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ANALYSIS OF NEGARA RIVER SEDIMENTATION AND PREDICTION OF DAMAGE ON ANDI TAJANG BRIDGE IN HULU SUNGAI SELATAN REGENCY

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ABSTRAK

Sedimen dapat menyebabkan agradasi dan degradasi secara terus menerus yang berpotensi mengubah morfologi sungai. Di lain sisi, gerusan terjadi sebagai konsekuensi dari kontraksi akibat keberadaan jembatan. Kontraksi akan membuat aliran membentuk sebuah lubang di bawah pilar. Penurunan pilar-pilar akibat gerusan dapat membahayakan keseluruhan struktur pada jembatan.

Data-data yang digunakan pada perhitungan volume sedimen adalah data debit sungai, sampel tanah, dan geometri Sungai Negara. Data kemudian dimasukkan ke dalam HEC-RAS 4.1.0, dengan menggunakan empat formula: Laursen, Engelund-Hansen, Meyer Peter Muller, dan Toffaleti, perhitungan kemudian dilakukan oleh HEC-RAS 4.1.0 dan kemudian dianalisis. Analisis dilakukan dengan menggunakan waktu simulasi tiga bulan. Sementara data teknis Jembatan Andi Tajang dimodelkan pada HEC-RAS 4.1.0, dan kemudian menghitung gerusan dengan mempertimbangkan gerusan akibat kontraksi dan akibat pilar. Debit yang digunakan dalam perhitungan gerusan jembatan yaitu debit rancangan dengan kala ulang 50, 100, 500, dan 1000 Tahun.

Hasil penelitian yaitu kapasitas maksimum rata-rata Sungai Negara yaitu 374,214 ton/hari, debit sedimen dan konsentrasi sedimen yaitu 35,347 ton/hari dan 6,668 mg/l. Gerusan terbesar pada Jembatan Andi Tajang terjadi pada debit 267,4116 m^3/d (kala ulang 1000 tahun) yaitu 2,98 m. Berdasarkan hasil penelitian, debit sedimen yang terjadi pada Sungai Negara bernilai besar pada beberapa bagian, sehingga kontrol sedimen perlu dilakukan. Selain itu, untuk mencegah kerusakan struktur jembatan akibat gerusan, perlu dibuat perlindungan pada struktur bawah Jembatan Andi Tajang.

Kata kunci: sedimen, gerusan, jembatan, Sungai Negara, Jembatan Andi Tajang, HEC-RAS 4.1.0

ABSTRACT

Sediments can lead to continuous agradation and degradation that potentially alters river morphology. On the other hand, scouring occurs as a consequence of contraction due to the existence of a bridge. Contraction will make the flow form a hole under the pillar. Decreasing pillars due to scouring may endanger the overall structure of the bridge.

The data used in the calculation of sediment volume is river discharge data, soil samples, and geometry of Negara River. The data were then fed into HEC-RAS 4.1.0, using four formulas: Laursen, Engelund-Hansen, Meyer Peter Muller, and Toffaleti, the calculations were then performed by HEC-RAS 4.1.0 and then analyzed. The analysis was done by using three months simulation time. While the technical data of Andi Tajang Bridge is modeled on HEC-RAS 4.1.0, and then calculates scouring by considering scouring due to contraction and pillar impact. The debit used in the calculation of the scouring of the bridge is the discharge design with 50, 100, 500, and 1000 Years reinstall.
The result of research is the maximum average capacity of Negara River that is 374,214 ton/day, sediment discharge and sediment concentration are 35,347 ton/day and 6,668 mg / l. The biggest scour on Andi Tajang Bridge occurred at the discharge of 267,4116 m3 / d (re-time 1000 years) that is 2.98 m. Based on the results of the study, the sediment discharges occurring in the Negara River are of great value in some parts, so that sediment control is necessary. In addition, to prevent damage to the bridge structure due to scouring, it is necessary to make protection on the structure under the Andi Tajang Bridge.

