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UTILIZATION OF GPM SATELLITE RAINFALL POWER IN FLOOD DISCHARGE MODELING USING HEC-HMS MODEL AT BENDUNGAN SEMANTOK

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Abstract
Climate has role important for life creature live on earth No exception role bulk Rain in field hydrology . Availability of bulk data Rain own diverse characteristics so that availability of adequate data become important thing in understand characteristics bulk rain in an area. along with development technology and research by institutions space there is Lots rain data product based the satellite launched one of them is GPM. Analysis hydrology important done For analyze description about the amount of water discharge in an area based on bulk data Rain satellite . So that need done Flood discharge analysis is one of them with use studies dam case Semantok . Research methods use simulation using the HEC- ResSim Research Data program obtained from bulk data Rain Global Precipitation Measurement (GPM) satellites for 20 years on the Giovanni website. Potency water availability in the area dam water catchment semantok with area that has been lineated amounting to 53.71 km2 based on from calculation of rain data GPM (Global Precipitation Measurement) satellite for 20 years from 2004 to with a simulated 2023 using the resulting HEC-HMS model hydrograph Q 100 Year flood with control Specification 2 days amounting to 139.1 m3/ second on January 1 2023 at 06:00, and the total outflow volume was 42.34 mm.

Keywords: Discharge; GPM; HEC-HMS; Semantok

1. INTRODUCTION

Climate has role important for life creature live on earth No exception role bulk Rain in field hydrology . Availability of bulk data Rain own diverse characteristics so that availability of adequate data become important thing in understand characteristics bulk rain in an area. However Data availability is still available become constraint Because spread station measurement bulk it 's still raining in Indonesia Not yet evenly (Misnawati , 2018). along with development technology and research by institutions space there is Lots rain data product based the satellite launched one of them is GPM (Grobal Precipitation Measurement) which is not only offer more technology Good but also more accurate as well

as scope more spatial wide If compared to with TRMM (Tropical Rainfall Measuring Mission) (Blumenfeld, 2019). Analysis hydrology important done For analyze description about the amount of water discharge in an area based on bulk data Rain satellite . So that need done Flood discharge analysis is one of them with use studies dam case Semantok .

Flood discharge modeling using the HEC-HMS model. HEC-HMS is a computer program numerical model that includes method For simulating watersheds, channels , and behavior control water structure so that can predict flow and time (Gede, 2005). The HEC-HMS model is utilized as flood discharge analysis at the " contol point" location of system warning early impending flood built . HEC-HMS is used in analyze hydrology with simulating bulk processes rain and runoff direct (run off) (Indah, et al. 2022).

2. LITERATURE REVIEW

Research conducted by Deprillianto et al in 2016 with title " Flood Discharge Calculation With Using the HEC-HMS Program (Case Study: Pesanggrahan River Watershed , Pesanggrahan River Jakarta" using bulk data Rain in period time ten year start from 1985 to with 1994 obtained from three station rain at the Pesanggrahan River . Then do calculation and repetition of secondary data use a number of method gumbel . Then done simulac HEC-HMS modeling via SCS Unit *Hygrograph* method with *loss method* includes Green and Ampt , Initial and constant, SCS Curve Number, Exponential. TRnsform methods include SCS unit hydrograph and Synder unit hydrograph .

Research conducted by Indah et al in 2022 with title " Evaluation System Regional Drainage in Curahpoh Village Subdistrict Brainstorm Regency Bondowo " using bulk data Rain annual from three station note taker bulk rain in 2012 to in 2021. With stages analysis use application Hydrognomon For get bulk data average rain Then Kolmogrov test was carried out Smirnov For determine One sample is at from something population that has distribution of certain data Then modeled using HEC-HMS. Analysis results show that debit value for each channel and peak discharge supreme is on Main Channel 2 (SU 2) and on Main Channel 1 (SU 1) experiencing Exiting conditions (Indah, et al. 2022).

Research conducted by Rizal in 2022 with headline " Report Research on Drainage and Zero Off Studies in the Villa Botosari Residential Area " using bulk data rained and processed use software hydrological data processing hydronomone with data distribution is limited become three namely gamma, person III, and Normal. Tests carried out use χ 2and Kolmogorov-Smirnov. The distribution used For predict period repeat is distribution of 'ACCEPT/ACCEPTED' from the two tests at level real (α) = 1% (Rizal, 2022).

Rain data GPM satellite in analyze hydrology describe that results recording rain data GPM satellites are capable estimate intensity Rain lower OK , and you can take notes results with high value on intensity Rain high (Marta et al , 2022).

Hydrognomon is application device soft open is used For processing and analysis of hydrological and meteorological data in the form of time series. Device soft this is possible

too support in analysis hydrology special like modeling evapotranspiration , discharge stage , and sediment discharge analysis , homogeneity test , methods water balance , as well as hydrometry (Rizal 2022).

Study previous about bulk Rain analyzed through a number of stages . Smirnov test kolmogrov is testing compatibility distribution to something data deviation . Before conformity testing is carried out plotting data for know probability of each data. For know the probability of each data using formula as following :

$$P = \frac{m}{n+1} X\ 100\%$$

Information :
P = Probability %
m = Number sort data
n = Number of Data

In doing plotting data using bulk data sorting Rain daily max especially formerly . Sorting the data sorted from the smallest data to bulk data Rain biggest , Next done calculations used For compare between Δ max and ΔCr. Distribution frequency stated accepted if Δ max < ΔCr and if Δ max > ΔCr distribution No can accepted .

Furthermore analyzed using the chi square test was carried out For test normality of data and testing data at nominal level or test difference of two or more proportion sample . Apart from that, test this used For do testing suitability of distribution data observation against data to direction verical . As for the formula the equation as following :

$$X^2 = \sum_{i-1}^{K} \frac{(O_i - E_i)^2}{E_i}$$

Information :
X2 = Chi- square parameter counted .
K = Number of subgroups .
Oi = Amount mark observations on subgroups i .
Ei = Amount mark theoretical in subgroups i

Sorting the data sorted from the smallest data to bulk data Rain biggest , next class boundaries are determined from each data to DK , then done calculations used For compare between X2 Calculate and X2 Cr. Distribution frequency stated accepted if X 2 Count < X 2 Cr.

