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Dam-Break Simulation of the Sepaku Semoi Dam Using Zhong Xing Hy21 For Flood Hazard Mapping and Disaster Mitigation Planning

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Abstract

Water is a vital resource for human survival, and its limited availability requires effective management, including dam construction. The Sepaku Semoi Dam in Indonesia has a storage capacity of 10 million m^3 and a reservoir area of 280 hectares, serving to mitigate floods and supply raw water of 2,000 L/s to the National Capital (IKN) and 500 L/s to Balikpapan. Despite these benefits, dams pose risks of failure, particularly dam break events that may cause flash floods. This study analyzes the potential dam break of the Sepaku Semoi Dam due to piping phenomena using Zhong Xing HY21 software. The simulation assessed inundation extent, water depth, flood arrival time, inundation, and flow velocity. The PMF discharge was 1,537.50 m^3/s, while the peak outflow discharge from the dam-break simulation reached 4,043.37 m^3/s. The reported simulation time of 2.25 hours should be clarified as either flood arrival time, failure time, or time to peak outflow. *Results indicate that overtopping does not lead to dam break, whereas bottom piping under design flood conditions produces the most severe impacts. Extreme piping scenarios result in flood inundation across five villages: Kel. Mentawir, Wono Sari, Suka Raja, Argo Mulyo, and Tengin Baru. Based on the national dam hazard zone classification, all five affected villages fall within Zone 1, with flood depths exceeding 0.6 m. Based on FEMA classification, Kel. Mentawir, Wono Sari, and Tengin Baru are categorized as extreme hazard, Argo Mulyo as high hazard, and Suka Raja as moderate hazard.*

Keywords: *Sepaku semoi dam, piping, dam break, flood, hazard classification*

INTRODUCTION

Dam construction is viewed as a potential solution to enhance water resilience and meet the water needs of communities, as recognized by ADB as cited in (Pambudi et al., 2023). Regulation of Minister of Public Works and Public Housing Regulation No. 27/PRT/M/2015 defines dams as earth, stone, or concrete structures that function to store water and as barriers for mine waste or mud, forming reservoirs (Kementerian Pekerjaan Umum dan Perumahan Rakyat, 2015). For example, the Sepaku Semoi Dam plays a role in flood reduction and supplies raw water to Balikpapan and the Capital City of Indonesia. Despite the myriad benefits of dams, their potential hazards cannot be overlooked (Erduran et al., 2024). Dam failures, whether caused by natural processes, structural deficiencies, or inadequate management, can trigger severe downstream disasters warns that flash floods resulting from dam breaches can sweep away buildings, infrastructure, and even lives (Adityawan et al., 2023). Similar disasters are emphasized (Pambudi et al., 2023), who notes the potential for damage to infrastructure, the environment, and loss of life. Categorizes these events as serious natural disasters (Khanal et al., 2025). The calculation of reservoir simulation begins by processing rainfall data so that the value of the design discharge and reservoir inflow discharge is obtained (Sejati et al., 2024). An illustrative example is the incidents in Libya, where the dam break of two dams caused flash floods resulting in thousands of casualties and significant damage (Adhitya et al., 2020). The types of data in this study consist of two categories: primary and secondary data (Kamil & Sejati, 2025). The potential hazards of dam break are reinforced by various factors, including inadequate design, poor construction, and lack of maintenance, as articulated by experts (Nasser et al., 2025). Therefore, efforts in prevention, mitigation, and sound management are crucial to avoid adverse impacts from dam failureskarin (Karin et al., 2024). Cracks due to overtopping occur when the dam cannot contain excess water, causing erosion downstream of the dam body (Sejati, Wahyu et al., 2024). The dam-break disaster in Libya illustrates the severe consequences of inadequate dam safety management. and similar events in other countries demonstrate how responsible dam management can save lives and prevent greater damage (X. Z. W. Zhang et al., 2024) Indonesia it self has experienced dam break, such as the Gintung Dam tragedy in 2009. The Sepaku Semoi Dam, with a capacity of 10

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million m^3, is the focus of this research. Due to its critical role, regular inspections and maintenance are necessary anticipate dam break risks (Affandi et al., 2024). Analysis of dam break is a crucial study for disaster mitigation. This research utilizes the Zhong Xing HY21 software (Ayu et al., 2021) also support this, citing HY21's reliability in dam break analysis across various countries. Not only software, but analytical methodology is also highlighted (Razak et al., 2024) Emphasizes the importance of flood inundation mapping and determining the distance from dams to potentially affected locations, which is in line with the objectives of this research. Further highlights the relevance of factors such as flow velocity, inundation depth, duration, and flood arrival time all of which are examined in this study (Sumira et al., 2023). Previous studies have commonly employed HEC-RAS 2D and CHIRPS satellite rainfall data, as demonstrated (Pambudi et al., 2023). In contrast, this study applies the Zhong Xing HY21 model, which is expected to provide more accurate and comprehensive analyses of dam break impacts, thereby strengthening disaster mitigation strategies. The research also incorporates flood tracing through spillways, development of flood distribution maps, delineation of inundation areas, and hazard classification of the Sepaku Semoi Dam dam break scenario. These efforts are anticipated to generate valuable datasets for reducing flood disaster risks resulting from dam failures (Yuan et al., 2024).

METHODOLOGY

This research method for analyzing flood flows and calculating dam opening parameters at Sepaku Semoi Dam involves a multidisciplinary approach. Sepaku Semoi Dam can be found in North Penajam Paser Regency, East Kalimantan, located in Sepaku District. Specifically, the dam is situated at coordinates 116°50’22.15" E and 0°54’31.90" S (Sejati, Wahyu et al., 2024).The dam failure analysis conducted in this study utilizes the Zhong Xing HY21 application following the technical guide for using Zhong Xing HY21 software through several trial-and-error stages. Zhong Xing HY21 software is a Windows-based application developed by Sinotech Engineering Group, Taiwan (Erdwyansa et al., 2024). This software functions to simulate and visualize flood distribution resulting from dam failures (Purwanto et al., 2017). Determining dam failure scenarios is crucial in the initial stages before conducting the dam failure simulation (Bharath et al., 2021).

Figure 1 Sepaku Semoi Dam Location

The stages of this research were carried out starting with conducting a hydrological analysis of the dam, then running the program to analyze the dam break, and finally analyzing the results of the dam break analysis. An explanation of the steps of the research on the collapse of the Sepaku Semoi Dam is as follows.