Keywords: sediment, scour, bridge, Negara River, Andi Tajang Bridge, HEC-RAS 4.1.0

1. INTRODUCTION

One of the aspects that can be discussed about river characteristics is sediment transport. The sediments are carried away by the distinguishable water stream as the base bed (bed-load-base charge) and the suspended load. Since the basic charge is constantly moving, the surface of the river basin sometimes rises (agradasi), but sometimes down (degradation) and the rise and fall of the river bed is called river bed alteration. Sediment buildup will result in changes in river morphology, one of which is the silting of the river bed.

In addition to sedimentation, there is also erosion. Erosion is the process of transporting the ground grains due to the flow of water in the river. Erosion will have a negative impact if the rate is uncontrollable. On the bridge, the lower structure will be submerged in water. Pillars are part of a submerged structure that will receive scouring due to river flow velocity. To avoid damage and collapse on the pillar of the bridge, it is necessary to study the depth of scouring that works on the pillar.

Negara River is one of the Rivers located in Hulu Sungai Selatan Regency. In this river, there is a bridge used by the surrounding community. One of the new bridges built in this river is Andi Tajang Bridge.

This research is expected to be able to analyze the characteristic of sediment transport in Negara River, and scouring on the bridge pillar in Negara River, so that it can be considered in the maintenance of Negara River, prevention of bridge damage at research location, and become information for planning of building which will made around the research site.

The study was conducted in the Negara River, on the river linked to the Amandit River. The river is located in South Daha District, Hulu Sungai Selatan District, South Kalimantan Province. In this study, a long boundary of the river that will be examined is 2 km long. The Andi Tajang Bridge is on the lower reaches of the Negara River.

2. METHOD

Data Matrix

No	Data	Source
1	Geometry River Negara	Field Survey
	a. Wide River	
	b. River Area	
	c. Length and Boundaries of Research Areas	
2	Flow Rate River	Field Survey
3	Average Debit River	Field Survey
4	Water Table Elevation	Field Survey
5	Basic Soil Samples River	Field Survey
6	Debit Data Negara River	BWS Kalimantan II
7	Soil Gradation	Laboratory Test Results
8	Andi Tajang Bridge Technical Data	Public Works Department of South Kalimantan Province
9	Flood Debit Period 50, 100, 500 and 1000 Years	The calculation results

Data processing

Data processing conducted in this research is done in the following way:

a. Primary data are; river geometry and soil gradation data are inputted into HEC-RAS 4.1.0 for sediment transport analysis.

b. Secondary data that is; the State River debit data is carried out by frequency analysis to obtain the debit with 50, 100, 500, and 1000 year re-currents and technical data of Andi Tajang Bridge inputted into HEC-RAS 4.1.0 for bridge scour analysis.

3. RESULT AND DISCUSSION

The results of sediment transport analysis are as follows:

	Mass Capacity (tons/day)	Shear Stress (pa)	Channel Invert (m)
Laursen	259,1122	4,9139	-0,0045
Eng-Hansen	374,2141	4,9228	-0,0020
MPM	61,9010	4,4380	-0,0001
Toffaleti	10,0277	4,8855	-0,0013
	Average Fall Velocity (m/s)	Sediment Discharge (tons/day)	Sediment Concentration (mg/L)
Laursen	0,0292	35,3475	6,6687
Eng-Hansen	0,1081	3,1519	0,8374
MPM	0,0349	0,2352	0,0654
Toffaleti	0,0743	9,9347	2,3432

Based on the value of sediment transport capacity occurring in the River Country, it can be seen that Formula Engelund Hansen displays the greatest value. In addition, the Toffaleti Formula displays the smallest value. This is strongly influenced by the parameters used in the calculations. Considering that every formula established by the inventor is based on experiments and empirical approaches, it is possible to differ in the value of sediment transport capacity occurring.

The downstream area of the study site has a larger sediment transport capacity than the upstream area of the study site. Given the sediment transport capacity referred to in HEC-RAS 4.1.0 is the amount of sediment that can potentially leave the corresponding cross section due to flow rate, this means sedimentation will tend to be in the downstream area of the study site. The large sedimentation capacity of the downstream is due to the upstream sedimentation that accumulates towards the downstream so that in the downstream sections the potential for sedimentation will tend to enlarge.

