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Relationship of Discharge Fluctuation Changes With Velocity of Meandering River Propagation

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ABSTRACT

Background: Modeling of river meanders propagation generally analyzed on a constant discharge condition. In fact no constant discharge in the river. Hence it is highly necessary to revealed that discharge fluctuations are very influential to the propagation velocity on groove of meandering river. **Objective:** To get the relationship between discharge fluctuations change with the meandering groove propagation velocity. **Results:** Relationship between discharge fluctuation changes with meandering river propagation, shows that the relationship in form of a line with exponential equation. **Conclusion:** The velocity of the meandering river propagation were increase in accordance with an exponential function V = 0,0631e0,1941□ Q in m/year.

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INTRODUCTION

Modeling of river meanders propagation generally analyzed on a constant discharge condition. In fact no constant discharge in the river [Kuntjoro, 2013.b.]. Several previous proposed models to forecast the river meander movement or river propagation can be found in literatures as follow:

Consideringly the parameters of shear stress , the river water surface slope, river geometry and the acceleration of gravity, D. M. Keady and M. S. Priest, (1977); A. J. Odgaard, (1987); Takes into account the parameters of basal and river cliffs material porosity, Duan, Jennifer G. dan Pierre, Y. Julien (2005); P. Ph. Jansen, L. van Bendegom, J van de Berg, M de Vries, and A. Zanen, (1979); The consummation of Keady and Priest with new data, J. L. Briaud, et. al., (2001); Consider the catchment area , the material and hight of clift , the comparison of depth and wide of the river, radius of meandering river arch and river bed slope, J. M.Hooke, 1980; Considered with the past changes of river geometries, Abad and Gracia (2006); Considered with the sedimentation patterns on groyne field, Suharjoko et. al. (2014)

All of thuse models used constant discharge condition. Hence it is highly necessary to revealed that discharge fluctuations is very influential to the propagation velocity on groove of meandering river. In this paper discussed the influence of discharge fluctuations change against the propagation velocity of the river meandering. KUN-QARSHOV method [Kuntjoro,2012.a,b,c; Kuntjoro, 2013.a.] used to determine the amount of meander shifting. From this magnitudes can be determined the velocity of meandering river propagation in unit time (year).

MATERIALS AND METHODS

Materials:

This research is done in Brantas river in Mojokerto area. Result of measuring discharge in the segment it is stated in the discharge fluctuation. Discharge fluctuation changes are caled discharge changes daily in multi-year, these are described as range of the minimum and maximum of discharges during years of data. Discharge change fluctuations in the study location have displayed in Table 1 and has served in graphical form as seen in Figure 1.

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Australian Journal of Basic and Applied Sciences, 9(7) April 2015, Pages: 11-14

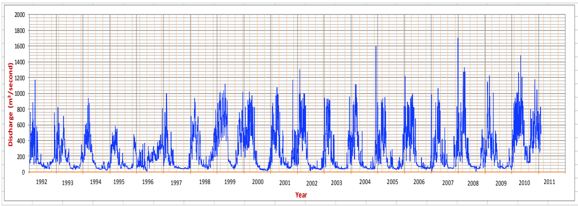

Fig. 1: The Brantas river Hydrograph in Mojokerto 1992–2011.

Table 1: The Brantas River Discharge range in Mojokerto 1992–2010.

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Maximum (m^3/second)	1172	822	938	584	809	1000	940	1120	1019	1019	1170	1304	955	1600	949	1219	1707	1329	1224	1482
Minimum (m^3/second)	38,8	31,2	21,9	36,1	9,58	34,23	30	33	9	9	41	14	34	30	28	31,34	9	6	31	60
Range	186,5	186,1	179	180,6	180,9	140	274,1	430,4	243,7	243,7	275	249,2	227,5	240,4	208,1	259,8	218,1	233,4	215,8	492,7

Fig. 2: Brantas River Meandering in Mojokerto.

Fig. 3: Field Condition Visualisation (scouring and sliding).

Table 2: Fluctuation discharge changes (m^3/second) and the velocity of meandering river propagation (m/day) 1992 until 2010.

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Discharge Range (10^2 m^3/second)	11,33	7,91	9,16	5,48	7,99	9,66	9,10	10,87	10,10	11,29	12,90	9,21	15,70	9,21	11,88	16,98	13,23	11,93	14,22
Propagation Velocity (10^{-4} m/day)	5,87	4,16	5,90	5,67	7,59	8,97	8,11	8,95	9,27	19,66	26,63	24,52	33,23	30,47	33,20	36,34	29,15	23,00	29,26

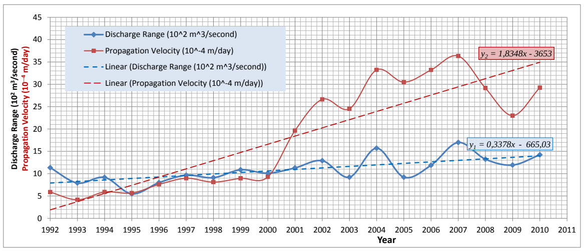

Fig. 4: Trend of discharge fluctuation changes and velocity of meandering river propagation 1992 until 2010.