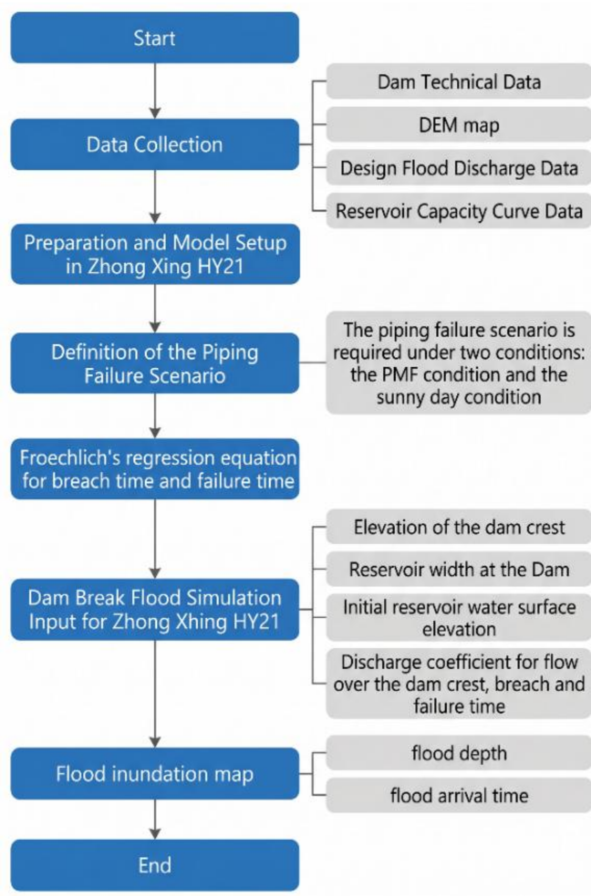

Figure 2 Research Flowchart

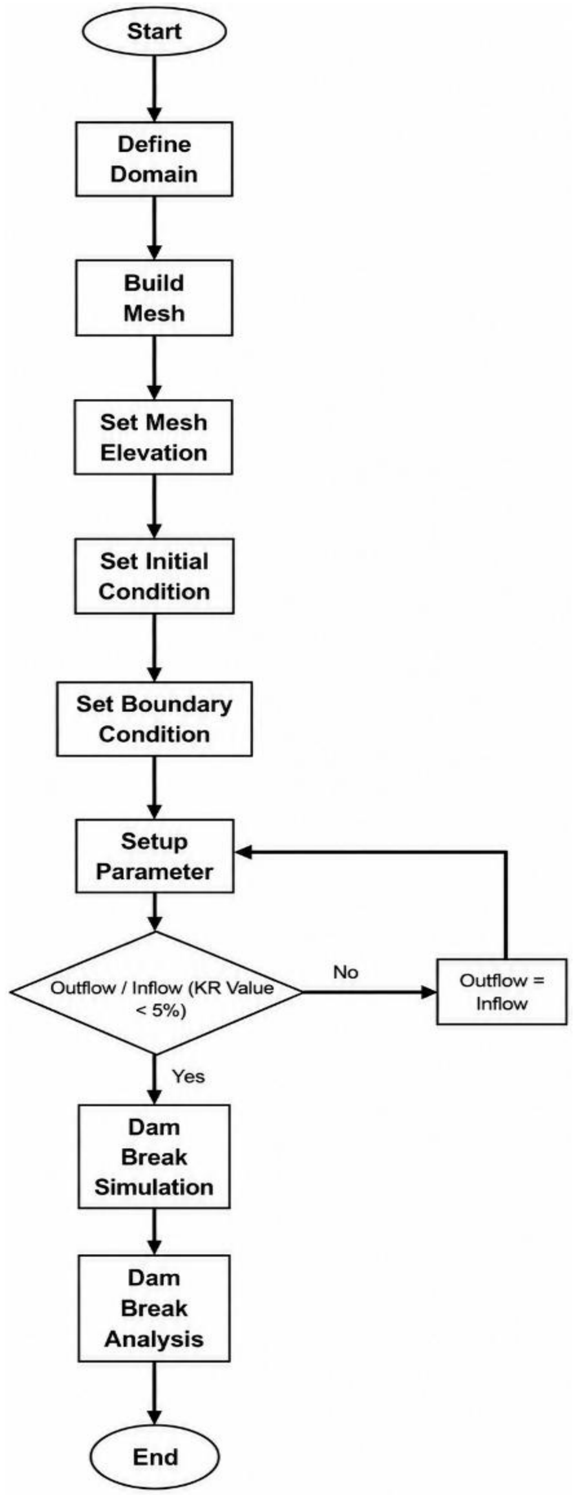

Figure 3 Dam Break Analysis Flowchart

Piping failure begins when seepage initiates through the dam body or bottom. As the seepage path enlarges, more water flows through the opening and progressively erodes the surrounding material. Froehlich (1987 as cited in (Aryadi et al., 2014) regression equation for the average breaching width and breaking time is expressed as follows (Aryadi et al., 2014):

$B\_BAR = 9.5\ K\ ((Vr\ hd)^{0.25})$ ....(1)

$TIME\_BF = 0.8\ ((Vr\ /\ hd2)^{0.5})$ ....(2)

With:

With: Bave = average breaching width (m)

K0 = constant (1.3 for the break of overtopping, 1.0 for piping)

Vr = storage volume at the break (m^3)

Hd = breaching final height (m)

Tf = breaking time (sec)

Froehlich stated that the height of the break is usually calculated by assuming that the break travels from the top of the Dam to the natural ground level at the site of a dam break (Ayu et al., 2021).

The data and parameters required for the Sepaku Semoi Dam break analysis using the Zhong Xing HY21 software are presented in Table 1.

