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Application of ROM Scale for Assessing Erosional Vulnerability in Lower Assam Region of River Brahmaputra.

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Abstract:*Natural hazard or disaster and human being of this globe are like the two faces of a coin. From the formation of life in this world, they are facing several types of hazard or disaster like earthquake, draught, cyclone, flood, volcanic eruption, river bank erosion etc. The river bank erosion is the very common and recurrenthazard to the people of the world causing multi-dimensional loss to the river side inhabitants with tremendous adverse effect on the environment. Any natural hazard cannot be prevented but the effect can be minimized by adopting appropriate measures. To adopt the appropriate measures, the intensity and hazard occurring locations must be identified. In case of river bank erosion also the erosional hazard is not same in all locations of the river reach. Therefore, for effective implementation of anti-erosive measures, the river reach should be identified and marked as per the probability of degree of erosion. In this work, it is tried to check the suitability of ROM scale to assess the vulnerability of erosion in lower Assam region of river Brahmaputra, so that with the help of this method the whole river reach can be categorized and pin pointed as per the probability of degree of erosion for taking anti- erosive measures on priority basis for the greater benefit of the affected people.*

Keywords*: Assam, Brahmaputra, Erosion, Erodibility, Hazard, River Bank, Vulnerable,*

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I. Introduction

The river Brahmaputra is one of the mightiest river of the world which is flowing through the middle of the state Assam, dividing the whole state into two distinct parts (Fig-1).All Assamese people feel very proud for this mighty river but at the same time this river is also the main cause of sorrow to the people living on its both sides due to excessive erosion and braiding nature of Brahmaputra. The mighty and extremely braided river Brahmaputra is eroding its bank here and there at an extremely large rate by causing havoc and all-round losses to the poor people living in its side. Due to very high-water current and alluvial nature of bank soil, the river water cut the soil at toe making the soil mass overhanging and ultimately fail after forming tension cracks. The erosional tendency of river Brahmaputra is quite high in entire course of Assam. But due to joining of some big tributaries like Beki, Manas, Aieetc in lower Assam reach (down side of Guwahati), the mightiness of the river increases in this reach and exhibits more power in eroding its both banks(Fig:3) with creation of heavy seasonal flood in all catchment areas of lower Assam, particularly in the district of Nalbari, Barpeta, Chirang, Goalpara, Kokrajhar and Dhuburi. Hence the study area is selected in lower Assam region. It has been estimated by GIS survey that about 750 km bank line in both banks are having very high tendency of erosion which means more than 50 % (total length of both banks in Assam is 1400 km) locations or reaches of river Brahmaputra is vulnerable to erosion. The study also reveals that, in the down side of Guwahati the tendency of erosion of north bank is higher than the south bank and in the upside of Guwahati, the case is reversed that is the tendency of erosion of south bank is higher than the north bank. The erosional tendency and braiding nature of river Brahmaputra or any other river is natural and cannot be eliminated but it can be reduced or controlled to great extent by taking appropriate measures or techniques. Since the degree of erosion is not same in all places, to adopt any remedial measures the location should be identified whether it is erosion prone or erosion free. In this particular work, it is attempted to check the appropriateness of application of ROM scale to identify the vulnerability of erosion in lower Assam region of river Brahmaputra.

Figure: 1(The river Brahmaputra through Assam)

II. Site Selection and Methodology

For the study purpose of application of ROM scale in assessing the vulnerability of river bank erosion, the whole reach of river Brahmaputra in lower Assam region has been observed carefully and finally sixteen locations are selected. Out of these selected sixteen locations, the first eight locations are very less or no erosion prone and last eight locations are of highly erosion prone (Table 1& Fig 2). From all these sixteen locations, soil samples are collected at least from five spots from each location covering minimum of 1 km length. All disturbed samples are carried to the laboratory and sieve and hydrometer analysis are performed in the laboratory as per Indian standard to determine the percent content of sand, silt and clay for each and every sample. Finally, the average is calculated for each location. After carrying the sieve analysis if the total percentage of silt and clay is found to be less than 10% then hydrometer analysis is not done. In this case for using in ROM scale the % of silt and clay is considered to be equal. For example, if the % of clay and silt is found 8% after sieve analysis then for calculating EI_{ROM} the % of silt is considered as 4% and % of clay is considered as 4%. The results of particle size analysis are tabulated in table 2.

