Journal of Physics: Conference Series **1450** (2020) 012030 doi:10.1088/1742-6596/1450/1/012030

The effect of river flow velocity distribution on indications of the occurrence of degradation of the Tambong River basin

Z Erwanto[1], A N I Sugata[1]

[1] Department of Civil Engineering, Politeknik Negeri Banyuwangi, Jalan Raya Jember, Banyuwangi, Indonesia

Email: zulis.erwanto@poliwangi.ac.id

Abstract. Floods that have high flow velocity can be indicated that there is degradation in the riverbed. If the deterioration of the riverbed is allowed to continue, it can cause damage to the existing building infrastructure around the river. Tambong River, located in the Kabat District of Banyuwangi, has experienced river overflowing. Process of measuring flow velocity uses the current meter. To determine the shape and contour of the Tambong River flow velocity distribution using the Surfer Software. In the Tambong River basin, the middle river of the downstream has the highest river flow velocity distribution of 0.92 m/sec, with a discharge of 1.75 m^3/sec. It was indicated that the Tambong River Basin in the middle of the downstream would experience river bed degradation by showing a Reynold of 426,997.33 and a Froude value of 0.55 so that it includes turbulent flow types and flow types subcritical. Average flow velocity distribution in the middle of the Tambong River basin is 0.901 m/sec and was indicated to have degraded as thick as 2.10 m/year. It can be concluded that the middle part of the Tambong river is a flood-prone zone due to the considerable velocity of the river flow.

1. Introduction

The river is a large and elongated water flow that flows continuously from upstream to downstream. Rivers that have high river flow velocity can cause degradation on the river bed. If the degradation of the river bed is allowed to continue, it can cause damage to the existing building infrastructure around the river. Tambong River, which is located in Kabat District in 2013, had experienced river water overflow. The water that flows through the river overflows with a very high volume capacity so that the river floods overflow on the Kabat-Banyuwangi highway [1]. The correlation that occurred between the discharge and suspended load obtained at each weir in Banyuwangi has a strong correlation value. For Poncowati Dam on the Tambong River, $R^2 = 0.738$ is obtained with a = 0.768. It is indicated that in each weir in the major rivers of the Banyuwangi Regency, the erosion level is still low because the index a <26, and the correlation value was stated to be consistent and reliable (R≈1) [2]. Therefore, to determine the causes and countermeasures for erosion and sedimentation of the river, it is necessary to study related to the distribution of flow velocity in the river as one of its parameters. The previous studies examined the distribution of flow velocity such as [3-8].

The modeling of the distribution of flow velocity in the Tambong river basin is using the program of Surfer. A Surfer is one of the software used for making contour maps and three-dimensional modeling based on the grid**.** Surfer helps in the analysis of slope, or land morphology of an aerial photograph or satellite image that already has elevation datum [9]. The measurement of discharge and flow velocity uses the Current Meter tool, to determine the distribution of flow velocity as a parameter determining whether or not the level of erosion, degradation, and aggregation levels can be one of the factors causing flooding. Based on these problems, it is necessary to research the effect of the distribution of river flow velocity on the indication of the occurrence of the degradation of the Tambong river basin in the upstream, middle and downstream areas. With a basis for finding out how much the flow velocity that can cause river degradation and the cause of flooding in the Tambong river basin.

2. Theoretical basis

2.1. River geometry

River geometry is a channel, riverbed, and river valley measured vertically and horizontally, where the required parameters are the length, width, slope, and elevation. River formation is a complex process involving many variables. It is a combination of water flow and sediment transportation. The river itself is an open channel whose geometric size changes with time, depending on the discharge, the base material of the cliff, and the amount and type of sediment transported by water. In channel planning, there is a known independent variable. The independent variable is input consisting of water discharge, sediment discharge, and the diameter of the bad river. Then the dependent variable is the result of the calculation, which includes width, depth, the slope of the talus, and the slope of the channel like equation in channel geometry in Figure 1 [10].

Section	Area (A)	Wetted perimeter (P)	Hydraulic radius (R)	Top Width (T)	Hydraulic mean depth y_h
	A	P	$R = \frac{A}{P}$	T	$y_h = \frac{A}{T}$
trapezoidal	$y\ (b+zy)$	$b+2y(z^2+1)^{0.5}$	$\frac{y(b+zy)}{b+2y(z^2+1)^{0.5}}$	$b+2zy$	$\frac{y(b+zy)}{b+2zy}$
triangle (b = o)	zy^2	$2y(z^2+1)^{0.5}$	$\frac{zy^2}{2y(z^2+1)^{0.5}}$	$2zy$	$\frac{zy^2}{2Zy} = \frac{y}{2}$
rectangle (z = o)	by	$b+2y$	$\frac{by}{B+2Y}$	b	$\frac{by}{b} = y$
circular	See below $(D^2/8)(\Theta^r - \sin\Theta)$	$\frac{D}{2}\ \Theta^r$	$\frac{D\ (\Theta^r - \sin\Theta)}{4\Theta^r}$	$D \sin\frac{\Theta}{2}$	$\frac{D\ (\Theta^r - \sin\Theta)}{8 \sin\Theta/2}$

Section factor $Z = A\ (y_h)^{0.5} = A\ (\frac{A}{T})^{0.5}$

Figure 1. Geometric elements of open channel cross section [10].