3. METHOD

Methods used in research This through a number of stages . Research methods in research This covers identification problem , study literature , data collection , pre processing , as well data processing .

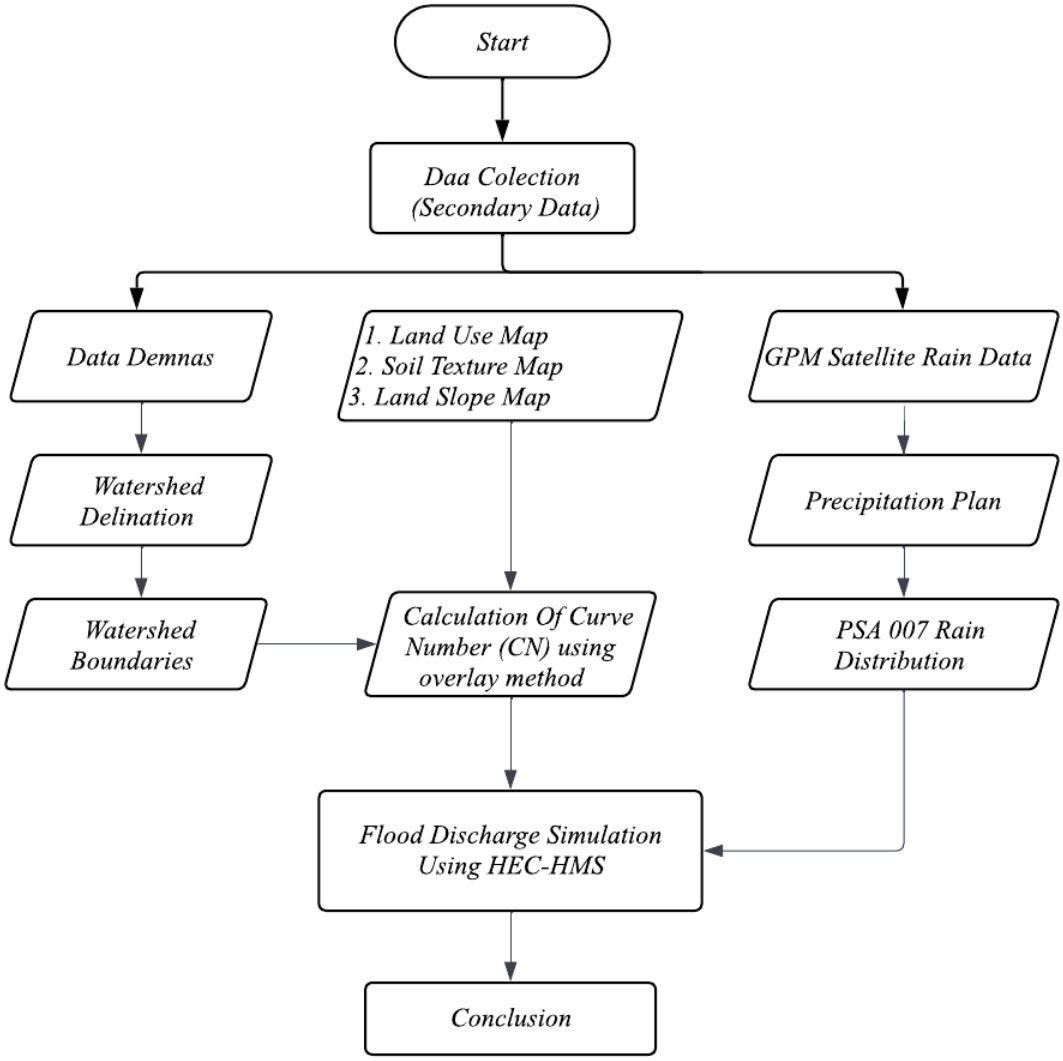


Figure 1. Flowchart Of Metodology

Along with development technology and research by institutions space there is Lots rain data product based the satellite launched one of them is GPM (*Grobal Precipitation Measurement*). Analysis hydrology important done For analyze description about the amount of water discharge in an area based on bulk data Rain satellite . So that need done Flood discharge analysis is one of them with use studies dam case Semantok .

Study of literature Study

Research literature studies are obtained from various sources, namely books, journals, the internet as well as research using the same methods and tutorials as researchers.

Data collection

Research data was obtained from bulk data Rain satellite *Global Precipitation Measurement* (GPM) for 20 years on the Giovanni website which is a *projects* together institution space international in monitor bulk rain on the earth in time series, technical data on the reservoir Semantok , among other things capacity storage in reservoirs semantok , long dam , high dams , and systems *outlet* at the reservoir semantok .

Pre Processing

Stages This is stages beginning in do flood discharge modeling with create special data area reservoir catchment with use application spatial Arcmap 10.8 for make overlay maps and GPM grid maps . Then analyzed with determine bulk Rain design , PSA 007, and HEC-HMS. Analysis more deep displayed as following :

1. Spatial Analysis

Analysis special is method used For create a model with using digital elevation model (DEM) data. In research Here, DEM data is obtained via the website https://tanahair.indonesia.go.id/demnas/#/demnas . DEM data processing is carried out through device Arc- Gis software is used For generates watershed boundaries, directions flow , accumulation River flows and networks .

Overlay map is map the overlay created from *the overlay* process or merging 3 maps including maps cover land , map type land , and maps slope processed slopes with use aapp Arcmap 10.8, from the process obtained mark *Curve Number* (CN) in the Bendungan watershed area Semantok , the best CN value obtained used for the flood discharge modeling process use HEC-HMS application .

Determination of the aiming grid For determine the region water catchment as well get future coordinates entered on the rain data website GPM satellite , On research This determination The number of grids is determined to be 10 so that the data obtained can more spread with scale 1:79,000.