Table :I(Description of selected locations)

Sl No	Position of locations	Name of locations	Remarks
1	$26^{0}11^{/}13.92^{//}$;$91^{0}44^{/}33.12^{//}$	Joypur(South bank)	No or less erosion
2	$26^{0}12^{/}4.07^{//}$;$91^{0}44^{/}26.95^{//}$	Uzan Bazar Ghat(South bank)	No or less erosion
3	$26^{0}11^{/}9.55^{//}$; $91^{0}43^{/}16^{//}$	Ferryghat(North Guwahati)	No or less erosion
4	$26^{0}8^{/}22.6^{//}$; $91^{0}34^{/}9.16^{//}$	Majirgaon(South bank)	No or less erosion
5	$26^{0}11^{/}9.71^{//}$;$90^{0}36^{/}43.15^{//}$	Goalpara (South bank)	No or less erosion
6	$26^{0}11^{/}1.7^{//}$;$90^{0}32^{/}57.1^{//}$	Pancharatna(Both bank)	No or less erosion
7	$26^{0}12^{/}1.04^{//}$;$90^{0}33^{/}52.1^{//}$	Jogighopa(Both bank)	No or less erosion
8	$26^{0}0^{/}48.92^{//}$;$89^{0}58^{/}57.5^{//}$	Dhuburi (North bank)	No or less erosion
9	$26^{0}06^{/}58.1^{//}$;$91^{0}25^{/}52.7^{//}$	Dakhala(South bank)	Highly eroded
10	$26^{0}7^{/}34.18^{//}$;$91^{0}32^{/}20.6^{//}$	Palasbari (South bank)	Highly eroded
11	$26^{0}08^{/}44.52^{//}$;$90^{0}14^{/}11.12^{//}$	Nayer Alga char (North bank)	Highly eroded
12	$26^{0}08^{/}13^{//}$;$90^{0}11^{/}52.8^{//}$	Mayer Char (North bank)	Highly eroded
13	$26^{0}08^{/}16.8^{//}$;$90^{0}15^{/}16.1^{//}$	Sonamukhi hills (North bank)	Highly eroded
14	$26^{0}15^{/}26.41^{//}$;$91^{0}06^{/}30.93^{//}$	Bahari(North bank)	Highly eroded
15	$26^{0}06^{/}30.69^{//}$;$91^{0}15^{/}58^{//}$	Garaimari(South bank)	Highly eroded
16	$26^{0}05^{/}52.89^{//}$;$91^{0}17^{/}55.87^{//}$	Saupata Pt-I(North bank)	Highly eroded

Figure :2(All locations showing in map)

(The red marked locations are highly eroded and green marked locations are very less eroded)

Table:2(Results of particle size analysis)

Location	% of Sand	% of Clay	% of Silt	% of Clay and Silt
1	80.4	14.6	5.0	19.6
2	82.6	15.5	1.9	17.4
3	89.2	8.6	2.2	10.8
4	80.8	13.6	5.6	19.2
5	78.6	18.2	3.2	21.4
6	81.4	16.5	2.1	18.6
7	89.2	9.4	1.4	11.8
8	87.0	8.6	4.4	13.0
9	94.6	2.7	2.7	5.4
10	95.2	2.4	2.4	4.8
11	91.9	4.05	4.05	8.1
12	88.8	3.2	8.0	11.2
13	97.5	1.25	1.25	2.5
14	94.9	2.55	2.55	5.1
15	98.6	2.2	8.2	1.4
16	94.4	2.8	2.8	5.6

Figure:3(Picture of river bank erosion in lower Assam region of river Brahmaputra)