2.2. Open channel flow

2.2.1. Laminar and turbulent flow. Laminar flow is a type of flow shown by the movement of liquid particles according to smooth and parallel flow lines. Conversely, the turbulent flow does not have a flat and parallel line at all. The characteristics of turbulent flow are shown by the formation of eddies in the stream, which results in a continuous mixing of liquid particles throughout the flow section.

The flow of the laminar is characterized by the path of the fluid particles along the smooth road and forming particular layers. The sequential paths of particles follow the correct way. Turbulent flow is characterized by a mixture of different fluid layers occurring at higher Reynolds number values, in this type of stream where almost no specific path can be seen.

The parameter used as the basis for distinguishing the character of the flow is a dimensionless parameter called the Reynold number (Re). Reynold established a dimensional analysis of the results of his experiments and concluded that the change from laminar flow to turbulent flow occurred at one price, now known as the Reynold (Re) number. This figure represents the ratio of inertia forces and viscosity forces [3].

2.2.2. Critical, subcritical, and supercritical flow. The flow is said to be essential if the number Froude is equal to one (Fr = 1), and the flow is called subcritical (quiet flow) if Fr <1 and Supercritical if Fr> 1, while the fast flow (rapid flow) and braking flow (shooting flow) are also used to express supercritical flow [3].

2.2.3. Steady and unsteady flow. A steady flow is a type of flux; the word "steady" indicates that throughout the flow analysis, the assumption is that the flow rate is fixed. If the flow through the prismatic channel then the flow velocity V is also adjusted, or the flow velocity does not change with time ($\partial V / \partial t = 0$), on the contrary, if the flow velocity changes with time ($\partial V / \partial t \neq 0$) the flow is called a non-permanent flow (unsteady flow) [3].

2.2.4. Uniform and nonuniform flow. Flow is called uniform if various flow variables such as depth, wet appearance, velocity, and discharge along a channel are constant. Likewise, the reverse current is not uniform if the flow variable is not consistent [3].

Uniform flow is another type of flux; the word "uniform" indicates that the flow velocity along a channel is fixed, in the case that the flow velocity does not depend on place or does not change according to location ($\partial V / \partial s = 0$), conversely if the speed changes according to place ($\partial V / \partial s \neq 0$) flow is called nonuniform flow [3].

In 1884 Osborne Reynolds experimented with showing the properties of laminar and turbulent flow. Based on flow tests in the pipe, Reynolds determined that for Reynolds numbers below 500, the current under these conditions was laminar. The stream will be turbulent if the Reynolds number is more significant than 1000. In general, the type of flow through an open channel is rough because the flow velocity and wall roughness are relatively large [3].

$$\mathrm{Re} = \frac{V_L}{V} \tag{1}$$

$$\nu = (1.14 - 0.031\,(T^{\circ} - 15) + 0.00068\,(T^{\circ} - 15)^2) \times 10^{-6} \tag{2}$$

$$\mathrm{Fr} = \frac{V}{\sqrt{gy}} \tag{3}$$

With, Re is the Reynolds number, V is the velocity of flow (m/s), L is the characteristic length (m), ν is viscosity (m^2/s), Fr is the Froude Value, g is the gravity (m/s^2), and y is the characteristic length / hydraulic depth (m). Fluid flows, especially water, are classified based on the comparison between inertial forces and viscous forces into three parts, namely laminar flow, transition flow, and turbulent flow. So, for open character channels (rivers) for each type of flow classified as follows, Laminar: Re<500, Transition: 500<Re <12500, and Turbulent: Re>12500. The determination of flow types can be based on the value of the Froude (Fr). Flow is sub-critical if Fr <1, critical if Fr = 1, and supercritical if Fr>1. If Fr<1 flow is subcritical, in this condition, the role of the earth's attraction is more prominent, and if Fr>1, flow is supercritical, the inertia force is very prominent, so that the flow has a high speed and fast [3].

3. Measurement of river flow discharge

Streams that flow at the same time, there will be a continuity equation in them, wherein the incoming discharge is equivalent to the outflow. It allows where variations in velocity will follow to meet the wet surface area of a channel. Long story short, if the initial speed is high, it has an impact on the area of the outlet and vice versa [11]. The determination of river discharge can be carried out by flow measurement and analysis. The measurement of river discharge can be done directly and indirectly by collecting data on river flow parameters and flood marks. In hydrology, the problem of determining river discharge utilizing measurement is included in the field of hydrometry, namely the study of water measurement problems or the collection of primary data for analysis including water level, discharge, and sedimentation data [12].

$$n = 0.26 – 0.97 \text{ than } V = 0.0991 \times (n + 0.034) \quad (4)$$

$$n = 0.97 – 4.71 \text{ than } V = 0.1105 \times (n + 0.023) \quad (5)$$

$$n = 4.71 – 27.06 \text{ than } V = 0.1071 \times (n + 0.039) \quad (6)$$

With, V is the flow velocity (m/s), and n is the number of rounds at any given time.