Table 1 Zhong Xing HY21 Input Parameters

Scenario	**Flood Water Level**			**Unit**
	Upper Piping	*Middle Piping*	*Lower Piping*	
	(Scenario 1)	(Scenario 2)	(Scenario 3)	
Upper Boundary	As Dam	As Dam	As Dam	
Lower Boundary	Downstream	Downstream	Downstream	
Elv. Crest Dam	28,13	28,13	28,13	m
Length Dam	450	450	450	m
Elv. MAB	25,19	25,19	25,19	m
Lebar Spillway	40	40	40	m
Elv. Crest Spillway	22	22	22	m
H_FAIL	25,19	25,19	25,19	m
H_BM	10,13	10,13	10,13	m
B_BAR	56,43	74,27	84,39	m
TIME_BF	12,86	4,29	2,57	hours
	46290,83	15430,28	9258,17	second
H_PIPE	22,68	17,66	12,64	m
Q_{inflow} PMF	1537,5	1537,5	1537,5	m^3/s

In this study, the determination of the hazard classification level was based on the guidelines provided by the Federal Emergency Management Agency (FEMA) Guidelines and Standards for Flood Risk Analysis and Mapping (Federal Emergency Management Agency (FEMA), 2020). The criteria for determining the flood hazard level caused by dam failure were established by considering the flood depth x velocity product parameter (Mirsa, et al., 2021). The flood hazard classification levels are presented in Table 2.

Table 2 Flood hazard classification

No.	Category	Depth x Velocity (m^2/s)
1.	Low	< 0,2
2.	Medium	0,2 – 0,5
3.	High	0,5 – 1,5
4.	Very High	1,5 – 2,5
5.	Extreme	> 2,5

Source: Adapted from Mirsa et al. (2021)

RESULTS AND DISCUSSION

Data Collection

The summary of design flood discharge and Probable Maximum Flood (PMF) data obtained from the Kalimantan IV River Basin Agency was used in the dam failure simulation with the Zhong Xing HY21 program. The flood discharge data considered include the design flood for the 1,000-year return period and the PMF. To determine the maximum design flood discharge, the highest discharge values for each return period were applied. Based on the analysis, PMF flood discharge is 1,537.50 m^3/s. Furthermore, the reservoir capacity curve was employed for flood routing through the spillways to assess whether the PMF design flood discharge would result in overtopping. The results of the flood routing analysis over the spillway are presented in Table 3 and Figure 4.

Table 3 Flood Routing Analysis over the Spillway for the Probable Maximum Flood (QPMF) Scenario

t (hour)	Inflow (m^3/s)	$(I_1+I_2)/2$ (m^3/s)	Outflow (m^3/det)	Elevation (m)
0	2.000	0.000	2.000	22.069
1	3.300	2.650	2.005	22.069
2	4.300	3.800	2.020	22.070
3	7.000	5.650	2.050	22.071
4	13.800	10.400	2.119	22.073
5	22.600	18.200	2.252	22.078
6	68.300	45.450	2.608	22.090
7	126.300	97.300	3.388	22.117
8	174.700	150.500	4.601	22.159
9	217.000	195.850	6.519	22.214
10	353.200	285.100	10.760	22.293
11	596.900	475.050	18.246	22.425
12	1537.500	1067.200	40.857	22.723
13	1438.900	1488.200	78.420	23.108
14	1027.800	1233.350	109.218	23.375
15	696.800	862.300	131.436	23.549
16	499.900	598.350	145.913	23.657
17	398.600	449.250	155.634	23.727
18	274.200	336.400	161.427	23.769
19	186.600	230.400	163.637	23.785
20	138.700	162.650	163.605	23.784
21	115.600	127.150	162.437	23.776
22	104.100	109.850	160.752	23.764
23	99.100	101.600	158.856	23.750
24	96.000	97.550	156.892	23.736
25	82.400	89.200	154.722	23.721
26	64.300	73.350	152.115	23.702
27	45.300	54.800	148.996	23.679
28	26.100	35.700	145.365	23.653
29	13.800	19.950	141.346	23.624
30	7.500	10.650	137.215	23.594
31	4.500	6.000	133.300	23.564
32	3.100	3.800	129.437	23.534
33	2.500	2.800	125.659	23.505
34	2.100	2.300	121.979	23.476
35	2.000	2.050	118.402	23.448
36	1.900	1.950	114.928	23.421

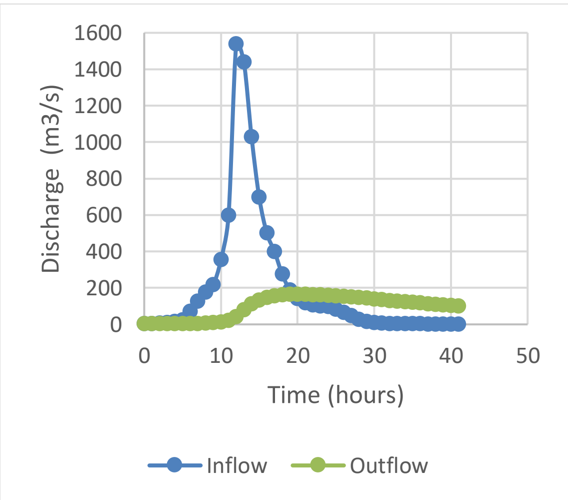

Figure 4 Graph of QPMF Inflow and Outflow Relationship on Spillway

Table 4 Sepaku Semoi Dam Reservoir Capacity

No.	Elevation	High from Base	Embung height	Area	Volume
	(mdpl)	m	m	Ha	m³
1	9	0	7	0.13	-
2	10	1	8	0.23	1,785.24
3	11	2	9	3.00	15,352.67
4	12	3	10	4.15	50,933.34
5	13	4	11	11.17	124,668.39
6	14	5	12	25.51	303,190.53
7	15	6	13	35.93	608,897.06
8	16	7	14	54.10	1,055,923.71
9	17	8	15	103.63	1,831,254.10
10	18	9	16	124.14	2,968,571.65
11	19	10	17	146.98	4,322,600.85
12	20	11	18	177.28	5,941,570.97
13	21	12	19	207.52	7,863,598.57
14	22	13	20	232.51	10,062,567.30
15	23	14	21	266.88	12,557,552.13
16	24	15	22	292.33	15,352,624.75
17	25	16	23	314.94	18,388,258.07

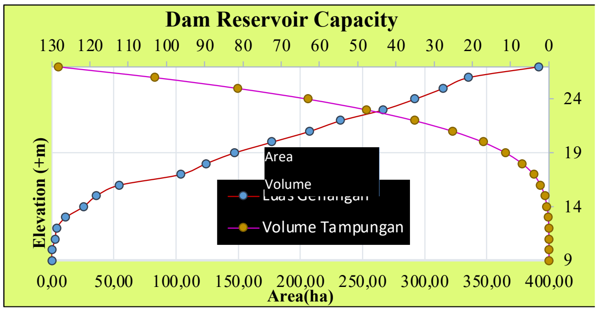

Figure 5 Sepaku Semoi Dam Reservoir Capacity

Analysis of Sepaku Semoi Dam Failure using the Zhong Xing HY21 Application

The analysis of dam failure was conducted following flood routing in order to determine the appropriate flood scenarios for failure assessment. Based on the results of the routing analysis, three scenarios were evaluated: failure due to upper piping, middle piping, and bottom piping. Since the Sepaku Semoi Dam does not experience overtopping, failure analysis under overtopping conditions was not considered necessary.