III. The ROM Scale

The soil erodibility can be defined as the resistance of soil particles against the detachment and transportation by erosive agents (Charman&Houghtan, 1986). This is an important parameter or index to determine the susceptibility of soil towards erosion. The value of soil erodibility is found to depend on several factors such as physical properties of soil, infiltration level, organic matter present, vegetative cover etc. Out of all physical properties the soil structure and its composition are the most important factor for determination of erodibility of soil. From long back attempts have been made to develop an index of erodibility of soil to assess the extent of erosion of different type of soils. The soil scientist Bouyoucos (1962) developed a relation to index the erodibility of soil on the basis of composition of soil such as % of Sand, % of Silt and % of Clay as:

$$\text{BouyoucosErodibility Index} = \frac{(\%\text{ of Sand} + \%\text{ of Silt})}{(\%\text{ of Clay})} \qquad (1)$$

This relation (1) shows that the index is directly proportional to the sum of % of Sand+ % of Silt and inversely to the % of Clay content. The work of Bouyoucos (1962) has been carried forward by Zainal Abidin and Mukri (2002) to develop a new, advanced and improved relation of erodibility index in Malayasia. Ultimately, they developed a scale known as ROM scale (in the name of researchers **Ro**slan and **M**azidah) on the basis of logical and predictive calculation to assess the degree of soil erosion extent. This scale was developed in the year 2011 and received the international recognition. This work also abled to won a Global Medal award with distinction in Geneva, Switzerland at the 30th International Exhibition on new inventions, innovations, design, technologies and products in 2002. Like BouyoucosErodibility Index, this scale is also based on soil grading characteristics (% of sand, % ofsilt and % of clay). The new ROM relation is given by :

$$\mathbf{EI}_{ROM} = \frac{(\%\text{ of Sand} + \%\text{ of Silt})}{2\,(\%\text{ of Clay})} \qquad (2)$$

The digit 2 in the denominator is used after considering the range of values to be categorized with respect to other standards of international values such as Richter scale for earthquake intensity. The calculated soil erodibility index on the basis of composition of soil can be used to categorized the risk of erosion using the table3.

Table:3(Relation between ROM scale erodibility index and soil erodibility category)

ROM Scale Erodibility Index	Soil Erodibility Category
Less than 1.5	Low
1.5 to 4.0	Moderate
4.0 to 8.0	High
8.0 to 12.0	Very High
Greater than 12.0	Critical

To use this scale for assessing or predicting the vulnerability of erosion of certain soil, the soil samples should be collected and sieve analysis and hydrometer analysis experiments should be performed to assess the actual percentage of sand, silt and clay. The relation clearly indicates that as the % of clay is increased the value of erodibility index is reduced and risk of erosion become less and vice versa. This means the clay content in soil is an important parameter for river bank erosion.

IV. Determination of erodibility index by using ROM Scale

After finding the percentage of sand, silt and clay and using the equation or relation (2) the ROM scale erodibility index for all locations are determined and soil erodibility category are assigned as per Table 3 and all theseresults are tabulated in Table 4.

Table :4(Assessed value of ROM index and erodibility category of all locations)

Location No	% of Sand	% of Silt	% of Clay	Value of ROM Scale	Erodibility category
1	80.4	5.0	14.6	2.92	Moderate
2	82.6	1.9	15.5	2.73	Moderate
3	89.2	2.2	8.6	5.31	High
4	80.8	5.6	13.6	3.17	Moderate
5	78.6	3.2	18.2	2.24	Moderate
6	81.4	2.1	16.5	3.50	Moderate
7	89.2	1.4	9.4	5.45	High
8	87.0	4.4	8.6	5.31	High
9	94.6	2.7	2.7	18.01	Critical
10	95.2	2.4	2.4	20.33	Critical
11	91.9	4.45	4.45	9.73	Very high
12	88.8	8.0	3.2	15.13	Critical
13	97.5	1.25	1.25	39.5	Critical
14	94.9	2.55	2.55	19.0	Critical
15	89.6	8.2	2.2	22.22	Critical
16	94.4	2.8	2.8	17.75	Critical