Furthermore done GPM satellite data download can downloaded on the Giovanni Nasa website (https://giovanni.gsfc.nasa.gov/giovanni/), steps beginning For come in and do it download that is with register and create account account more so First , picture the download process can seen in the picture as following :

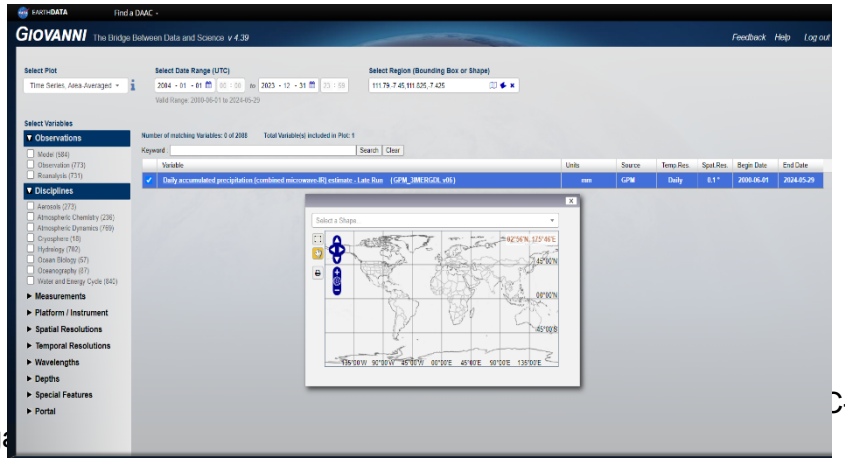


Figure 2. Grid Coordinate Input
Source : giovanni.gsfc.nasa.gov

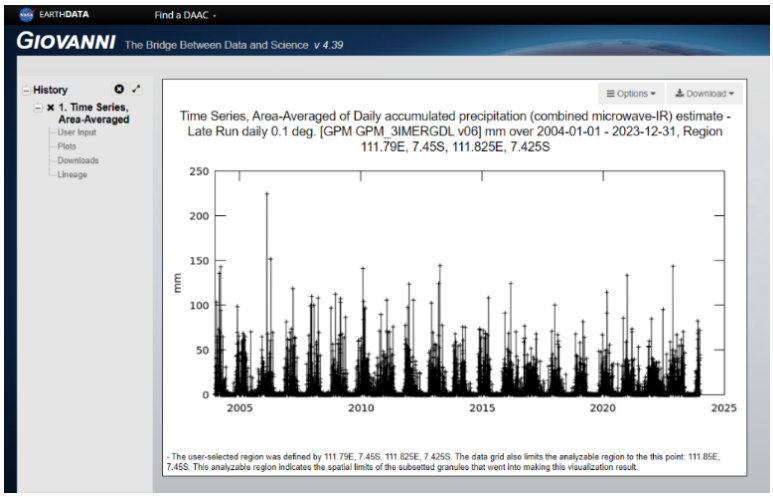


Figure 3. Rain data plot satellite GPMl
Source : giovanni.gsfc.nasa.gov

Data processing

1. Rainfall Design

In research this , distribution *Generalized Extreme Value* (GEV *Max*) approach (L-Moment) becomes ideal choice to use For estimate big bulk Rain plan with mark extreme . Because it has flexibility , stability against outliers, and conformity with hydrological data . Testing carried out are the *Chi-Square* and *Kolmogorov-Smirnov* Tests . Distribution used For predict period repeat is 'ACCEPT/ACCEPTED' distribution of the two tests on the value real (α) = 1%. Test process steps using *Hydrognomon* can showed as following :

1. Open the app *Hydrognomon* , click *Create new time series* , give filename Precipitation For the 100 year anniversary plan , select the *Precipitation* menu in the column variable , select GMT *time zone* , use units (mm), click *next* , select *Annual* , then click *Finish.* Then Enter the Average Maximum Daily Rain data Annual (HHMT) from 10 grid data viz from 2004-2023 with method press Ctrl+I , fill year initial data (2004), add to 20 years with method Press Shift + Ctrl + I. Press *view then add time series to graph* For displays rain data in form line graphs and bar charts. Bulk data graphic display Rain can seen in the picture following:

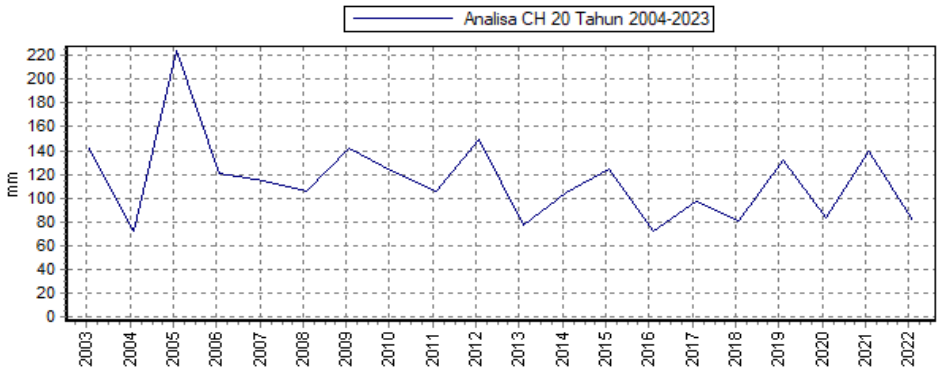


Figure 4. Rain graph 2004-2023
Source : Hydrognomon analysis

2. Select *the Hydrology* menu on the tollbar, then choose *Pythia –Statistical analysis* , select GEV Max L-Moments analysis for appearance chart analysis .