4. Degradation and aggregation

Riverbed degradation is generally a result of erosion, and as the leading intermediary is water, that is affected by flow velocity. Riverbed degradation can occur when, stable discharge (sediment supply) that comes is smaller than the ability to transport sediment, eroded riverbed, and riverbed down. Aggregation is a process that causes an increase in the landscape. Included in the process of aggregation is sedimentation or deposition. Aggregation occurs when solid discharges are higher than the ability to transport sediments, resulting in deposition of deposits, which causes the riverbed to rise. Following is the equation for finding the value of degradation/aggregation [6].

$$h = \frac{(Qb_{in} - Qb_{out})}{A} \quad (7)$$

With, h is the height of degradation/aggregation, Qb_{in} is the bed load located at the inlet point, Qb_{out} is the bed load located at the outlet point, and A is the surface area of the river (m^2).

5. Methodology

5.1. Location of study

- The upstream section of the Tambong River Basin is in Poncowati Weir, Tambong Village, Kabat District, Banyuwangi Regency.
- The middle section is on the Tambong Bridge, Jember Kalibaru-Banyuwangi highway, Pakistaji Village, Kabat District, Banyuwangi Regency.
- The downstream section is located at Pondok Nongko Bridge, Sukojati Village, Kabat District, Banyuwangi Regency.

5.2. Data collection

- Primary data include length measurement, width measurement per segment, measurement of the depth of each layer on river segments, elevation, determining coordinates, analysis of flow velocity, and discharge using Current Meter. The cross-section of the river segment divided by six measurement points.
- Secondary Data: Tambong River Map and Tambong Sub-watershed map to determine the location of the study. The sedimentation data is using data from previous studies [13].

6. Results and discussion

6.1. The modelling of the velocity distribution in the upper Tambong River

In Figure 2, the lowest depth can be known at upper Tambong river is 0.55 m from the water level. Then, in Figure 3 shows that the minimum flow velocity of the upper Tambong river to be able to erode the base of the river is 0.7 m/sec. Based on Figure 4**,** it can be seen that the average flow upstream of the Tambong River Basin is Q = 3.18 m^3/sec, whereas the flow rate of the left side upstream river flow is on average Q = 0.33 m^3/sec. The flow of the right-side upstream river flow is an average of 0.12 m^3/sec.

Furthermore, the downstream river flow is an average of Q = 0.39 m^3/sec. On the left side of the upstream segment, it has an average Reynold number of Re = 128765.59. On the right side upstream, it has an average Reynold number of Re = 100253.67, whereas downstream has an average Reynold number of Re = 54987.10. The weir itself has an average Reynold number of Re = 136084.30. So, in the upper part of the Tambong River Basin, the turbulent flow is due to Re>12500. In Figure 5, the left side upstream has an average Froude of Fr = 0.08. On the right side upstream has an average Froude of Fr = 0.07, whereas downstream has an average Froude of Fr = 0.13. The weir itself has an average Froude number of Fr = 0.59. So, in the upper part of the Tambong River Basin, this type of flow is subcritical due to Fr <1.

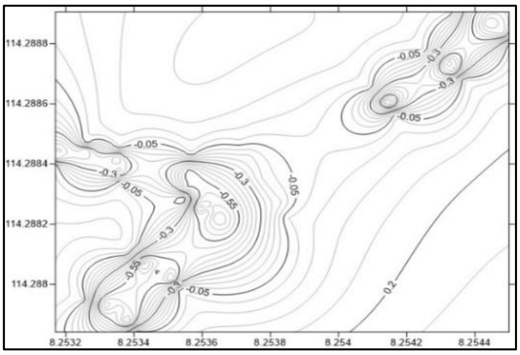

Figure 2. The contour of the depth of the upper Tambong river basin.

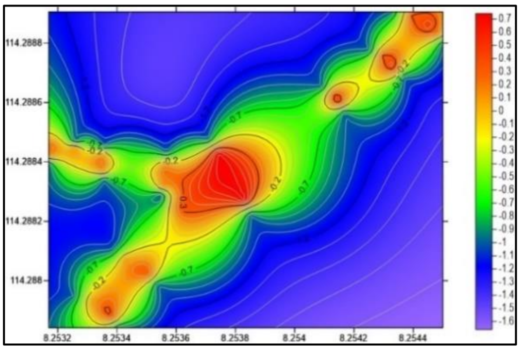

Figure 3. The flow velocity distribution of the upper Tambong river basin.

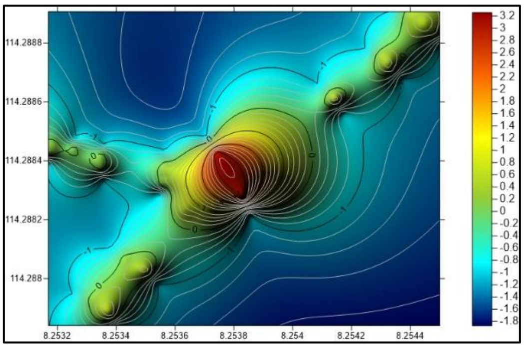

Figure 4. The discharge distribution of the upper Tambong river basin.

