International Journal of Innovation Scientific Research and Review
Vol. 04, Issue, 02, pp.2377-2379, February 2022
Available online at http://www.journalijisr.com
SJIF Impact Factor 4.95

ISSN: 2582-6131

Research Article

DEVISING MANNING'S "N" ROUGHNESS COEFFICIENT AS AN ANALYTICAL APPROACH TO ASSESS THE UPLAND FLOOD BUFFERING CAPACITIES OF RIVERINE MANGROVES

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Received 13th December 2021; Accepted 15th January 2022; Published online 28th February 2022

ABSTRACT

Mangroves are the primary protector of the coastal ecosystem against flood, surge or enormous waves. They can dissipate the negative impact of these natural hazards for the biotic and abiotic factors in the marine zone. The study provides an analytical approach in describing the buffering capacities of mangroves in the riverine system against upland flooding. The study utilized the Manning's "n" Roughness Coefficient for irregular open channel to deliver a systematic procedure in estimating the buffering capacities of mangroves against flooding. The study was conducted in the mangrove ecosystem of Sukol River, Bongabong, Oriental Mindoro, Philippines. Based on the result of the study, using the regular condition of the water current in Sukol River as basis of estimation, the mangroves of the study site reduced the velocity of river water by 0.57 m/s with a discharge of 190.12 m3/s engaging a 2691.64 cfs flow rate. This is an implication that the mangroves influenced the movement of floodwater when they reached this ecosystem during the run-off. The test implies that Manning's "n" Roughness Coefficient is an efficient tool in evaluating the capacities of mangrove ecosystem in buffering the upland flooding. The procedure using the abovementioned approach provides a more logical analysis in the role of mangroves to disintegrate upland flooding.

Keywords: Mangroves; Manning's "n" Roughness Coefficient; Upland flooding; Riverine system; Floodwater.

INTRODUCTION

Mangroves are effective barrier of the coastal zone from flooding that are usually induced by strong or big waves, and storm surge during typhoon. The roots of some mangrove species serve as a buffering mechanism against the rushing water. Meanwhile, others have enormous trunk that serves as barrier on the strong current of flood. The population density and zonation pattern of mangroves are also factors that dissipates the movement of water entering this ecosystem (Thampanya *et al.,* 2006). Furthermore, these saline trees can efficiently decrease water current energy by 66 percent along their initial100-meter forest cover (Menéndez 2020). Globally, mangroves are considered as natural wall of the shoreline against coastal flooding or surge (Smolders *et al.,* 2015). Most of the analysis regarding the efficiency of mangroves as barrier for waves and coastal surge were based on catastrophic model, computer simulations, and other engineering equations. Moreover, research studies on mangrove flood water protection capacities are more focused in the bay area than in the riverine system (Narayan 2017). Mangroves in the riverine are not particular in the buffering of waves or surge in the shoreline because there are species of these trees that already thrive the area. Instead, mangroves in the estuarine are notable barrier of the flood water coming from the upland ecosystem; protecting human settlements, associated biotic and a biotic factors. However, riverine mangroves are scattered in both sides of the river edge within the estuarine which made their flood buffering capacity assessment hard to evaluate. For the abovementioned situation, the objective of this study is to utilized the Manning's "n" Roughness Coefficient for irregular open channel in order to analyze the significance of mangroves in reducing the impact of upland flood water to marine ecosystem. The study used the regular condition of the current in the river system as an analogy to estimate the possible reduction in velocity of the flood water by the mangroves. The approach estimates the flow of water in an open channel considering the obstruction factors that reduced the current running through the river bed. The vegetation stand of mangroves are considered factors that obstruct and reduce the flow of water in a riverine system at any condition.

MATERIALS AND METHOD

Research Setting

In describing the Manning's "n" Roughness Coefficient capacity to describe the buffering abilities of mangroves, the study was conducted in the riverine system of Sukol River, Bongabong, Oriental Mindoro, Philippines. The study site was inhabited with different mangrove species that grows on both side of the river along the communities of Barangay Aplaya, Sitio K.I. and Sitio Asiatic. The setting of the studied ecosystem is fitted to the interest of the research objective.

