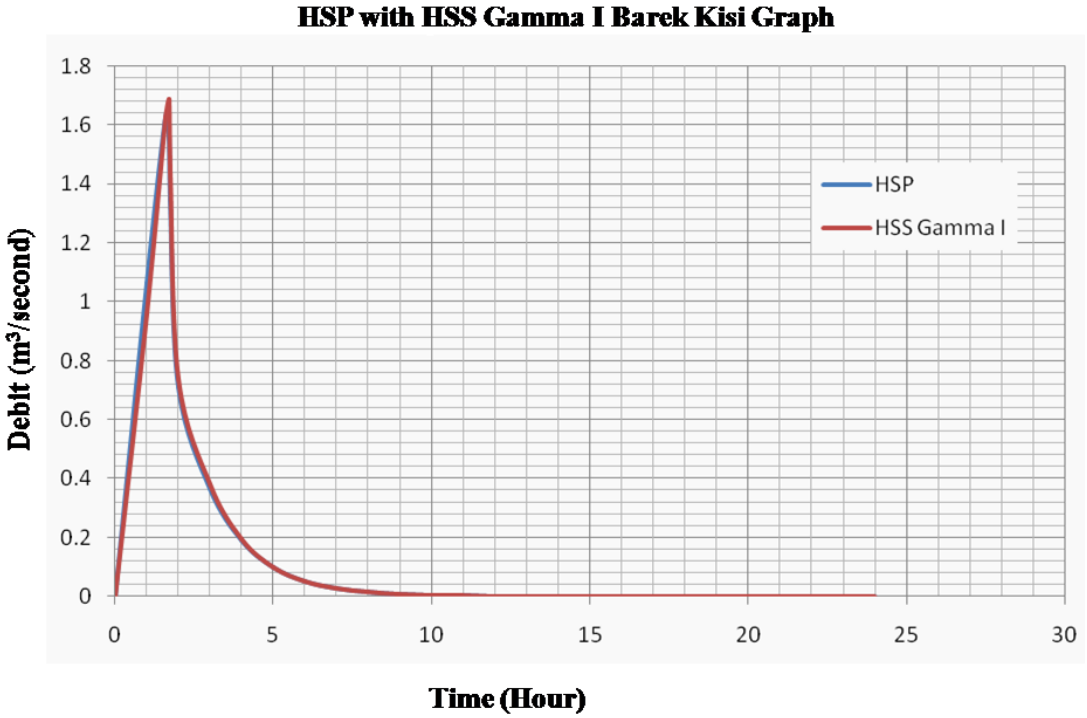

Fig. 5: Graph of HSP with HSS Gamma I.

Based on Table 3 and Figure 5, the HSS Gamma I do not need to be adjusted for the results of the calibration equation has a value of 0.9946 which is close to 1 so that the HSS Gamma I can be used for further analysis. Results erosivitas flow analysis (Rw) can be seen in Table 4 below

Table 4: Effective Rain Forest Volume Year 2007

Time	I effective =	13.2032786	Volume
0	0	0	22792.775
1	0.95905369	12.662653	31818.942
1.613	1.625596	21.4631968	6454.431
1.695	1.6864	22.266009	4674.899
1.758	1.43591978	18.9588488	12503.367
2	0.73806905	9.74493127	26556.963
3	0.37937072	5.00893732	13650.395
4	0.19499821	2.57461571	7016.363
5	0.10022993	1.32336374	3606.441
6	0.05151862	0.68021476	1853.727
7	0.0264808	0.34963336	952.824
8	0.01361125	0.17971308	489.755
9	0.00699624	0.09237331	251.736
10	0.0035961	0.04748028	129.394
11	0.00184841	0.02440507	66.509
12	0.00095009	0.01254431	34.186
13	0.00048835	0.00644783	17.572
14	0.00025101	0.00331421	9.032
15	0.00012902	0.00170352	4.642
16	6.6318E-05	0.00087562	2.386

17	3.4088E-05	0.00045007	1.227
18	1.7521E-05	0.00023134	0.630
19	9.006E-06	0.00011891	0.324
20	4.6291E-06	6.112E-05	0.167
21	2.3794E-06	3.1416E-05	0.086
22	1.223E-06	1.6148E-05	0.044
23	6.2864E-07	8.3001E-06	0.015
24	0	0	
		Volume	132888.832
		Vo	132888.832
		Qp	22.266
		RW	38061.146

Table 4 Results of the analysis of the flow erosivitas (Rw) on Grid Barek watershed.

The results of erosion in the watershed analysis Barek Grid can be seen in Table 5 below.