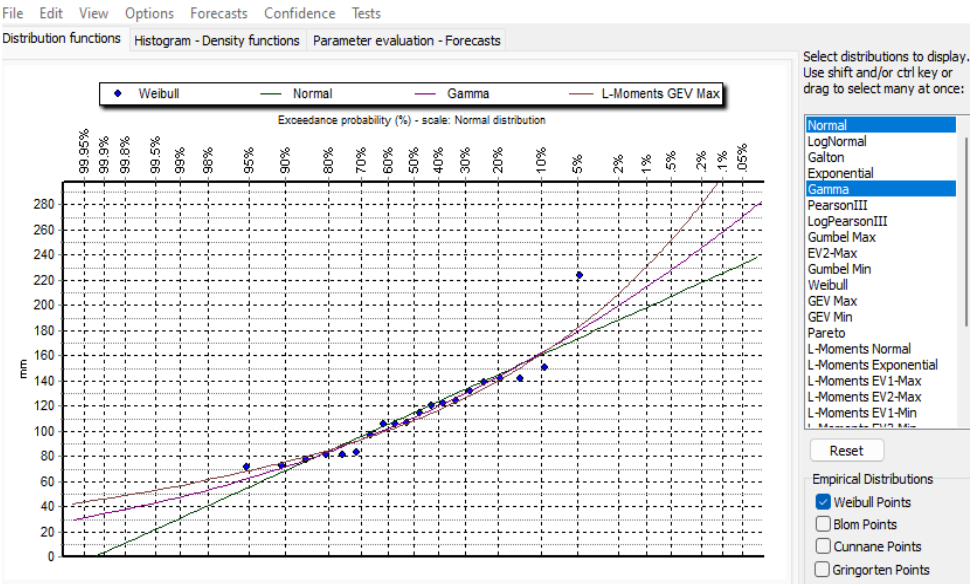


Figure 5. GEV MAX Curve (L-Moments)
Source : Hydrognomon analysis

3. Select the Forecast menu , click To *Return Period* (*Max*), then enter Tr=100 Years .

2. Data Suitability Test
1. Smirnov Kolmogrov test

Testing This intended For know largest horizontal deviation between calculation data with data theoretical . Smirnov test kolmogorov It is often also called a non-parametric fit test , because of the test No using the distribution test certain . Steps the test is as as follows (Soewarno , 1995: 198):

1. Sort the data (from largest data to small or otherwise) along with opportunity biggest from each of these data
2. Determine value of each opportunity theoretical from results data depiction (eq distribution).
3. Determine difference the biggest between opportunity observation with opportunity theoretical from second mark opportunity .
4. Determine price Do from based from table critical Smirnov kolmogorov .

If the value D produces mark more small from Do then distribution theory used For determine equality distribution Can accepted , if more D value big from Do then distribution theory used For determine equality distribution No can accepted . On research This with use application *Hydorgnomon* Smirnov test kolmogorov on distribution *Generalized Extreme Value* (GEV Max) approach (L-Moment) concludes ACCEPT,

2. Square Method

Chi *square test* use application *Hydrognomon* is something method analysis For test deviation distribution of data from observation with method measure in a way systematic proximity between data from observations and all part based on the equation line in the distribution theoretically .

3. PSA 007

Duration or distribution Rain arranged based on from rain data GPM from rain data satellite , based from watershed size , or also from time watershed concentration . In research This use method distribution raining every now and then use method distribution to in method distribution temporal PSA 007 model Genta, following is results from calculation bulk raining every now and then using the PSA 007 Genta model method.

4. HEC-HMS

Modeling hydrology using the HEC-HMS model consisting from a number of stages . After do spatial data analysis with the Arc- Gis program can done use modeling hydrology with flood discharge output simulation with repeat time use Synder UH method . Following is stages analysis hydrology with using HEC-HMS:

1. *Basin Model*

Represents stages beginning in compile *project* in the HEC-HMS program. Deep goals stage This is For make elements hydrology , step First that is enter map of the Dam watershed that has been processed use Arcmap , then displays element hydrology namely Subbasin and Sink and so on connected .

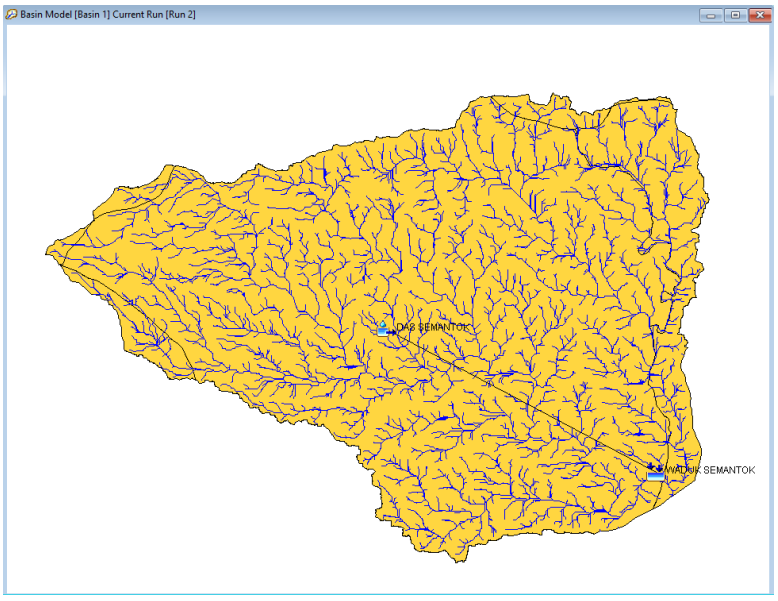


Figure 6. *Basin Model*
Source : HEC-HMS Analys

2. Input parameter Subbasin

Done Filling in data on Subbasin parameters begins with Dam watershed area Semantok amounting to 53.71 km ^{2} , use *loss method SCS Curve Number* as well use method *transform Synder Unit Hydrograph* , input composite CN number with marks 58.71 and marks *impervious* 0.1 in the loss section , enter peaking coefficient value with assumption of 0.7 and value *time lag* of 2 hours.

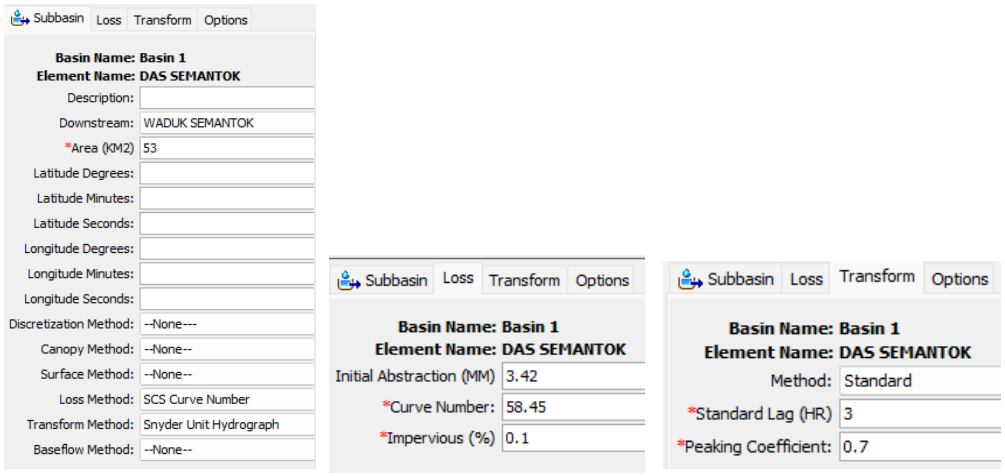


Figure 7. *Subbasin parameter input*

Source : HEC-HMS Analys

3. Input Time Series Data

Time Series of input data is rain data effective over time with Tr 100 Years Duration of 6 hours of use PSA 007 distribution . Input time *series data* using hourly intervals with unit *incremental millimeters* .