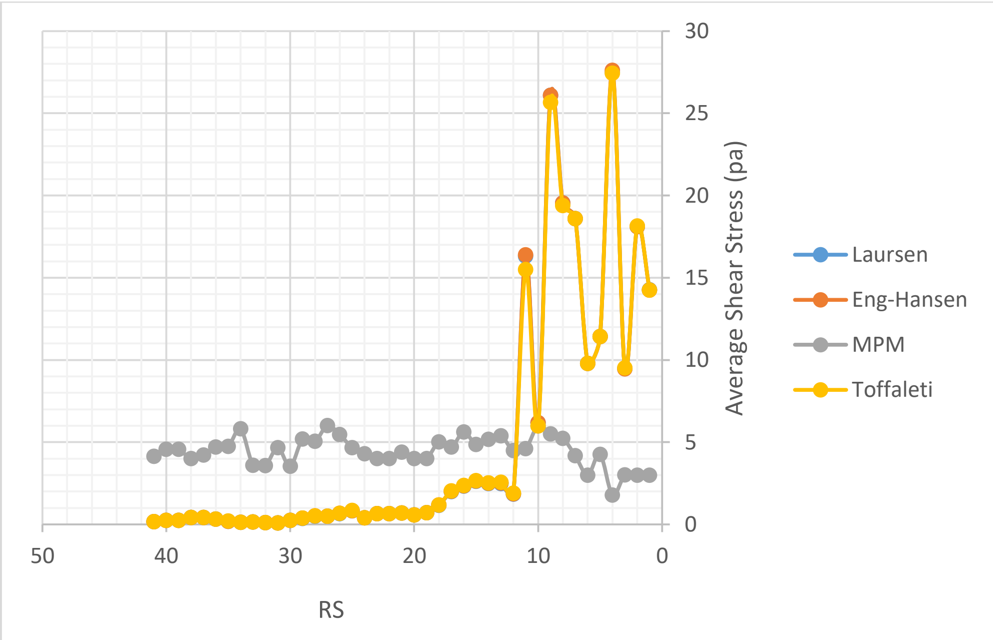


Figure 1. Average Shear Stress

Based on the mean shear stress values obtained by calculation, the shear stress values acting on the cross section of the River Country by Formula Laursen, Engelund-Hansen, and Toffaleti display similar results. While using Formula Meyer Peter Muller, obtained relatively different results. In the cross section near the bottom of the study site, obtained a large shear stress value.

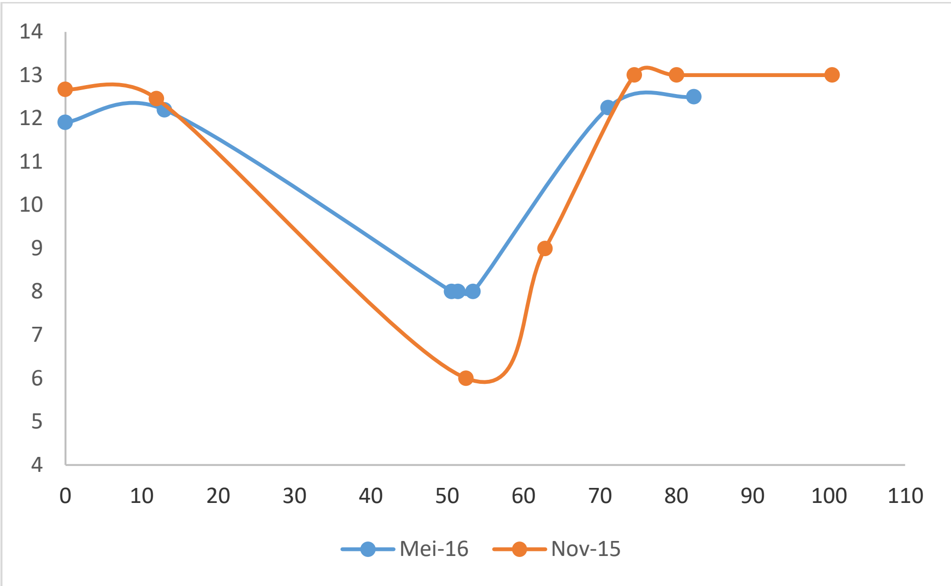


Figure 2. Cross-section Pattern Change Negara River Currents

In this study, two river cross sectional measurements were performed with echo sounding, ie in November 2015 and May 2016. Both data from the results of this measurement were then compared to determine the cross-sectional changes in the river that occurred. Based on the pattern of change, the downstream part of the River Negara undergoes agradasi (base of the rising channel). This is due to the sedimentation that occurs in the relatively large downstream.