Table 3: The relationship of of discharge fluctuation changes (m^3/s) and meandering river shifts (m/year).

Propagation Velocity (m/yaer)	0,21	0,15	0,22	0,21	0,28	0,33	0,30	0,33	0,34	0,72	0,97	0,90	1,21	1,11	1,21	1,33	1,06	0,84	1,07
Discharge Range (10^2 m^3/second)	11,33	7,91	9,16	5,48	7,99	9,66	9,10	10,87	10,10	11,29	12,90	9,21	15,70	9,21	11,88	16,98	13,23	11,93	14,22

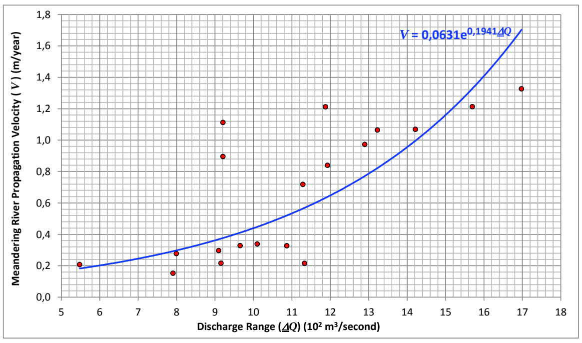

Fig. 5: The relationship between discharge fluctuation changes with meandering river propagation velocity.

Meandering river parameter in Brantas river in Mojokerto area from Google Eart displayed in Figure 2 and visualisation field condition in Figure 3.

Mathods:

Initiation of River Groove Movement:

Sedimentation from the collapse of a slide banks are calculated by equation: $q^{f}_{br} = x$ □ $h_{bank}(1-p)$, Kuntjoro et. al. (2013.b.)

KUN-QARSHOV method:

Meandering river propagation velocity is analyzed by KUN-QARSHOV method, acquired very varied behavior [Kuntjoro, 2013.a.]. This is caused by the complexity of the relationship between the parameters as seen in that equation.

To get the relationship between discharge fluctuations change with the meandering river propagation velocity, reviewed the river propagation in each point on the cross section of the river from the result of KUN-QARSHOV method analysis [Kuntjoro, 2014].

Results:

Relationship between changes of discharge fluctuations against the velocity of meandering river propagation in span of 1992 until 2010 by KUN-QARSHOV analytical method are expressed in Table 2. and Figure 4.

The equation of relationship between discharge fluctuation changes (□*Q*) with meandering river propagation (*V*), generated from discharge fluctuation changes and meandering river propagation a indicated in Table 3. and as seen in Figure 5.

Discussion:

Considering Figure 2. in the 1992 until 2010 period occurs the trend of discharge fluctuation changes follows the linear equation $y_1 = 0,3378x_1 - 665,03$, where y_1 is the number of discharge fluctuation changes, x_1 is the number of the year.

While the trend of the shifting velocity follows the linear equation $y_2 = 1,8348x_2 - 3653$, where y_2 is a number changes velocity of meandering river propagation and x_2 is the number of years.

There is the difference between gradient of the equation of fluctuation changes with the equation of velocity changes of the meandering river propagation as seen in the Figure 2. This is proves that an increase in discharge fluctuations be accelerate the shift of the river geometry.

Span 1992 until 2000 happened with trends change meandering river propagation velocity according to linear equations $y_3 = 0,5945x_3 - 1179,4$ where y_3 was the number of velocity change of meandering river propagation and x_3 is the number of the year.

While on the next span time, namely 2000 to 2010 there have been changes in the velocity of meandering river propagation according to linear equation $y_4 = 1,3132x_4 - 2606,2$ where y_4 was the number of velocity change of meandering river propagation and x_4 is the number of the year.

Visible at both equation that there is a gradient difference between the equation of meandering river propagation velocity in span 1992 until 2000 with 2000 until 2010, this prove that the increasing in discharge fluctuations can accelerate the meandering river propagation.

Figure 5. is relationship between discharge fluctuation changes with meandering river propagation, shows that the relationship in form of a line with exponential equation by the equation $V = 0,0631e^{0,1941□Q}$, where *V* is meandering river propagation velocity in metre/year and □*Q* is fluctuation discharge changes in form of the difference between maximum with minimal discharge in m^3/second.

Conlusion:

At the time of discharge fluctuation changes □*Q* = 0 m^3/second, that means on constant discharge fluctuation changes, the velocity of the meandering river propagation occurs also constant.

A result of increased the discharge fluctuations was occured linear propagation velocity $y_2 = 1,8348x_2 - 3653$, it means the meandering river propagation velocity increases with a gradient ±1,83.10-4 m/day = 0,07 m/year.

The velocity of the meandering river propagation were increase in accordance with an exponential function $V = 0,0631e^{0,1941\square Q}$ in m/year.

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