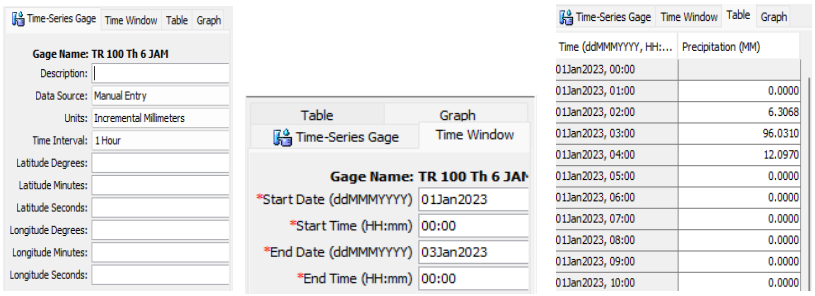


Figure 8. Input parameter Time Series Data
Source : HEC-HMS Analys

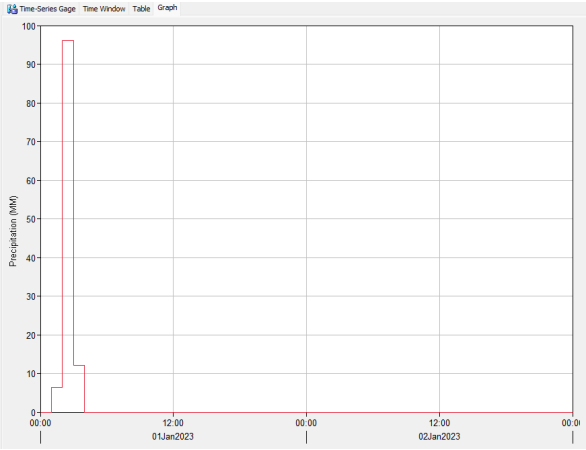


Figure 9. Grafik *Time Series Data*
Source : HEC-HMS Analys

4. Control Specifications (Waktu proses running)

Control Specifications is the time input When begins and ends execution (*running*) of the program and the desired time interval (15 minutes, 1 hour, or 1 day). Procedure used The same like with making *basin model* nor *meteorological model* . On research This use *Control Specifications* 2 days with *start time* and *end time* are 00:00 , as well using *a time interval* of 1 day

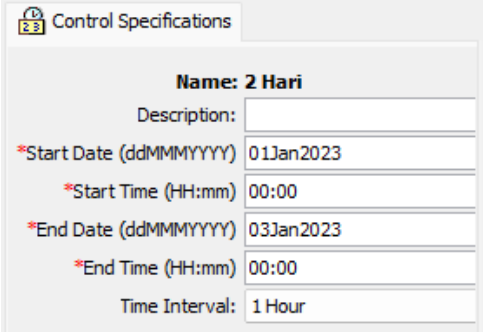


Figure 10. Input Control Specification
Source : HEC-HMS Analys

5. Simulation Run

After step charging parameter values and some step previous , step furthermore that is with do *Simulation Run* , steps This intended For know value and results from bulk data it

has rained inputed before so that get something results form description information chart value that describes flood discharge peak etc .

4. RESULTS and DISCUSSION

Map o *verlay* generated mark Smallest *Curve Number* (CN). with value 40 scattered on the land forest plant , with type podzolic chocolate grayish , whereas mark The largest *Curve Number* (CN). obtained amounting to 82 spread across residential areas with type land Regosol . So that from map *overlays* can seen spread pattern ability land in absorb water and produce runoff .

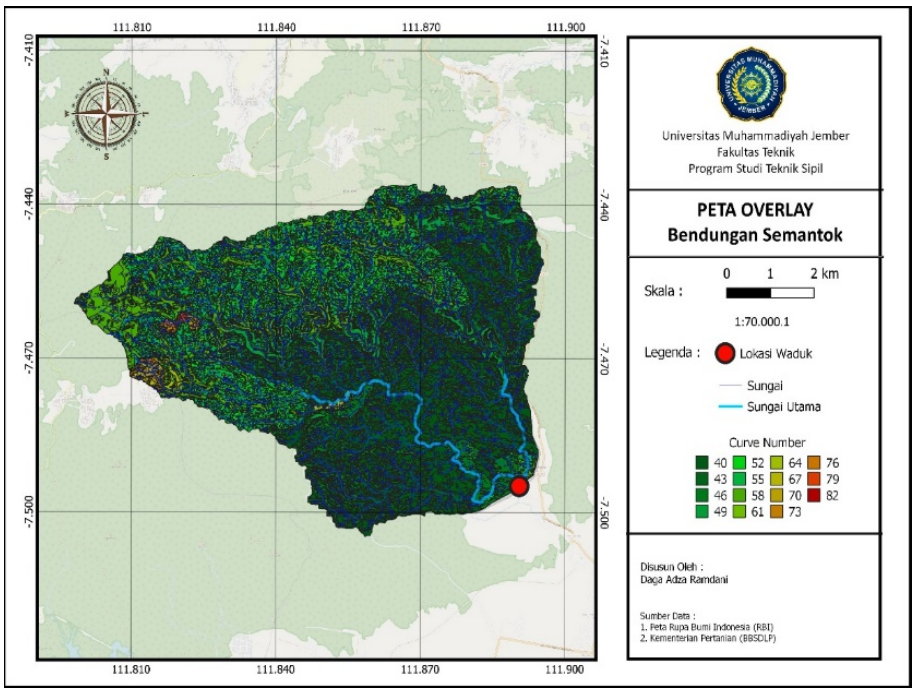


Figure 11. Peta Overlay
Source : ArcMap 10.8

Determination of the aiming grid For determine the region water catchment as well get future coordinates entered on the rain data website GPM satellite , On research This determination The number of grids is determined to be 10 so that the data obtained can more spread with scale 1:79,000, fig results analysis grid map can seen as following :

