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SCOUR AND EROSION ALONGSIDE BANK PROTECTION WORK: CASE STUDIES FROM BANGLADESH

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Progression, speed of scour development, and the final scour depth at riverbank protection work play an important role for planning and design. In a country like Bangladesh, with insufficient resources, bank protection often fails as a result of undercutting. This paper presents data from field measurements to provide the reader with an understanding of the order of magnitude of river depths and scour progression in the Brahmaputra / Jamuna Rivers. This is a sand-bed river system and because of difficulties associated with defining a normal bed elevation in a braided sand-bed river, we suggest using the total river depth measured from the 100-year water level for design purposes.

1 Introduction

1.1. *Rivers and Bank Protection in Bangladesh*

Bangladesh is one of the most densely populated countries in the world with about 900 persons per square kilometer. Most of the country is formed by the riverine delta of three major rivers: the Brahmaputra/Jamuna, Ganges and Meghna River (Figure 1).

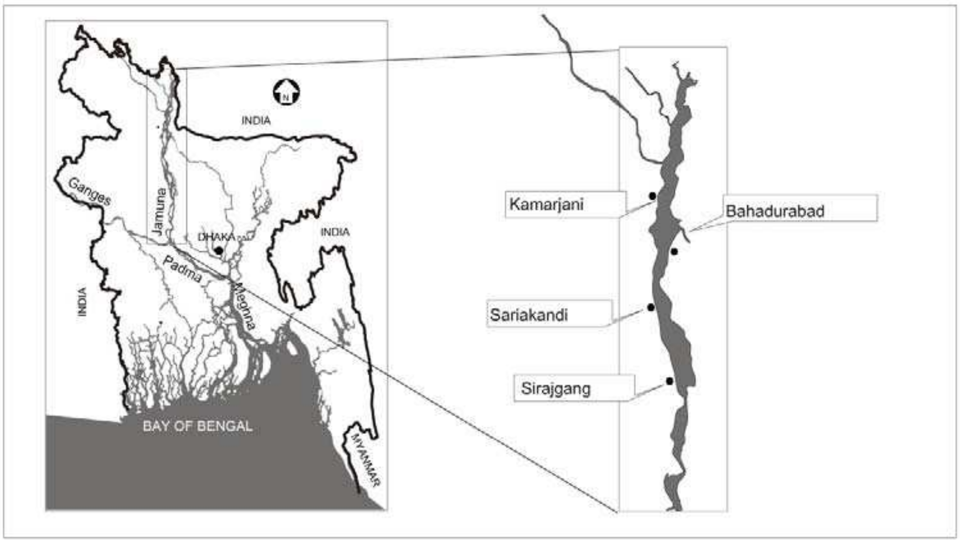


Figure 1. Map of Bangladesh with locations of bank protection work cited in this article.

These rivers are commonly many kilometres wide and are characterized by braiding or meandering. The average width of the Brahmaputra / Jamuna River is about 12.5 kilometres, and conveys a discharge of about 100,000 m³/s during the 100-year flood. The floodplains consist of fine unconsolidated sands and silts with little clay content. Lateral erosion rates of more than 1 kilometre per year can occur in extreme cases.

The high and increasing population density forces people to live in areas prone to erosion and flooding. Therefore bank protection, which prevents the loss of valuable floodplain land and infrastructure, plays an important role in Bangladesh. However, despite more than 100 years of bank protection experience in and around Bangladesh, there are still many examples of sudden failure of bank protection work. The primary reason is rapid and deep scouring, which mitigates against rapid mobilization of protective efforts.

2 Measured Erosion at Unprotected Banks – an Example of Bend Scour

The bend scour data presented here were measured along the right bank of the Brahmaputra / Jamuna River near Kamarjani. The measurements cover a period of four years. Figure 2 shows the path of the scour along the bank with different bank lines, Figure 3 shows the depth of the development of the deepest river level. The 100-year flood level is at about 23 m+PWD and consequently the greatest water depth measured was about 28 m in 1995 at the downstream end of the groynes and 25 m in 1998 about 3 km downstream at the unprotected bend.