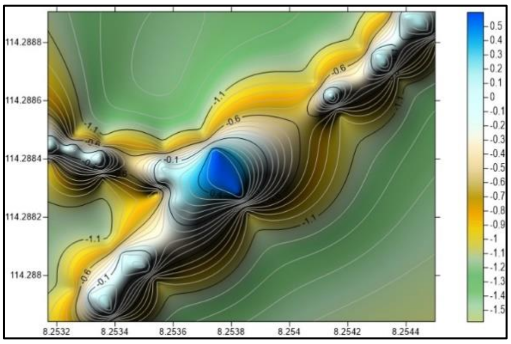

Figure 5. The froude value distribution of the upper Tambong river basin.

In Figure 6, it can be seen the distribution of river flow velocity in the upper reaches of the river, Poncowati weir upstream to the left of V = 0.292 m/sec. In Figure 7, it can be seen the distribution of river flow velocity in the upper reaches of the river, Poncowati weir upstream to the right of V = 0.249 m/sec. In Figure 8, it can be seen the distribution of river flow velocity in the upper reaches of the river, Poncowati weir downstream of V = 0.473 m/sec.

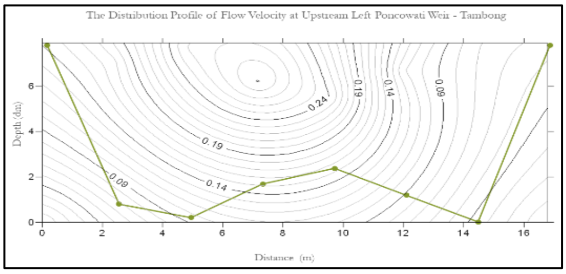

Figure 6. The distribution profile of flow velocity at upstream left Poncowati weir.

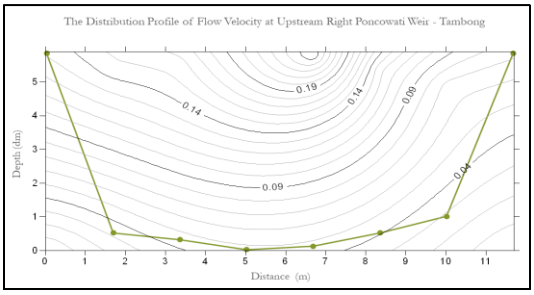

Figure 7. The distribution profile of flow velocity at upstream right Poncowati weir.

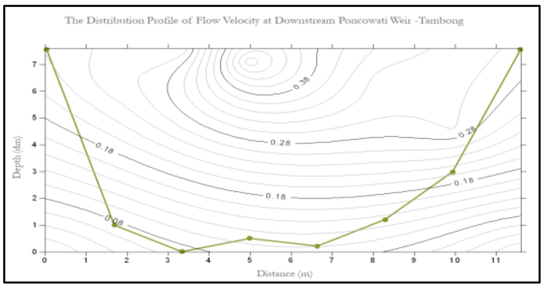

Figure 8. The distribution profile of flow velocity at downstream Poncowati weir.

6.2. The modelling of the velocity distribution in the middle Tambong River

The condition in the middle Tambong River was a confluence of two river channels that have different flow speeds. During the dry season on the left upstream, the rate was prolonged when compared to the right upstream. But during the rainy season, the flow velocity in both river basins is very heavy. In Figure 9, the lowest depth can be known at middle Tambong River is 0.5 m from the water level. Then, in Figure 10 shows that the minimum flow velocity of the middle Tambong River to be able to erode the base of the river is 0.8 m/sec.

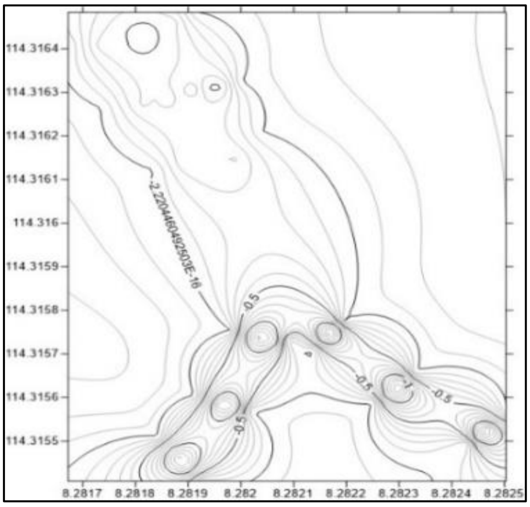

Figure 9. The contour of the depth of the middle Tambong River basin.