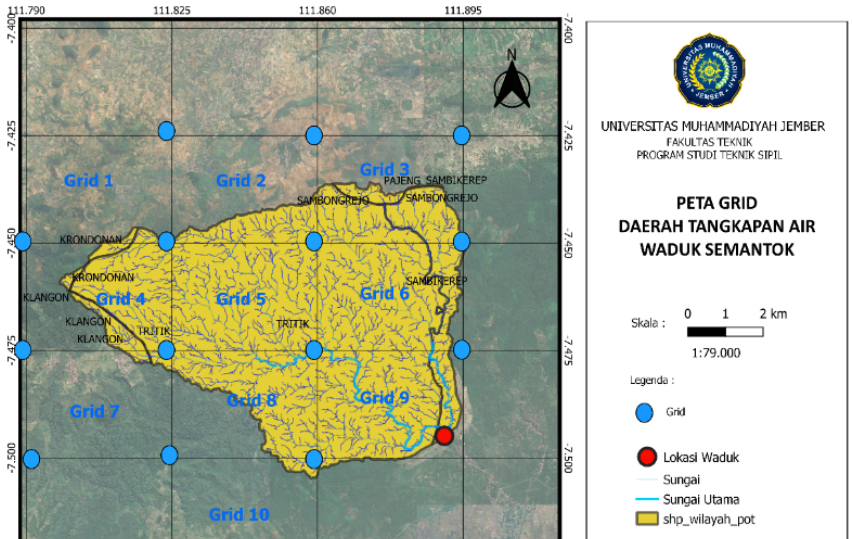
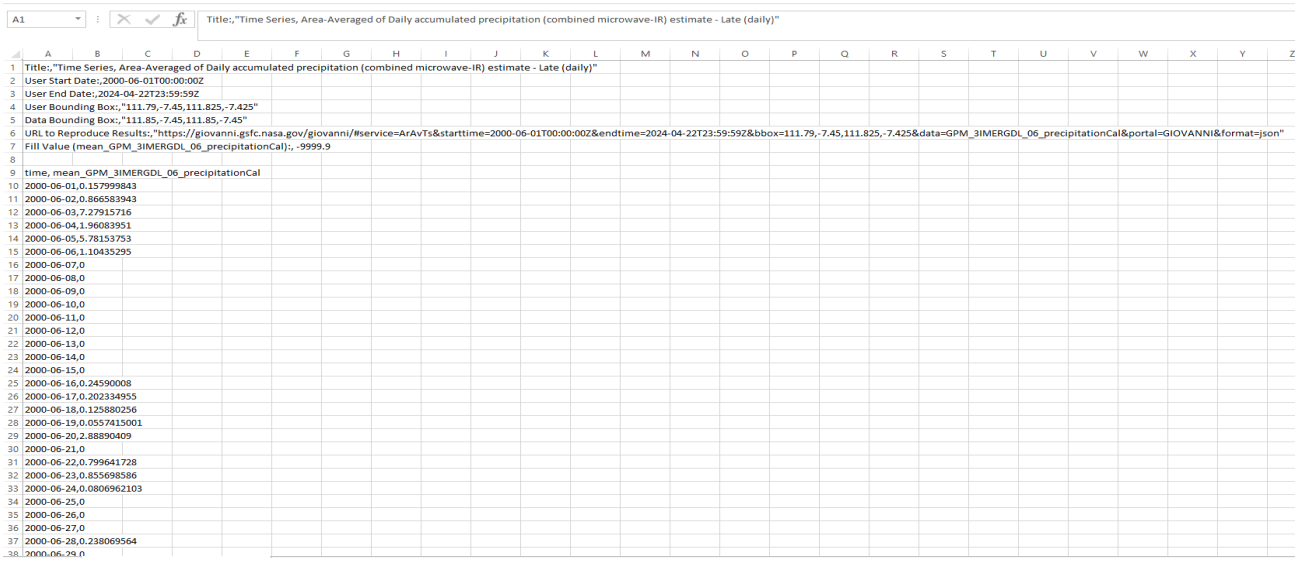


Figure 12. Grid Map
Source : ArcMap 10

Figures and tables following is results download process GPM satellites on the Giobanni Nasa website can seen in the picture as following :



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	Title:,"Time Series, Area-Averaged of Daily accumulated precipitation (combined microwave-IR) estimate - Late (daily)"																									
2	User Start Date:,2000-06-01T00:00:00Z																									
3	User End Date:,2024-04-22T23:59:59Z																									
4	User Bounding Box:,"111.79,-7.45,111.825,-7.425"																									
5	Data Bounding Box:,"111.85,-7.45,111.85,-7.45"																									
6	URL to Reproduce Results:,"https://giovanni.gsfc.nasa.gov/giovanni/#service=ArAvTs&starttime=2000-06-01T00:00:00Z&endtime=2024-04-22T23:59:59Z&bbox=111.79,-7.45,111.825,-7.425&data=GPM_3IMERGDL_06_precipitationCal&portal=GIOVANNI&format=json"																									
7	Fill Value (mean_GPM_3IMERGDL_06_precipitationCal):, -9999.9																									
8																										
9	time, mean_GPM_3IMERGDL_06_precipitationCal																									
10	2000-06-01,0.157999843																									
11	2000-06-02,0.866583943																									
12	2000-06-03,7.27915716																									
13	2000-06-04,1.96083951																									
14	2000-06-05,5.78153753																									
15	2000-06-06,1.10435295																									
16	2000-06-07,0																									
17	2000-06-08,0																									
18	2000-06-09,0																									
19	2000-06-10,0																									
20	2000-06-11,0																									
21	2000-06-12,0																									
22	2000-06-13,0																									
23	2000-06-14,0																									
24	2000-06-15,0																									
25	2000-06-16,0.24590008																									
26	2000-06-17,0.202334955																									
27	2000-06-18,0.125880256																									
28	2000-06-19,0.0557415001																									
29	2000-06-20,2.88890409																									
30	2000-06-21,0																									
31	2000-06-22,0.799641728																									
32	2000-06-23,0.855698586																									
33	2000-06-24,0.0806962103																									
34	2000-06-25,0																									
35	2000-06-26,0																									
36	2000-06-27,0																									
37	2000-06-28,0.238069564																									
38	2000-06-29,0																									

Figure 13. Rain data download results GPM satellite
Source : giovanni.gsfc.nasa.gov

Table 1. Maximum Daily Rainfall Table Annual (HHMT).