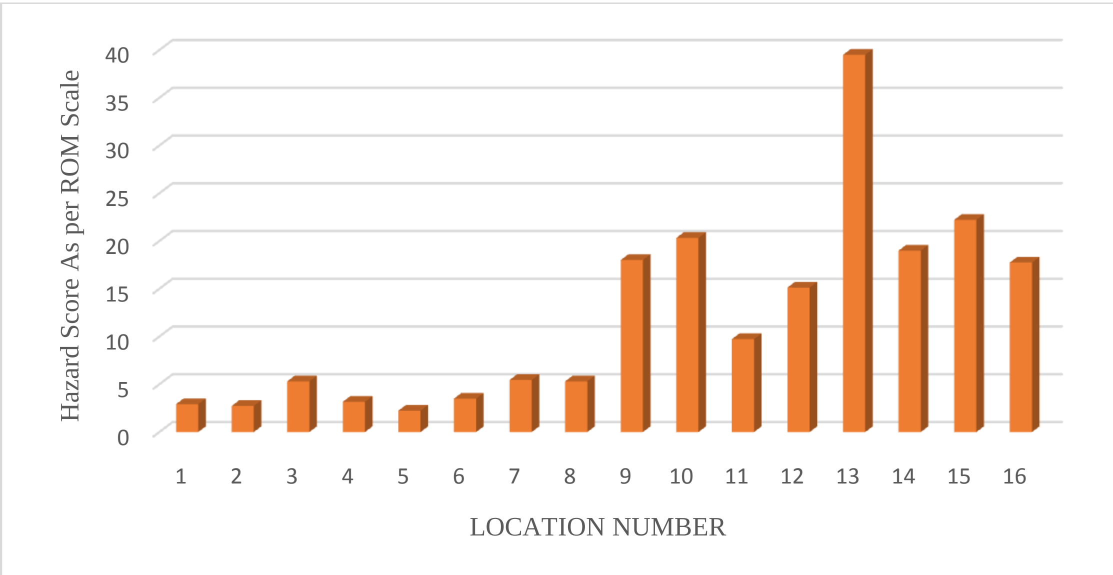

Figure:3(Comparison of Hazard scores of all locations as per ROM scale)

IV. Results Analysis and Conclusion

The results obtained from particle size analysis are put in the EI_{ROM} equation to find the ROM values for different location to categorize the erodibility. The new improved ROM scale reveal that if the percentage of clay is more than 20 % then the soil erodibility category will be low. But in our case no location is found with clay content more than 20% and hence no location with soil erodibility category low is obtained. Out of considered sixteen locations 50% locations(location number 1 to 8) are of low or very low category and another 50 % locations(location number 9 to 16) are of extreme or critical category of erosion. As per the analysis of results obtained from ROM scale 31.25 % locations come under moderate category, 18.75 % locations come under high category, 6.25 % locations come under very high category and 43.75 % locations come under critical category.

The river erosion hazard is a burning problem of Assam. The river Brahmaputra and its tributaries creating tremendous despoliation to the people living on the riverside. Almost every year the river Brahmaputra is eroding both banks forcing so many poor people to migrate after losing their fertile land and livelihood and thus creating a great problem to the state. This particular natural hazard cannot be suppressed but it can be controlled with proper remedial arrangements. For application of ant-erosive measures or remedial arrangements, it is necessary to spotting out the locations vulnerable to erosion beforehand. So many methodologies or ways are available to predict the strength and weakness of river bank against the erosion. The EI_{ROM} equation is one such established very simple methodology to assess the extent of erosion on the basis of soil composition. In this work the validity of this methodology is checked in lower Assam region of river Brahmaputra by applying it into sixteen predetermined locations. After analyzing the result, it has come to light that this method gives very much acceptable results in identifying the highly erosion prone areas as all already high erosion prone areas are shown or identified as very high and critical, but it inflates in giving the results in case of erosion less areas by giving moderate category instead of low. Since our main concern is the proper identification of erosion hazardous locations, it can be finally concluded that this EI_{ROM} equation can effectively and widely be used to identify the risky and erosion vulnerable locations for proper implementation of ant-erosive measures.

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