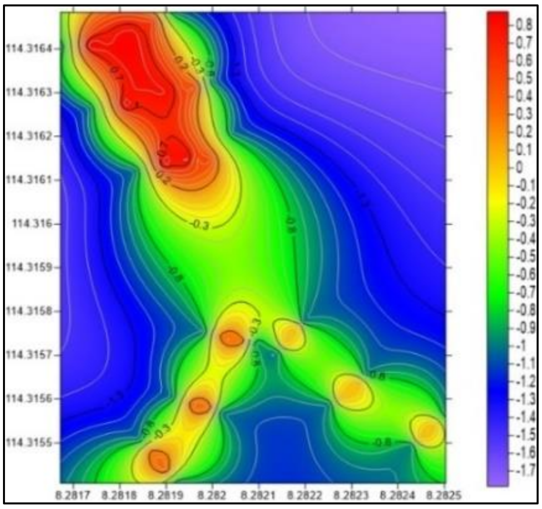

Figure 10. The flow velocity distribution of the middle Tambong River basin.

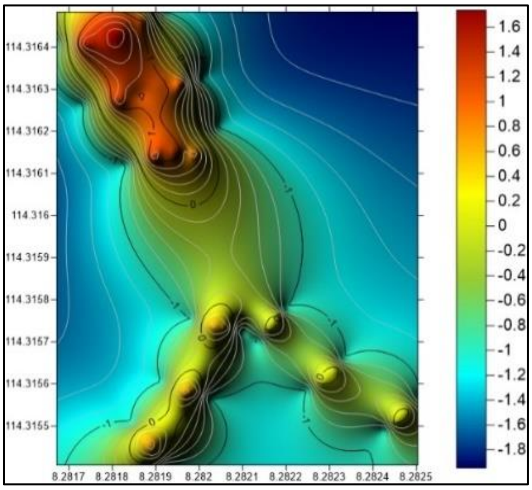

Figure 11. The discharge distribution of the middle Tambong River basin.

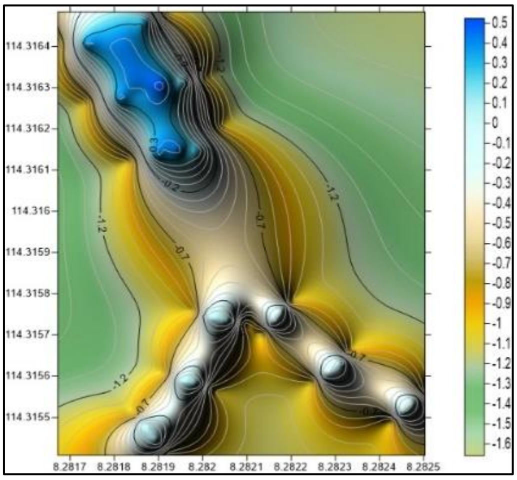

Figure 12. The froude distribution of the middle Tambong River basin.

Based on Figure 11, the average discharge of the left stream upstream flow of the river is Q = 0.044 m^3/sec. The flow of the right-side upstream river flow is an average discharge of 0.49 m^3/sec. Furthermore, the average downstream river flow is Q = 1.18 m^3/sec. The middle of the Tambong river basin at downstream has the most significant average Reynold number around the area, amounting to Re = 290,427.16. On the left side of the upstream segment, it has an average Reynold number of Re = 11,510.76. Whereas in the upstream section of the right, the Reynold number has an average of Re = 145,597.15. In Figure 12, it can be seen that the middle of the Tambong River Basin has a low Froude average number of the largest around the area, equal to Fr = 0.356. Upstream on the left side has an average Froude number of Fr = 0.004. Whereas in the right-side upstream section, it has an average Froude number of Fr = 0.075. So, in the middle of the Tambong River Basin is a type of subcritical flow due to Fr <1.