Figure1. The map of the study site, Sukol River, Bongabong, Oriental Mindoro Philippines

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Data Collection Procedures

The initial step to get the estimate of the reduced velocity of rushing water entering the mangroves of the study site was providing the Manning's "n" value. This was done by identifying the figures in each component of the equation suited for the site. These were the roughness coefficient components; n0 (rate bed material), n1 (rate channel irregularities), n2 (rate cross-sectional variations), n3 (rate obstruction) and n4 (rate vegetation) and m (rate meander). The study used the equation below to get the Manning's "n":

n values = n0 + n1 + n2 + n3 + n4 (m)

Then, after identifying the Manning's "n" value, the Side Slope, Bed Width, and Depth of Flow were set. The Side Slope was acquired by measuring the vertical and horizontal angle of the dike or edge slope of the channel using meter as unit of measurement. The Bed Width was identified using Google Earth Pro, an application that can virtually compute the width of any channel or surface apparent to Earth. The Depth of Flow of the river in the study site was measured using improvised measuring pole. Moreover, Area, Wetted Perimeter and Hydraulic Radius of the river were also computed. The acquired figures from the measurement of the Side Slope, Bed Width, and Depth of Flow were utilized for calculation. The equations below together with the previous results were used by the study to attain the abovementioned given:

Area:

A = (B + my)y

Wetted Perimeter:

$$P = B + 2\sqrt{m^2 + 1y}$$

Hydraulic Radius:

$$R = \frac{A}{P}$$

Then, Flow Rate and Bed Slope were also included in the computation of the water velocity to describe the flood reduction capacity of the mangroves in the study site. The Flow Rate was acquired using floating method. This was a procedure that computes the average flow rate of the river, designating a starting-to-finish point of floating object along the edge of the channel. Meanwhile, the Bed Slope was acquired by measuring the width and depth across the downstream section using an improvised measuring pole. The equations below were used to achieve the Flow Rate and Bed Slope of the river in the study site:

Flow Rate:

CFS = A x V (area multiplied by velocity)
A (Area) = Width of Channel (feet) x Depth of Water (feet)
V (Velocity) = Distance Travelled / Time to travel (feet travelled divided by seconds)

Bed Slope:

$$S = \left(\frac{Qn}{1.49AR^{2/3}}\right)^2$$

Then, when the needed numerical result from previous test were acquired, the following equations below to get the velocity and discharge of water as they passed the studied mangrove ecosystem were used:

Velocity:

$$V = \frac{1}{n} R^{2/3} S_0^{1/2}$$

Discharge:

Q = A/V

RESULTS

The "n" value of the different channel condition based on the collected data were projected on Table 1; bed material (0.26), irregularities (0.010), sectional variations (0), obstruction (0.004), vegetation (1.00) and meander (1). These are the basis of estimates regarding the capacity of Sukol River in plummeting the impact of the running water. The collation of data resulted to the total n value of 0.374.

Table 1. Results for the computation of Manning's n Roughness Coefficient in an open channel

Name of River Channel	Manning's Roughness Coefficient						
	m (Meander)	n0 (Bed Material	n1 (Channel Irregularities	n2 (Cross-sectional variations)	n3 (Obstruction)	n4 (Vegetation)	Total
Sukol	1	0.26	0.010	0	0.004	0.100	0.374

Meanwhile, the results for Side slope (1.75: 1.50 m), Bed width (141 m), Depth of Flow (2.3 m), Area (333.558 m^2), Wetted Perimeter (149.623 m) and Hydraulic Radius Entry (2.229 m) are shown in Table 2.