The simulations were performed using the Zhong Xing HY21 program, with topographic input provided by a Digital Elevation Model (DEM) (Saranani et al., 2024). Prior to use, the DEM data were processed in the Global Mapper application to adjust the coverage area and subsequently converted into jpg format, making it compatible with Zhong Xing HY21. The creation of boundary curves within the model was based on assumptions and carried out in two stages: first, the delineation of flood boundaries around the dam, and second, the delineation of river boundaries extending from the upstream to the downstream at the dam axis.

Two areas are formed: the outer area covering the flood boundary and the inner area defining the boundary of the main downstream river (Saranani et al., 2024). Mesh density significantly affects the distribution of resulting floods. A denser mesh or smaller mesh density values lead to more accurate and detailed flood distributions. The running process is performed twice with different mesh densities to compare the flood inundation results from both simulations. In this analysis, two types of boundary conditions are used: upper boundary and lower boundary. The lower boundary refers to the axis of the Sepaku Semoi Dam, while the upper boundary is the downstream area of the Sepaku Semoi Dam. For the upper boundary, no additional data input is required as it is not affected by factors such as tidal fluctuations or other factors.

For the lower boundary, several parameters must be specified, including technical data of the dam. The inputs required during the simulation process consist of the dam span, reservoir water surface elevation at the planned failure, dam crest elevation, and other structural parameters. In this study, the failure scenario applied is piping, since the Sepaku Semoi Dam did not exhibit overtopping failure conditions.

The dam failure simulation data include the initial failure elevation, final failure elevation, crack width, and failure time. These parameters are essential for the simulation model configuration, as they determine how the Zhong Xing HY21 software executes flood simulations under predefined conditions. In this analysis, output data were retrieved at intervals of 900 seconds, while the total simulation time was set to 345,600 seconds (equivalent to four days).

Additionally, simulation control parameters were adjusted based on the number of iteration steps defined for each run. The initial simulation was carried out using the cold run mode, which serves as the first step in running the model. Subsequently, the hot run mode was applied to continue the simulation from a previous cold run, ensuring computational efficiency and continuity in the modeling process.

The simulation process was carried out based on predetermined parameters and scenarios by inputting all necessary data (Affandi et al., 2024). An output generated by the Zhong Xing HY21 program includes maximum flood water level elevation, maximum flow velocity in the channel, flood depth, flood arrival time, and receding time in the form of time series (Yu et al., 2025). Besides the time series, other output results include flood inundation maps, which are further overlaid with administrative area maps around the Sepaku Semoi Dam to determine affected areas. The flood maps resulting from the dam break are derived from the findings of the dam failure analysis conducted using the Zhong Xing HY21 program. The overall purpose of these maps is to provide information about areas prone to flooding due to sediment dam break (Mello & Eleutério, 2025). The local Government can use these maps to issue warnings and alerts to the public, coordinate evacuation actions for at-risk individuals, based on the information provided in the maps. There are six alternatives in analyzing dam break: when the reservoir is filled to the normal water level under upper piping, middle piping, and lower piping conditions; and dam break analysis at the maximum flood water level or under PMF flood discharge conditions with upper piping, middle piping, and lower piping conditions. The results obtained from the six alternatives are shown in figure 6 – 11. The Dam breach simulation showing Flood design conditions (QPMF) and reservoir water level change over time following a breach event.

A. Flood Hydrograph and Reservoir Water Level Drawdown Curve

- Sunny Day Breach Collapse Scenario Upper Piping Condition (QPMF)

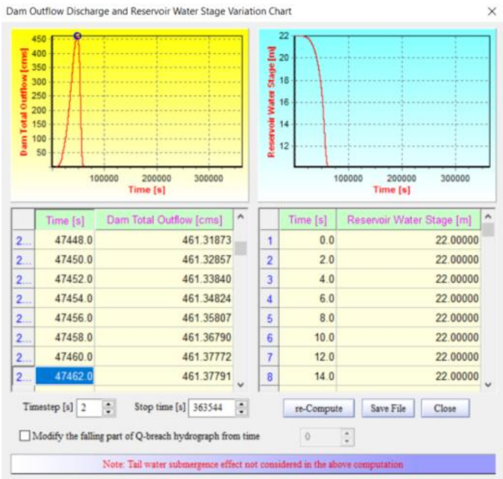

Figure 6 Flood Hydrograph and Reservoir Subsidence Curve Upper Piping Scenario Normal Water Level Condition

- Sunny Day Breach Collapse Scenario Middle Piping Condition

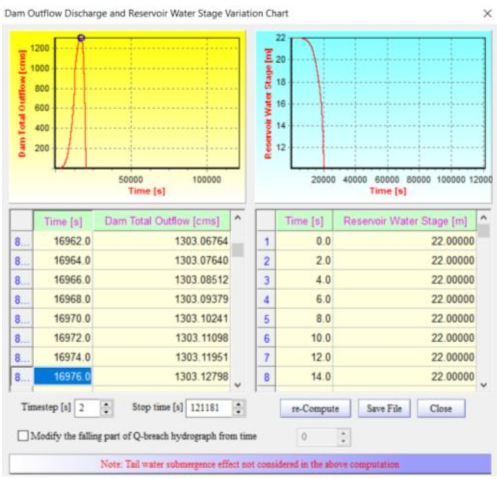

Figure 7 Flood Hydrograph and Reservoir Subsidence Curve Middle Piping Scenario Normal Water Level Condition