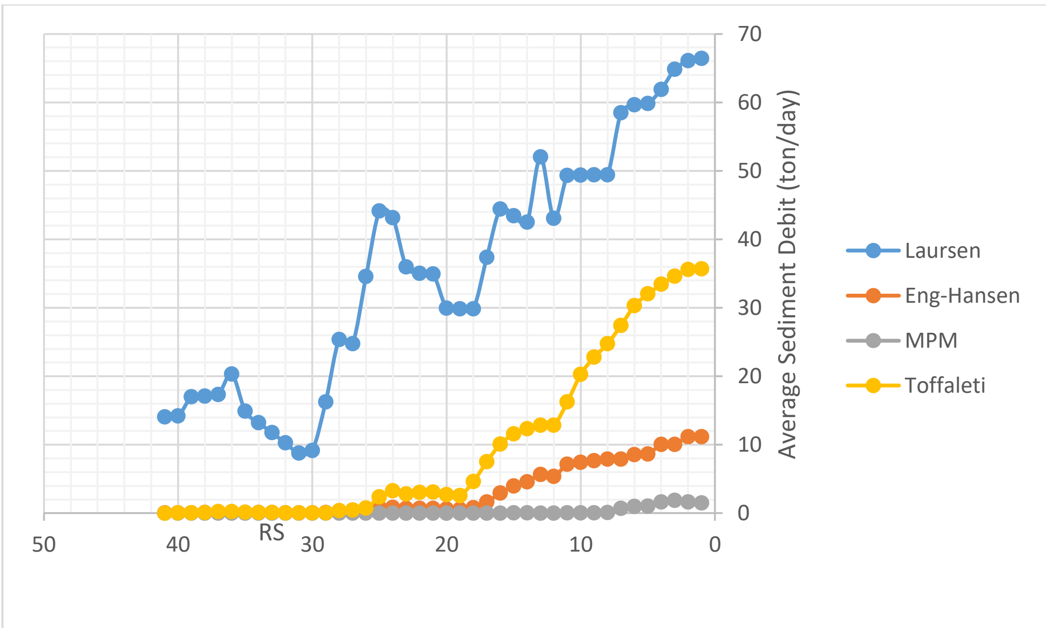
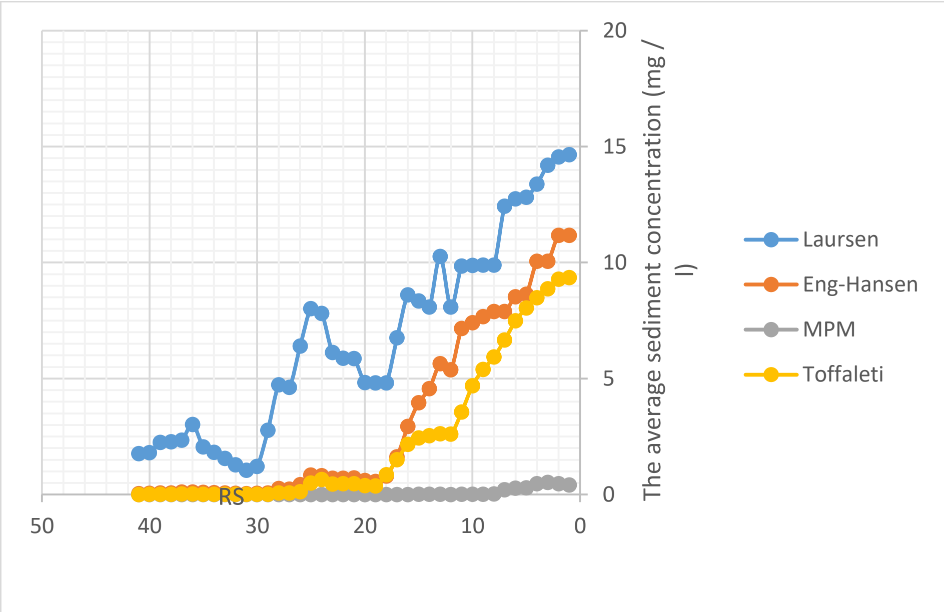