Table 6: Results of Analysis of Watershed Erosion Barek Grid

No	Years	MUSLE Parameters				MODEL MUSLE (ton/ha/th)
		Rw	K	LS	CP	
1	2007	21739.946	0.086	0.748	0.014	20.271
2	2008	31197.128	0.086	0.748	0.014	29.089
3	2009	29788.479	0.086	0.748	0.014	27.776
4	2010	38987.038	0.086	0.748	0.014	36.353
5	2011	18561.598	0.086	0.748	0.014	17.307
6	2012	27260.288	0.086	0.748	0.014	25.418
7	2013	19247.914	0.086	0.748	0.014	17.947

Reliability models MUSLE using DAS parameters is done by comparing the results of erosion prediction methods MUSLE with erosion observations. Analysis can be seen in Table 7 and Figure 6. The following

Table 7: Results of Test Reliability with Erosion Erosion Observation Model MUSLE

Measurement Data (ton/h/th)	MUSLE MODEL (ton/ha/th)	Residual	RMSE	ME
21.986	20.27089931	-1.715100686	7.869	13.951
8.234	29.08902538	20.85502538		
6.5796	27.7755639	21.1959639		
18.575	36.35254371	17.77754371		
7.897	17.30732359	9.410323592		
5.344	25.41821186	20.07421186		
7.889	17.94726293	10.05826293		

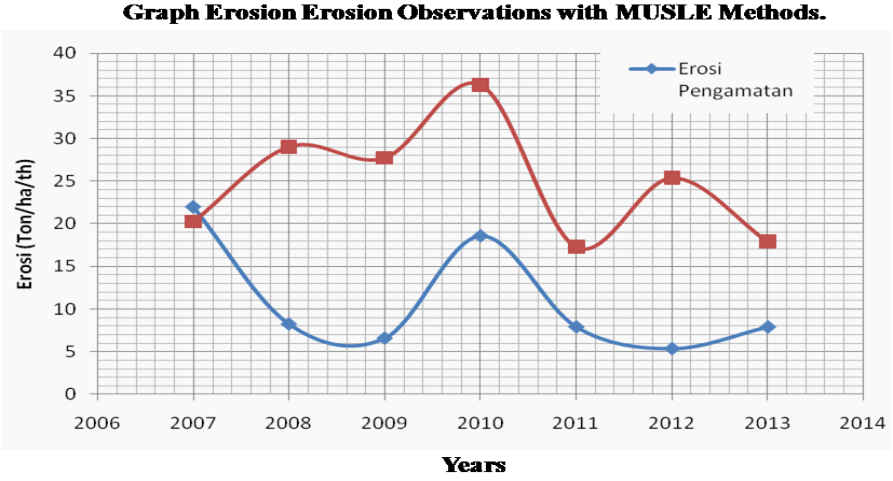

Fig. 6: Graph Erosion Erosion Observations with MUSLE Methods Results Analysis.

Conclusion:

Based on the results of erosion prediction MUSLE method on Kisi Barek watershed, it can be concluded the following.

1. Equation HSS Gamma I at the time used to perform analysis on the unit hydrograph Barek watershed Kisi results were very satisfactory because the F value close to 1.
2. Gamma HSS I that equation using morphometry DAS can be used to analyze the flow erosivitas (Rw).
3. The results of the analysis of erosion by using morphometric methods MUSLE indicate that DAS can be used to predict erosion despite the prediction value is too excessive (over estimate).

REFERENCES

Bisri, Mohammad, 2009. Pengelolaan Daerah Aliran Sungai. CV Asrori. Malang.

Chow, V.T., 1964. Handbook of Applied Hydrology. New York: Mc. Graw-Hill Book Company.

Darmadi, 1990. Analisis Hidrograf Satuan Berdasarkan Parameter Fisik DAS. Disertasi Doktor (Tidak dipublikaikan), Program Pascasarjana IPB. Bogor.

Frevert, R.K., 1959. Soil and Water Conservation Engineering. New York: John Wiley & Sons, Inc.

Gray, D.M., 1970. Handbook on Principles of Hydrology. The Iowa State University Press, Ames, Iowa.

Haan, C.T., H.P. Johnson, and D. L. Brakenseik, 1982. Hydrologic Modelling of Small Watersheds. American Society of Agricutural Engineers

Hadisusanto, N., 2011. Aplikasi Hidrologi. Malang: Jogja Mediautama.

Hewlett, J.D. and W.L. Nutter, 1969. An Outline of Forest Hydrology. Athens: University of Georgia Press.

Linsley, R.K., M.A. Kohler and J.L.H. Paulus. 1949. Surface Retention andDetention and overland Flow. Applied Hydrology. New York. Mc Graw Hill Book Co.

Nash, J.E., and J.V. Sutcliffe, 1970. River Flow Forecasting Through Conceptual Models Part ICA Discussion of Principles, Journal of Hydrology, 10.

Seyhan, 1977. Dasar-dasar Hidrologi. Subagyo S, penerjemah; Prawirohatmodjo S, editor. Yogyakarta: Gajah Mada University. Terjemahan dari: Fundamentals of Hydroloy.

Sosrodarsono, *at al*, 1983. Hidrologi Untuk Pengairan. Jakarta: PT Pradnya Paramitra.

Soerjono, R. 1978. Kegiatan dan Masalah Kehutanan dalam DAS. Dalam Proceedings Pertemuan Diskusi. Pengelolaan Daerah Aliran Sungai. DITSI. Jakarta.

Sri Harto, 1985. Pengkajian Sifat Dasar Hidrograf Satuan Sungai-sungai di Pulau Jawa untuk Perkiraan Banjir. Disertasi Doktor UGM (Tidak dipublikasikan). Yogyakarta

Sri Harto, 1993. Analisa Hidrologi. Jakarta, PT Gramedia Pustaka Utama.

Utomo, W.H., 1994. Erosi dan Konservasi Tanah. Malang; IKIP Malang.