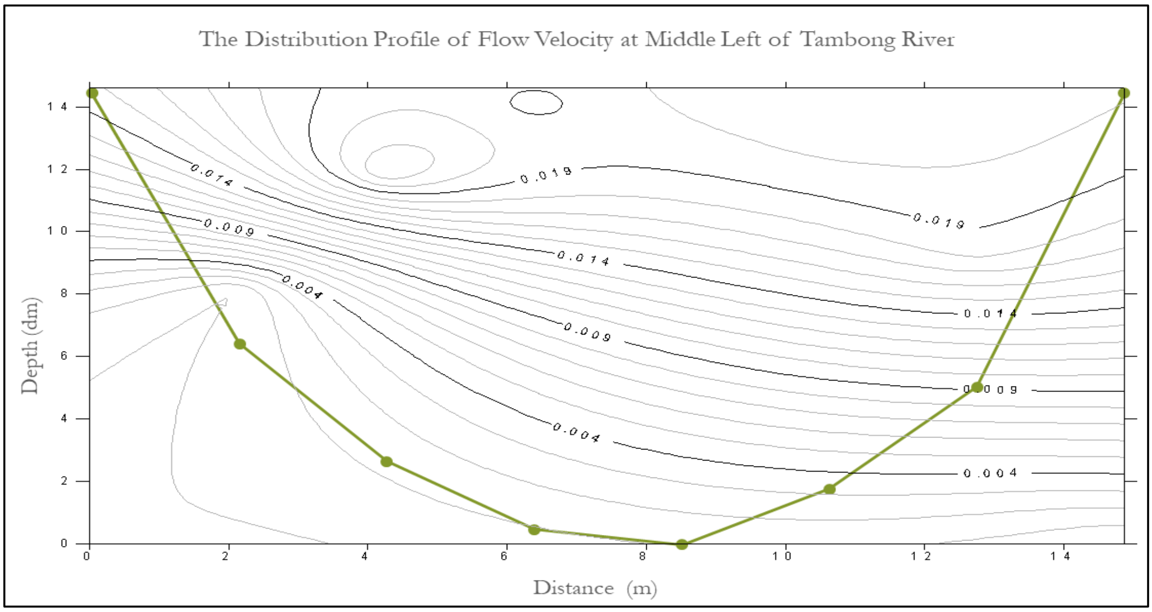

Figure 13. The distribution profile of flow velocity at middle left of Tambong river.

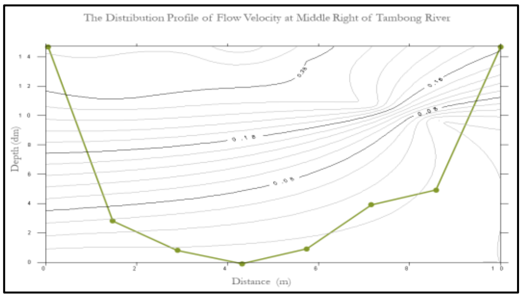

Figure 14. The distribution profile of flow velocity at middle right of Tambong River.

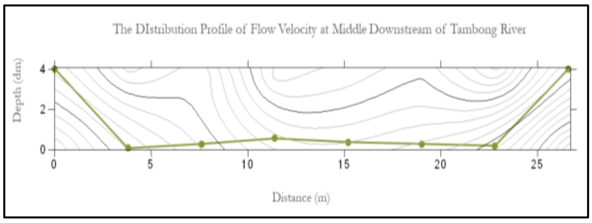

Figure 15. The distribution profile of flow velocity at middle downstream of Tambong River.

In Figure 13, it can be seen the distribution of river flow velocity in the middle of the left upstream river of V = 0.022 m/sec. In Figure 14, it can be seen the distribution of river flow velocity in the middle of the right upstream river of V = 0.333 m/sec. In Figure 15, it can be seen the distribution of river flow velocity in the middle of the downstream river of V = 0.916 m/sec.

6.3. The modelling of the velocity distribution in the lower Tambong River

In the downstream condition of the Tambong River, a lot of sedimentation occurs because of the flow velocity distribution changes gradually. In Figure 16, the lowest depth can be known at lower Tambong river is 0.8 m from the water level. Then, in Figure 17 shows that the minimum flow velocity of the lower Tambong River to be able to erode the base of the river is 0.4 m/sec.

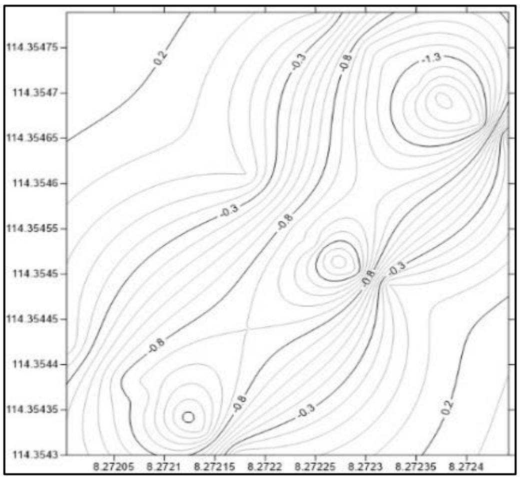

Figure 16. The contour of depth of the lower Tambong River basin.

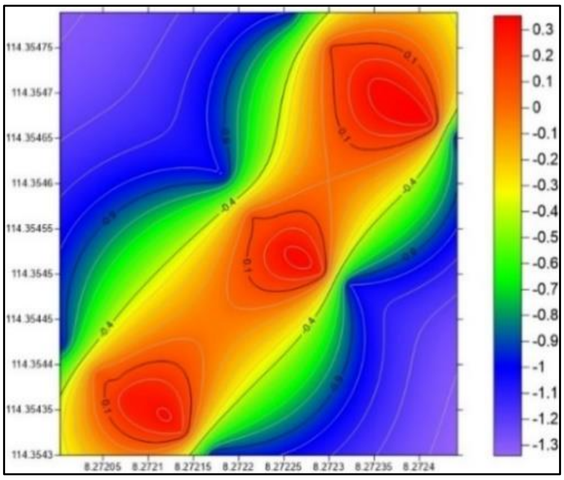

Figure 17. The flow velocity distribution of the lower Tambong River basin.