Year	Rainfall (mm)
2004	141.86
2005	72.51
2006	223.97
2007	120.35
2008	114.19
2009	106.02
2010	142.02
2011	121.63
2012	105.56
2013	149.94

2014	76.69
2015	105.10
2016	123.94
2017	71.55
2018	97.15
2019	81.40
2020	131.62
2021	83.38
2022	138.98
2023	81.20

Source : Calculation results

Next on the calculations analysis end use hydrogonom with select the Forecast menu click To *Return Period* (*Max*), then enter Tr=100 Years , result analysis calculation bulk Rain 100 year anniversary plan of 230.647 mm.

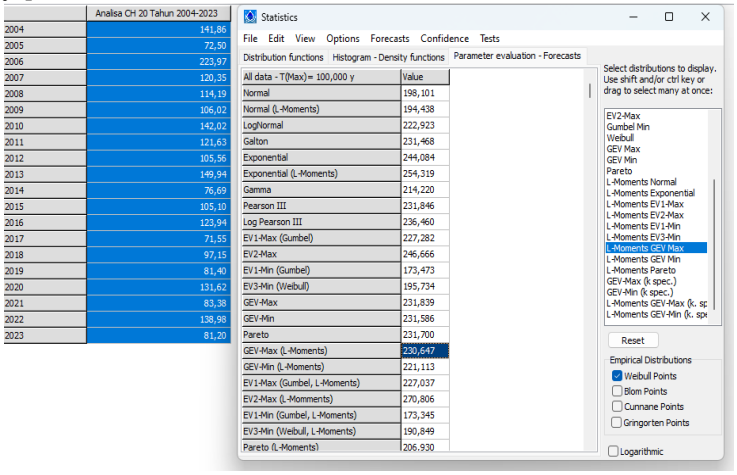


Figure 14. Results of Rainfall Analysis Tr 100 design
Source : Application Hydrognomon

Table 1. Rainfall Table Design

No	Return Time (Tr)	Rain Draft (mm)
1	2	108.12

2	5	139.83
3	10	161.26
4	25	188.84
5	50	209.66
6	100	230.65

Source : Calculation results

In the calculation of the Smirnov Kolmogrov test, the test results were obtained using *Hydrognomon* can seen in the picture following :

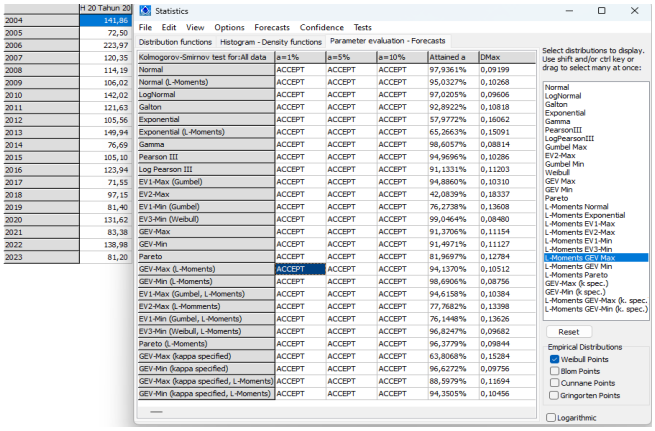


Figure 15. Result Of Smirnov Kolmogorov Analysis
Source : Calculation results

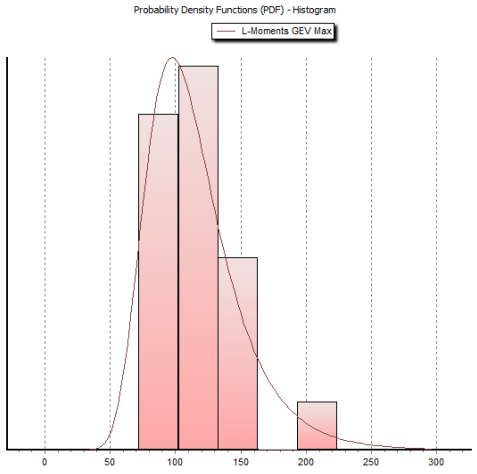


Figure 16. Bar Chart Of Hydrognomon Analysis
Source : Calculation results

Table 2. Watershed Area Classification

No	Watershed area (km ^{2})	Classification	Duration	Tc
1	>100	Big Watershed	>=24 hours	HRCS Velocity Method

2	10-100	Intermediate Watershed	<=24 hours	Kripich
3	1-10	Small Watershed	<24 hours	Kerby

Source : Module 1 Rainfall Analysis Baltek Dam , 2022

On research This Dam watershed area Semantok amounting to 54 km ^{2} so that classification watershed area for determine duration or distribution Rain is an intermediate watershed i.e. <=24 hours, so use duration of hours 6 hours . In research This use method distribution raining every now and then use method distribution to in method distribution temporal PSA 007 model Genta, following is results from calculation bulk raining every now and then using the Genta model PSA 007 Method:

Table 4.. Hourly Distribution Table PSA 007 6 Hours m

Return Time	R_{24}	R_6		Distribution rain (mm)					
				Hour -					
	(mm)	(%)	(mm)	1	2	3	4	5	6
2	108.12	79	85.63	3.43	5.02	60.97	9.36	3.43	3.43
5	139,83	78	109,07	4.36	7.27	76.35	12.36	4.36	4.36
10	161,26	76	122,56	4.90	9.80	83.34	14.71	4.90	4.90
25	188,84	75	141,63	5.67	12.27	94.89	17.47	5.67	5.67
50	209,66	73	153,05	6.12	15.31	99.48	19.90	6.12	6.12
100	230,65	72	166,07	6.64	17.71	106.28	22.14	6.64	6.64

Source: Calculation Results

Distribution method PSA 007 temporal rain pattern model clapper in a way general modeling pattern become distribution raining every now and then Where intensity the rain is greatest in this section middle hyetograph of 106.28 mm at the 3rd hour, decreasing in section beginning hyetograph amounted to 6.64 mm at the 1st hour, and also decreased in section end hyetograph of 6.64 mm at the 6th hour