- Sunny Day Breach Collapse Scenario Base Piping Condition

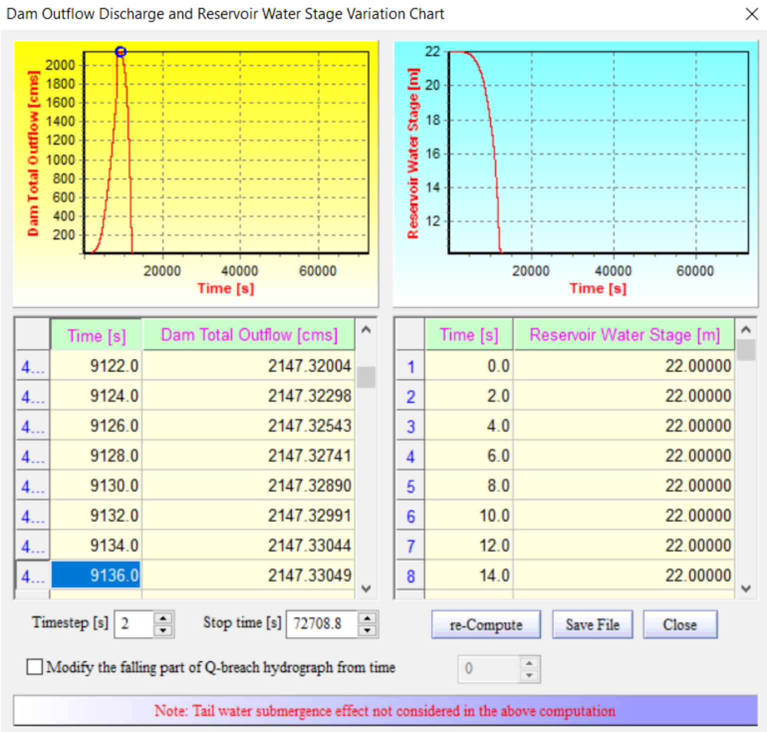

Figure 8 Flood Hydrograph and Reservoir Subsidence Curve Base Piping Scenario Normal Water Level Condition

- Upper Piping Collapse Scenario Flood Design Condition (QPMF)

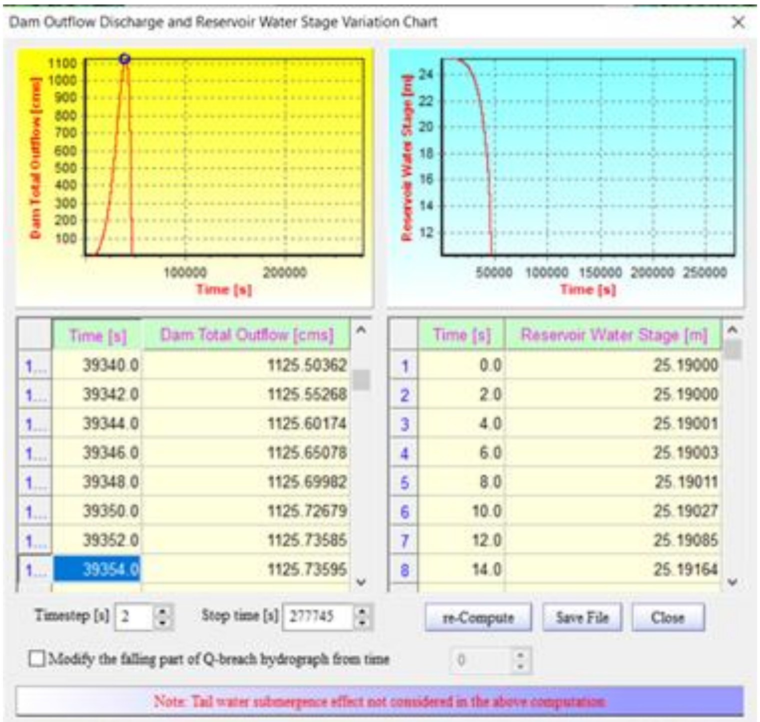

Figure 9 Flood Hydrograph and Reservoir Subsidence Curve Upper Piping Scenario Flood Design Condition

- Middle Piping Collapse Scenario Flood Design Condition (QPMF)

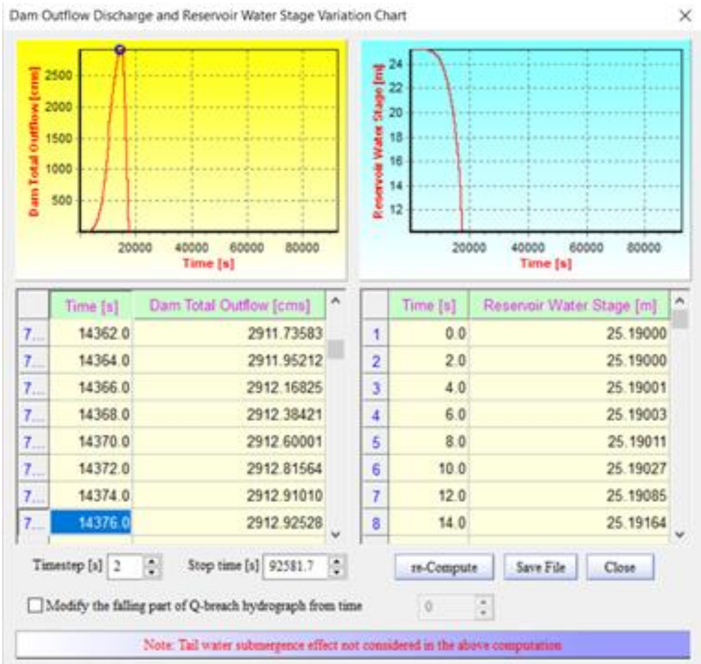

Figure 10 Flood Hydrograph and Reservoir Subsidence Curve Middle Piping Scenario Flood Design Condition

- Base Piping Collapse Scenario Flood Design Condition (QPMF)