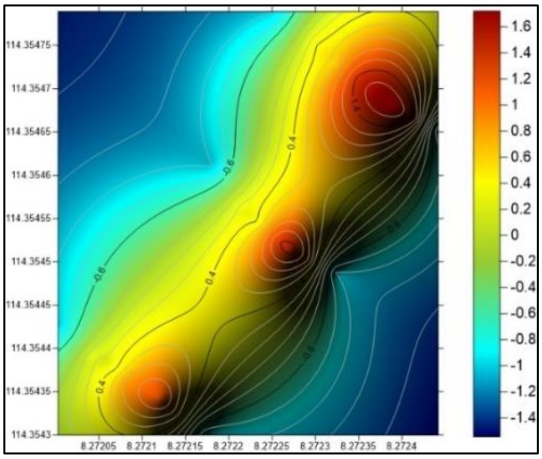

Figure 18. The discharge distribution of lower Tambong River basin.

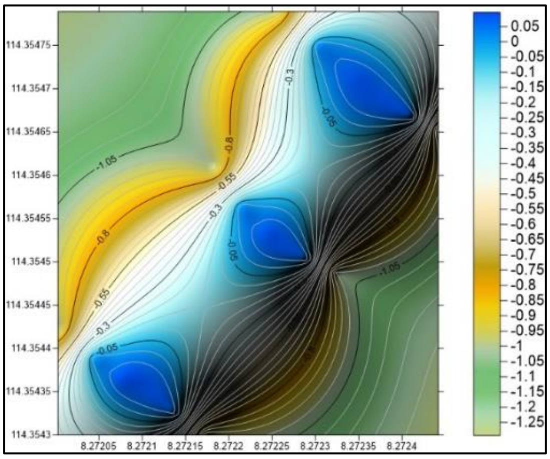

Figure 19. The froude distribution of lower Tambong River basin.

Based on Figure 18, it can be seen that the most significant discharge is 1.72 m^3/s, and the smallest release is 0.19 m^3/s. This downstream river flow has an average discharge of Q = 0.96 m^3/s. The higher Reynold rate is Re = 324,972.59. And has a minimum value of Re = 47,555.44. At the downstream of the Tambong River Basin, the average of Re = 185,107.50. So downstream of the Tambong River basin is a turbulent flow due to Re>12,500? In Figure 19, a higher Froude value is Fr = 0.10 and has a minimum amount of Fr = 0.03. The downstream of the Tambong River Basin has an average of Fr = 0.068. So, in the downstream part of the Tambong River Basin, this type of subcritical flow is due to Fr <1.

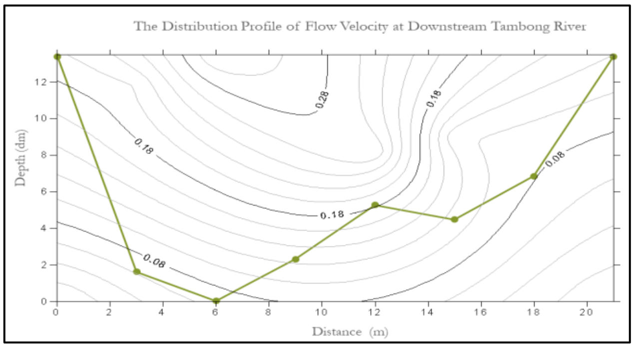

Figure 20. The distribution profile of flow velocity at downstream Tambong River.

From Figure 20, it can be seen the distribution of river flow velocity downstream of the Tambong River of V = 0.318 m/sec.

6.4. The result of the distribution of flow velocity

All of the above output data can be recapitulated based on the measurement location to see the velocity distribution. The recapitulation of output results can be seen in Table 1.

Table 1. Recapitulation of the distribution of flow velocity in Tambong River basin.

No.	Location	Velocity (m/s)		Discharge (m^3/s)		Reynold (Re)		Froude (Fr)		Stream Type	Flow Type
		Ave	Max	Ave	Max	Ave	Max	Ave	Max		
1	Upper of Tambong River (Upstream Left of Poncowati Weir)	0.20	0.32	0.33	0.55	100,253.67	162,409.17	0.08	0.13	Turbulent	Sub Critical
2	Upper of Tambong River (Upstream Right of Poncowati Weir)	0.15	0.25	0.12	0.24	54,987.10	103,793.57	0.07	0.12	Turbulent	Sub Critical
3	Upper of Tambong River (Downstream of Poncowati Weir)	0.34	0.49	0.39	0.61	136,084.30	212,910.98	0.13	0.19	Turbulent	Sub Critical
4	Middle of Tambong River (Upstream Left of Tambong Bridge)	0.02	0.02	0.04	0.07	11,510.76	19,527.57	0.00	0.01	Turbulent	Sub Critical
5	Middle of Tambong River (Upstream Right of Tambong Bridge)	0.27	0.36	0.49	0.73	145,597.15	225,817.23	0.08	0.10	Turbulent	Sub Critical
6	Middle of Tambong River (Downstream of Tambong Bridge)	0.72	0.92	1.18	1.75	290,427.16	426,997.33	0.36	0.55	Turbulent	Sub Critical
7	Lower of Tambong River (Downstream of Pondok Nongko Bridge)	0.24	0.36	0.96	1.72	185,107.50	324,972.59	0.07	0.10	Turbulent	Sub Critical

From Table 1 above, it can be seen that the location of the Middle Tambong River Basin downstream of the Tambong bridge is indicated to have almost degraded because the Froude (Fr) number is close to 1, which is 0.55, which if Fr = 1 flow type is critical. Likewise, the Reynold number of Re = 426,997.33, which indicates the type of flow is turbulent (Re>12500). If this type of flow is turbulent, it means that the river is bumpy, the speed is uneven, and the current is circling. At this location also has a flow velocity of V = 0.92 m/sec and a discharge of Q = 1.75 m^3/sec.