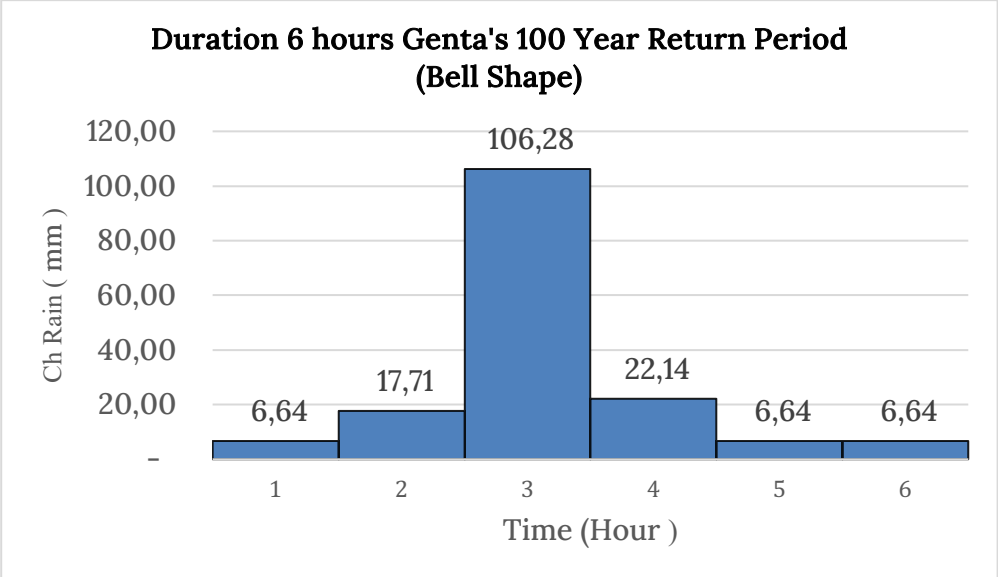


Figure 17. Genta Bell Shape PSA 007 graph for 6 hour period 100th anniversary .
Source : Calculation results

After do spatial data analysis with the Arc- Gis program can done use modeling hydrology with flood discharge output simulation with repeat time use UH Synder method as well has through stages of the analysis process hydrology using HEC-HMS through stages *basin model*, input subbasin parameters, input time series data, control specification, and simulation run, then can analyzed chart as following :

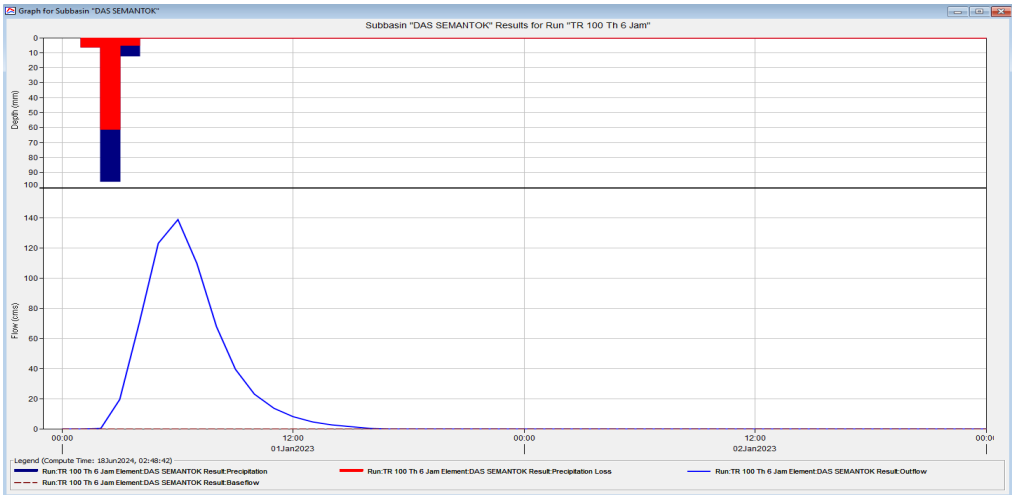


Figure 18. Graph Of Simulation Flood Q100 model HEC HMS
Source : HEC-HMS analys

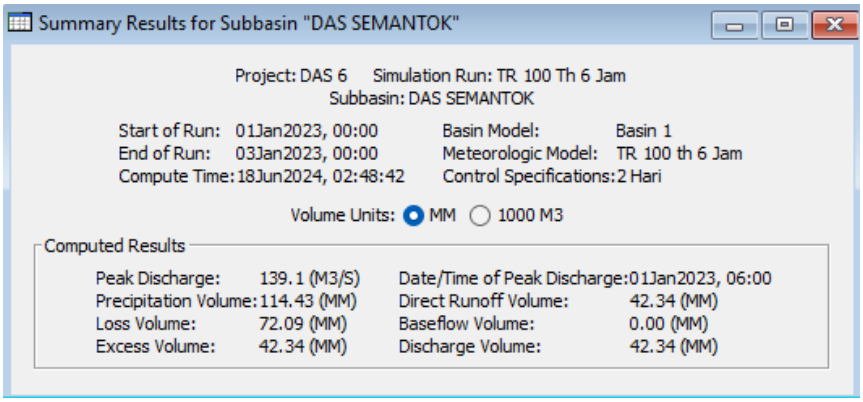


Figure 19. Summary Result for Subbasin
Source : HEC-HMS analys

As for the results from The HEC-HMS model simulation is obtained results Hydrograph Q 100 Year flood with *control Specification* 2 days amounting to 139.1 m ^{3} / second on January 1 2023 at 06:00, and the discharge *volume* of 42.34 mm.

5. CONCLUSION

Potency water availability in the area dam water catchment semantok with area that has been lineated amounting to 53.71 km2 based on from calculation of rain data GPM (Global Precipitation Measurement) satellite for 20 years from 2004 to with 2023 being simulated using the resulting HEC-HMS model Hydrograph Q 100 Year flood with control Specification 2 days amounting to 139.1 m3/ second on January 1 2023 at 06:00, and the total outflow volume was 42.34 mm

Acknowledgments

About discharge modeling with rainfall data satellite need corrected with rain data surface (groundstation).

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