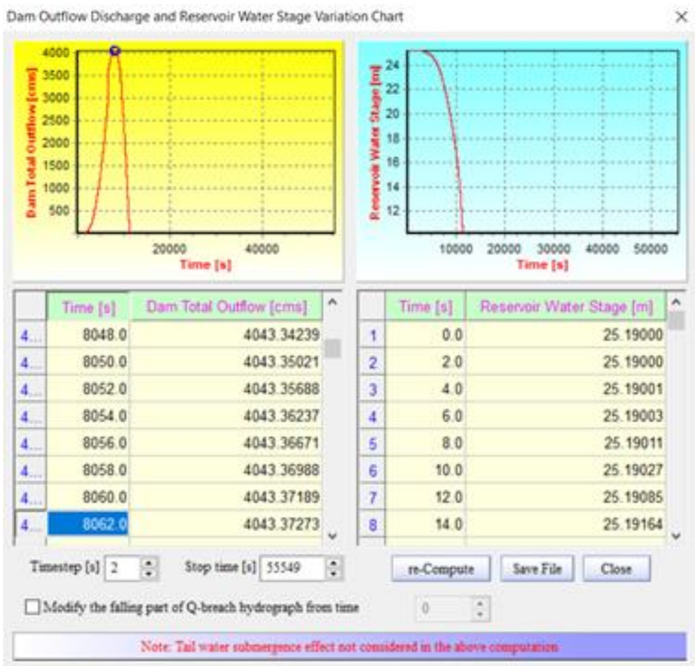

Figure 11 Flood Hydrograph and Reservoir Subsidence Curve Base Piping Scenario Flood Design Condition

B. Flood Inundation Map

The flood map generated by the dam collapse is derived from the findings of the dam collapse analysis conducted with the Zhong Xing HY21 program. The purpose of the map as a whole is to provide information on areas that have the potential to cause flooding due to sediment collapse . The Local Government is able to carry out the process of warning and alerting the public, as well as taking evacuation measures for individuals at risk, in a coordinated manner, according to the map containing such information. The boundary conditions was developed in two stages: one for the floodplain boundary around the dam, and another for the river boundary, which starts and ends at the dam axis. Two areas were defined: the outer area, which represents the floodplain boundary, and the inner area, which defines the boundary of the main river flowing downstream. The two boundary conditions applied in the simulation are presented in Figures 12 and 13.