Figure 3. Comparison Graph of State River Sediment Debit by Various Methods

From the results of running, obtained the largest sediment discharge value in Formula Laursen. While the smallest value obtained with Formula Meyer Peter Muller. Small sediment discharge values with the Meyer Peter Muller Formula are due to the small shear stress values, so that the basic sediment has not moved. Whereas on the contrary with Formula Laursen, obtained a large sediment discharge value due to the value of shear stress is also large.



The largest sediment concentration values were obtained by using Formula Laursen. While the smallest value obtained by using Formula Meyer Peter Muller. This relates to the falling speed acting on the sediment. The greatest falling speed is owned by Formula Engelund-Hansen. As for Formula Laursen, the speed fell quite small. This results in sediments tending to drift in the flow which makes the concentration of the sediment to be large. In contrast to Formula Laursen, Formula Meyer Peter Muller with a falling velocity value greater than Formula Laursen resulted in sediment tends to fall to the bottom of the river so that the sediment concentration becomes small.

In the process of running bridge scour with HEC-RAS 4.1.0, all formulas used are left default. This is done to facilitate the selection of the formula used. In the calculation, for scouring due to contraction used live bed formula. While the formula for calculation scouring due to pillar is Froehlich. The scour depth value that occurs on

Andi Tajang Bridge with discharge design with 50, 100, 500, and 1000 year reset times is as follows.

Pile	Scour depth (m)			
	KU 50	KU 100	KU 500	KU 1000
1	2,9	2,92	2,98	2,98
2	2,9	2,92	2,98	2,98
3	2,9	2,92	2,98	2,98
4	1,07	1,08	1,1	1,11
5	1,07	1,08	1,1	1,11
6	1,07	1,08	1,1	1,11
7	1,07	1,08	1,1	1,11
8	1,17	1,18	1,2	1,21

Based on the analysis result, the scour depth at each pillar is different according to the location and the re-discharge time of the design. At discharge with 50 year re-time, the biggest scour depth is 2,9 m. While on the debit with 100-year re-enactment, the biggest scour depth is 2.92 m. By looking at these two values, it can be concluded that the scour depth value at Andi Tajang Bridge is not significantly changed with the discharge with different re-scaling. This is also seen in the largest scour depth results at the discharge with the 500 and 1000 year re-scales that yield the same value. From this result, it can be concluded that with extreme discharges with 1000 year re-scaling period, the scour depth occurring at Andi Tajang Bridge is 2.98 m.

4. CONCLUSION

1. Based on the research that has been done, the methods that can be used to analyze the capacity of sediment transport and sediment discharges in River Negara are by using formula of Laursen, Engelund Hansen, Meyer Peter Muller, and Toffaleti. These methods produce different sedimentation results. This is due to the different calculation approaches in each formula.
2. The average sediment transport capacity of the State River using the Laursen formula is 259,112 ton/day, using the Engelund Hansen formula that is 374,214 ton/day, using the formula Meyer Peter Muller is 61,9 ton/day, and with using Toffaleti formula that is 10,027 ton/day.

3. The average sediment discharge of State River using Laursen formula is 35,347 ton/day, using Engelund Hansen formula that is 3,151 ton/day, using Meyer Peter Muller formula that is 0,235 ton/day, and using Toffaleti formula that is 9,934 ton/day. While the average sediment concentration of River Country using Laursen formula is 6,668 mg/l, by using Engelund Hansen formula that is 0,837 mg/ l, using Meyer Peter Muller formula that is 0,065 mg/l, and by using Toffaleti formula that is 2,343 mg/l.
4. The maximum scour depth that occurred at Andi Tajang Bridge with the plan discharge with 50 year re-time of 2.9 m, with a 100 year re-time of 2.92 m, and with a re-time of 500 and 1000 years of 2.98 m.

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