6.5. The results of degradation/aggregation

In the calculation of this degradation required bed load discharge data and cross-sectional river area. Bed load discharge data obtained from previous studies [4]. The following are the results of the calculation of the degradation of the Tambong River Basin can be seen in Table 2.

Table 2. The results of the degradation/aggregation in Tambong River basin

No	Location	Average Velocity (m/s)	Qb in (m^3/yr)	Qb out (m^3/yr)	A (m^2)	Degradation/ Aggregation (m/yr)	Riverbed Conditions
1	Upper of Tambong River (Upstream Left of Poncowati Weir)	0.20	13.87	16.51	11.51	-0.23	Degradation
2	Upper of Tambong River (Upstream Right of Poncowati Weir)	0.15	5.94	5.15	6.44	0.12	Aggregation
3	Upper of Tambong River (Downstream of Poncowati Weir)	0.34	16.84	19.84	7.68	-0.39	Degradation
4	Middle of Tambong River (Upstream Left of Tambong Bridge)	0.02	1.51	1.27	20.12	0.01	Aggregation
5	Middle of Tambong River (Upstream Right of Tambong Bridge)	0.27	21.63	25.52	12.40	-0.31	Degradation
6	Middle of Tambong River (Downstream of Tambong Bridge)	0.72	54.95	76.72	10.37	-2.10	Degradation
7	Lower of Tambong River (Downstream of Pondok Nongko Bridge)	0.24	36.08	66.88	21.14	-1.46	Degradation

Table 2 shows that aggregation occurred in the upper part of the Tambong River at 0.12 m/yr. While in the middle of the Tambong River downstream of the Tambong bridge, there was degradation of

2.10 m/yr. It can be concluded that the middle part of the Tambong River is a flood-prone zone due to the enormous velocity of the river flow.

7. Conclusions

In the Tambong River Basin, the middle part of the Downstream has the maximum river flow velocity distribution of 0.92 m/sec, with a maximum discharge of 1.75 m^3/sec. It is indicated that the Tambong River Basin in the middle of the Downstream will experience river bed degradation with a maximum Reynold (Re) number of 426,997.33 (Re> 12,500) and a maximum Froude value of 0.55 (Fr <1), with turbulent flow types and types subcritical flow that approaches the critical flow (Fr ≈ 1). The average flow velocity distribution in the middle of the Tambong River Basin is 0.901 m/s, and during the rainy season, it can have an impact on river bed degradation, which results in sedimentation in the lower reaches of the Tambong River. The calculation of degradation/aggregation proves this that in the Tambong River basin, the middle part of Downstream has the highest degradation, amounting to h = 2.10 m/year. So it can be concluded that the central part of the Tambong River is a flood-prone zone due to the enormous velocity of the river flow.

8. References

[1] Erwanto Z 2014 *Logic Jurnal Rancang Bangun dan Teknologi* 1 22
[2] Dewi T A 2018 *Logic Jurnal Rancang Bangun dan Teknologi* 1 1-7
[3] Junaidi F F 2014 *Logic Jurnal Teknik Sipil Dan Lingkungan* **3**
[4] Putra A S 2014 *Logic Jurnal Teknik Sipil Dan Lingkungan* **3**
[5] Putro H 2013 *Variasi Koefisien Kekasaran Manning (n) pada Flume Akrilic pada Variasi Kemiringan Saluran dan Debit Aliran* (Depok: Universitas Gunadarma)
[6] Raharjo A S 2017 *Tinjauan Morfologi Angkutan Sedimen Dasar dan Agregasi/Degradasi Sungai Progo (Studi Kasus Tahun 2012 dan 2017) Pasca Letusan Merapi Pada Tahun 2010* (Yogyakarta: Universitas Muhammadiyah Yogyakarta)
[7] Umar S N 2013 *Studi Eksperimen Distribusi Kecepatan Aliran Sungai* (Makasar: Universitas Hasanuddin)
[8] Wahyuni S 2014 *Logic Jurnal Rekayasa* **2** 1693-9816
[9] Aprilyawan D 2015 *Pengertian Surfer* (Denpasar: Universitas Ganesha)
[10] Gooda E A 2017 *CVLE-342 Hydraulic-II Open Channel Flow & Dimensional Analysis & Hydraulic Modelling* (Arab: Beirut Arab University)
[11] Soewarno 1991 *Hydrology Measurement and Watershed Processing* (Bandung: Nova)
[12] Harto S 2000 *Hidrologi* (Yogyakarta: Nafiri Offset)
[13] Erwanto Z 2018 *IOP Conference Series Earth and Environmental Science* **1**

Acknowledgments

Thanks to Politeknik Negeri Banyuwangi for their support for our research.