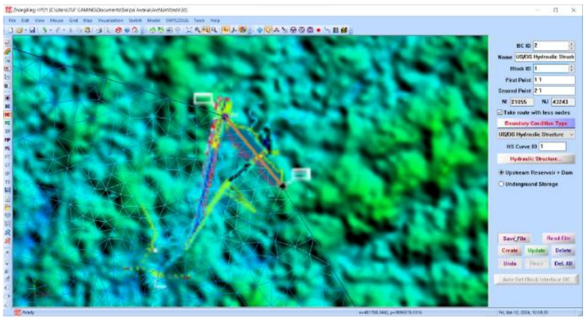

Figure 12 Upper Boundary

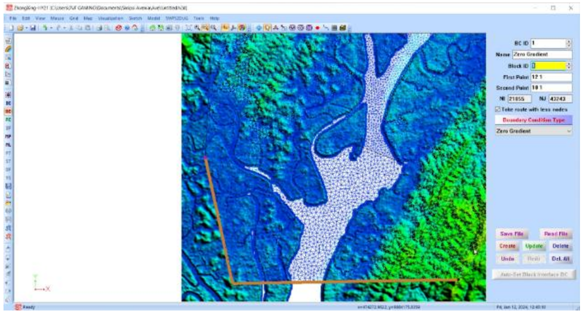

Figure 13 Lower Boundary

- Sunny Day Breach Collapse Scenario Upper Piping Condition

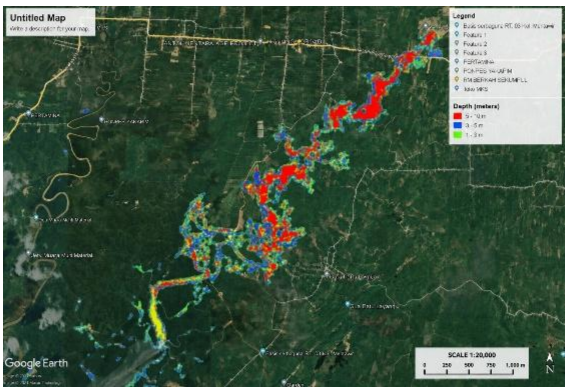

Figure 14 Flood Inundation Map of Sunny Day Breach Upper Piping Scenario

- Sunny Day Breach Collapse Scenario Middle Piping Condition

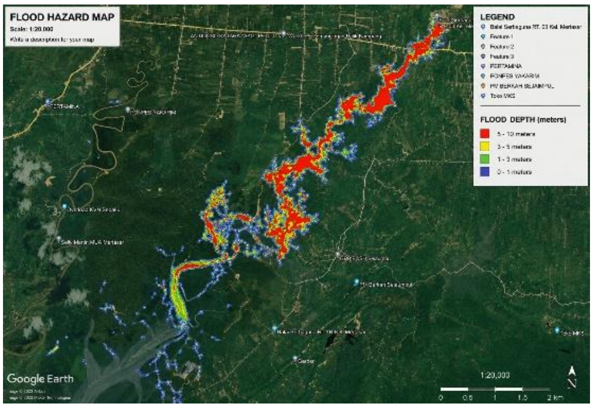

Figure 15 Flood Inundation Map of Sunny Day Breach Middle Piping Scenario

- Sunny Day Breach Collapse Scenario Base Piping Condition

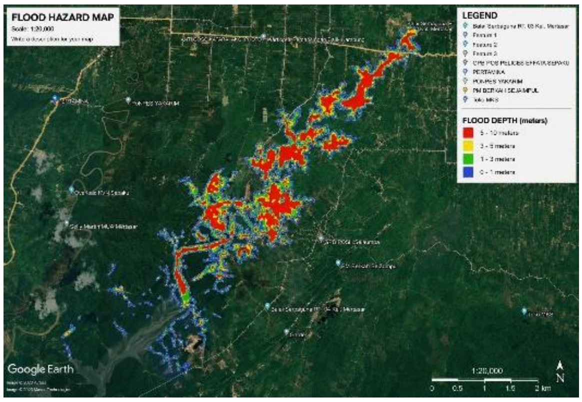

Figure 16 Flood Inundation Map of Sunny Day Breach Base Piping Scenario

- Upper Piping Collapse Scenario Flood Design Condition

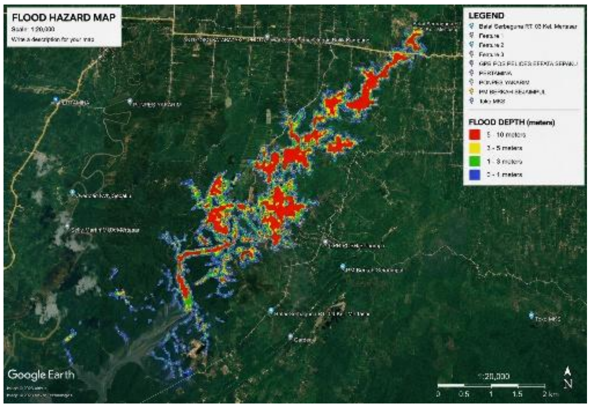

Figure 17 Flood Inundation Map of Upper Piping Scenario Flood Design Condition

From the results of the flood inundation map obtained during running, it can be concluded that the most extreme condition is the base piping scenario when the design flood occurs so that calculations are carried out to obtain the flood inundation area that occurs. In dam break simulations, the base piping failure scenario commonly produces the most critical condition, as the failure mechanism initiates at the lower part of the dam body, resulting in a faster and larger release of reservoir storage compared with other piping scenarios, such as middle and upper piping failures. The total flood inundation area obtained is 2,491,691.7314 m^2 or 249.1692 ha.

C. Affected Villages

The results of the running process through the Zhong Xing HY21 software are that there are 5 villages affected by flooding due to the Sepaku Semoi Dam collapse. Then the village data and village coordinates can be observed in Table 5.

Table 5 List of Villages Affected by the Sepaku Semoi Dam Collapse

No.	Village	District	X	Y
1	Kel. Mentawir	Sepaku	475764	9891670
2	Wono Sari	Sepaku	478606	9894500
3	Suka Raja	Sepaku	476562	9894850
4	Argo Mulyo	Sepaku	482208	9898760
5	Tengin Baru	Sepaku	481240	9898860

source: Running Program Zhong Xing HY21, 2024

D. Flood Depth

Obtained by running through Zhong Xing HY21 software, which generates hydrographs from time series table data in the most extreme scenario in all affected areas. In this case, the base piping scenario under design flood conditions is considered the worst-case scenario, based on the peak outflow discharge recorded in Table 2 at the time of the collapse. The resulting flood depth hydrograph at the time of the Sepaku Semoi Dam collapse can be found in figure 18.

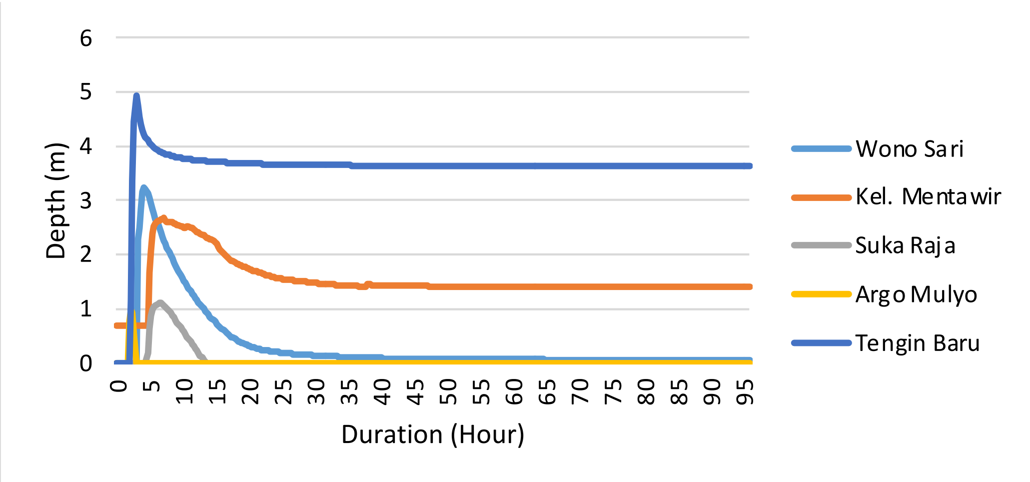

Figure 18 Flood Depth Hydrograph

Based on the hydrograph above, it can be seen that the floods that occurred in Tengin Baru Village and Kel. Mentawir Village did not recede. This is because the areas observed are river inundation areas. As for the other villages, the flood receded according to the time that can be seen in the flood depth hydrograph above.

E. Flood Water Elevation

Obtained through the process of running through Zhong Xing HY21 software, hydrographs were generated from time series table data in the worst scenario, i.e. based piping conditions. This scenario is based on the peak outflow discharge generated during the collapse. The resulting flood water level elevation hydrograph during the collapse of the Sepaku Semoi Dam can be found in Figure 19.

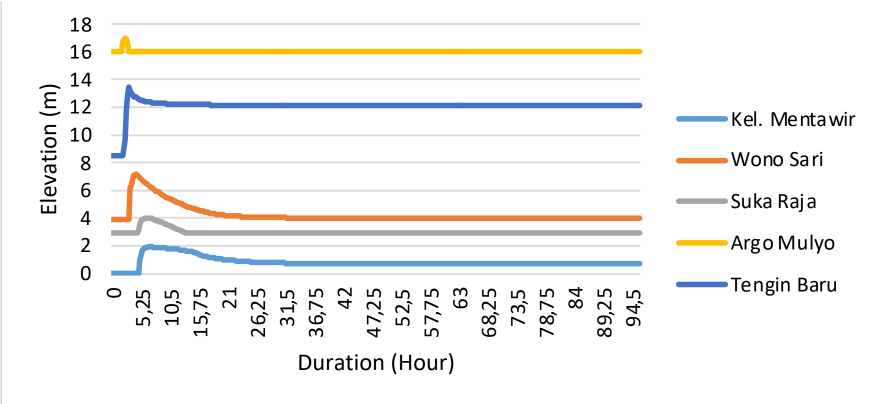

Figure 19 Flood Water Elevation Hydrograph

The flood water level elevation hydrograph above shows the relationship between flood water level elevation and time. Where each village experiences an increase and decrease in MAB elevation with different times.

F. Flood Propagation Velocity

Flood propagation velocity is obtained from the results of the running process through the Zhong Xing Hy21 program in the form of hydrographs from time series table data in the worst scenario, namely base piping conditions. The resulting flood propagation velocity hydrograph during the collapse of the Sepaku Semoi Dam can be seen in Figure 20.