Table 2. Results for Side slope, Bed width, Depth of Flow, Area, Wetted Perimeter and Hydraulic Radius Entry

Side Slope	Bed Width	Depth of Flow	Area	Wetted Perimeter	Hydraulic Radius
1.75: 1.50m	141 m	2.3 m	333.558m^2	149.623m	2.229 m

The mangroves of the study site inclined the velocity of river water by 0.57 m/s with a discharge of 190.12 m^3/s engaging a 2691.64 cfs flow rate (refer to Table 3).

Table 3. Flow Rate, Bed Slope, Velocity and Discharge Entry

Flow Rate	Bed Slope	Velocity	Discharge
2691.64 cfs	0.01565	0.57 m/s	190.12 m^3/s

DISCUSSION

Based on the results of the study, the mangroves of Sukol River have the capacity to reduce the velocity of water current by 0.57 m/s as they passed through the studied ecosystem. Noticeably, the "n" value for vegetation characteristics reached the maximum value adjustment giving the most significant figure among the other channel characteristics. The vegetation of the Sukol River which are mostly dominated by different riverine mangrove species are deliberative and precise for the designated "n" value. The result of the test mainly for vegetation characteristic is a phenomenal parameter that made the Sukol channel to have a 190.12 m^3/s discharge going down the estuarine. The Manning's "n" Roughness Coefficient is usually used in engineering specifically in developing irrigation system in closed or open channel. The study utilized the technique to analytically describe the mangroves' ability to act as barrier against upland flooding (Dasgupta *et al.,* 2019). Thus, the data collected were based on the normal flow of water during the transition of high tide to low tide instead of the actual flooding situation. This is due to the risk and chance of flooding in the study site especially during typhoon. Nevertheless, the data collected through the approach can be used as baseline data for estimates and comparison regarding the ability of mangroves to buffer the impact of flood water.

CONCLUSION

The Manning's "n" Roughness Coefficient is an efficient tool to describe the capacities of the mangroves in reducing or buffering the upland floodwater and surge of seawater in the shoreline. The elements or involving parameters of the abovementioned tool also displays a logical approach in acquiring relevant figures to estimate the velocity reduction made by the mangroves on the moving water that pass through this ecosystem.

Acknowledgements

The author would like to thank Dr. Donna Paz Reyes for providing this research paper with suggestions and critiquing.

Author Contribution:

RAQ: crafting of research concept and data collection, and analysis, PPP and MUS: provides feedback and critiquing for the paper, and finalizing the manuscript.

Conflicts of Interest

The authors declare no conflict of interest

Ethics Approval

Not applicable for this paper.

REFERENCES

Dasgupta, S., Islam, M. S., Huq, M., Huque Khan, Z., Hasib, M. R.,& et al. (2019). Quantifying the protective capacity of mangroves from storm surges in coastal Bangladesh. PLOS ONE, 14(3), e0214079. https://doi.org/10.1371/journal.pone.0214079

Menéndez, P., Losada, I. J., Torres-Ortega, S., Narayan, S., Beck, M. W., & et al. (2020). The global flood protection benefits of mangroves. Scientific Reports, 10(1).

Narayan, S., Beck, M. W., Wilson, P., Thomas, C. J., Guerrero, A., Shepard, C. C., Reguero, B. G., Franco, G., Ingram, J. C., Trespalacios, D., & et al., (2017). The value of coastal wetlands for flood damage reduction in the Northeastern USA. Scientific Reports, 7(1). https://doi.org/10.1038/s41598-017-09269-z

Smolders, S., Plancke, Y., Ides, S., Meire, P. and Temmerman, S.,& et al., (2015). Role of intertidal wetlands for tidal and storm tide attenuation along a confined estuary: A model study. Nat. Hazards Earth Syst. Sci. 15, 1659–1675.

Thampanya, U., Vermaat, J., Sinsakul, S., Panapitukkul, N., & et al., (2006). Coastal erosion and mangrove progradation of Southern Thailand. Estuarine, Coastal and Shelf Science, 68 (1–2), 75–85. https://doi.org/10.1016/j.ecss.2006.01.011

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