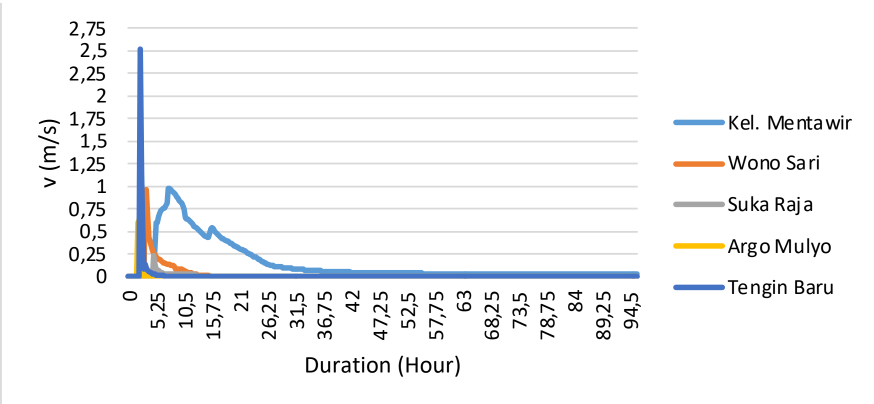

Figure 20 Flood Propagation Velocity Hydrograph

The hydrograph above shows the flood speed in each affected village against time. It can be concluded that the greatest flood velocity with a short time span occurred in Tengin Baru Village.

G. Flood Arrival Time and Settlement Time

Time travel is one of the components of a dam collapse analysis. This is because the time of flooding in a certain area, especially in residential areas, can be a guide for the surrounding community if one day the dam collapses.

Table 6 Arrival Time and Settling Time Due to Base Piping in Design Flood Condition

No	Village	Sub district	Regency	Flood Depth (m)	Flood Speed (m/s)	Arrival Time (Hour)	The time of low tide	Flood Duration (Hour)
1	Argo Mulyo	Sepaku	Penajam Paser Utara	0.978	0.699	1.75	3	1,25
2	Tengin Baru	Sepaku	Penajam Paser Utara	4.932	2.511	2.25	96	93,75
3	Wono Sari	Sepaku	Penajam Paser Utara	3.228	0.967	3.25	96	92,75

No	Village	Sub district	Regency	Flood Depth (m)	Flood Speed (m/s)	Arrival Time (Hour)	The time of low tide	Flood Duration (Hour)
4	Suka Raja	Sepaku	Penajam Paser Utara	1.103	0.231	4.75	13.75	9
5	Kel. Mentawir	Sepaku	Penajam Paser Utara	2.665	0.975	0.1	96	95,9

Source: Running Program Zhong Xing HY21, 2024

According to the analysis results of the running process through the Zhong Xing HY21 software, the basic piping scenario under design flood conditions has the highest outflow discharge at 4043.373 m^3/s than other scenarios and conditions. Details can be observed in Table 7.

Table 7 Comparison of Scenarios Output Results of Zhong Xing HY21

No	Scenario	Qout (m^3/s)	Time (h)
1	Sudden collapse under clear weather, reservoir filled to its normal water level (upper piping)	461.38	13.23
2	Sudden collapse under clear weather, reservoir filled to its normal water level (middle piping)	1303.13	4.72
3	Sudden collapse under clear weather, reservoir filled to its normal water level (bottom piping)	2147.33	2.54
4	Failure occurs under flood design conditions, reservoir water level at maximum flood level, where hydrograph inflow equals flood design inflow (upper piping)	1125.74	10.93
5	Failure occurs under flood design conditions, reservoir water level at maximum flood level, where hydrograph inflow equals flood design inflow (middle piping)	2912.93	3.99
6	Failure occurs under flood design conditions, reservoir water level at maximum flood level, where hydrograph inflow equals flood design inflow (bottom piping)	4043.37	2.2

The maximum outflow discharge of 4,043.373 m^3/s is primarily governed by the rapid enlargement of the breach under the base piping failure scenario, which accelerates the release of the reservoir storage. The high reservoir water level associated with the design flood condition generates a large hydraulic head across the breach, resulting in a substantial increase in flow velocity and discharge according to hydraulic principles. It is known that the basic piping scenario under design flood conditions has the greatest impact than other scenarios, so it can be decided that the one that can be the basis for the preparation of the Sepaku Semoi Dam Emergency Action Plan is the Collapse scenario under design flood conditions, reservoir water at the maximum flood level of the design flood, where the hydro inflow is the same as the design flood inflow (Base Piping).

Classification of Flood Hazard Levels due to the dam break of Sepaku Semoi Dam

After completing the run with Zhong Xing HY21, a flood inundation map in .dxf format is obtained, which can be opened in AutoCAD. Subsequently, it is overlaid with ArcGIS to identify affected villages. Following this, flood hazard levels are classified based on flood depth zones and according to FEMA classification. For the hazard zone classification, the flood depth parameter was used, where inundation depths of less than 0.6 m are classified as Zone 2, while inundation depths exceeding 0.6 m are classified as Zone 1, in accordance with the Decision of the Director General of Water Resources No. 257/KPTSD/D/2011 (Direktur Jenderal Sumber Daya Air, 2011). According to the FEMA classification, Suka Raja Village was categorized as medium hazard, Argo Mulyo Village as high hazard, while Kel. Mentawir, Wono Sari, and Tengin Baru Villages were categorized as extreme hazard.

CONCLUSIONS

This study evaluated the potential consequences of the Sepaku Semoi Dam failure under various piping scenarios using hydraulic dam-break simulations. The results indicate that the base piping failure scenario under the Probable Maximum Flood (PMF) represents the most critical condition, producing the highest peak outflow and the largest flood inundation extent. Under this scenario, The PMF flood discharge of 1,537.50 m^3/s and the peak outflow discharge resulting from the dam-break simulation was 4,043.37 m^3/s. the maximum flood inundation depth reached 4.93 m, the maximum flow velocity reached 2.51 m/s, and the earliest flood arrival time was 2.23 hours in the nearest downstream settlements. A total of five villages—Mentawir, Wonosari, Sukaraja, Argo Mulyo, and Tengin Baru—were identified as being directly exposed to dam-break flooding, with varying levels of hazard depending on their proximity to the dam and local topographic conditions. These findings provide quantitative information for flood hazard zoning by identifying areas with the greatest risk based on inundation depth, flow velocity, and flood arrival time. The resulting hazard maps constitute an important scientific basis for developing Emergency Action Plans (EAPs).

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