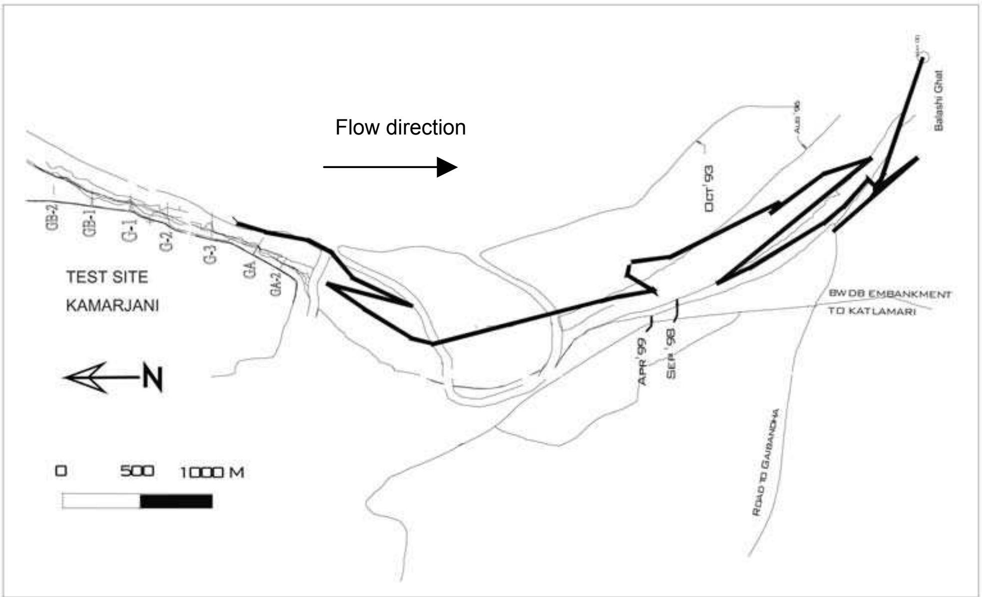


Figure 2. Movement of scour hole along the river bank at Kamarjani.

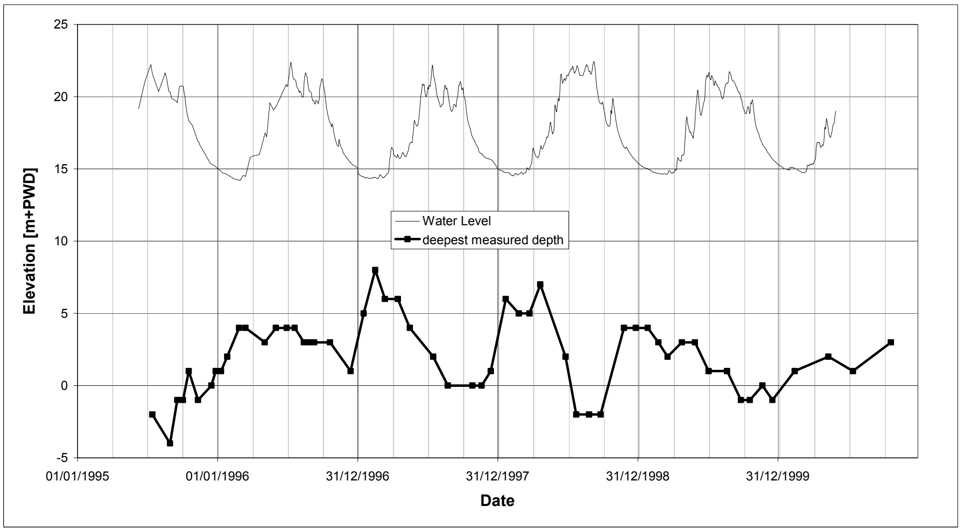


Figure 3. Development of river depth along the bend.

3 Measured Scour at Protected Banks

1.2. *Two Examples of Scour Developments at Revetments*

Scour measurements from two locations along the Brahmaputra/Jamuna River were used: Sirajganj Town Protection which consists of a revetment about 2 kilometers in length at the right bank, and Bahadurabad, which consists of a revetment about 700 m in length at the left bank. The type of scour at both sites is quite different: at Sirajganj, the revetment protrudes into the flow and the deepest scour occurred at the upstream end; at Bahadurabad, deep scour occurred at both ends of the structure depending on the angle of the attacking flow.

The Sirajganj scour development, presented in Figure 4 and 5, shows the most rapid scouring observed through systematic measurements.

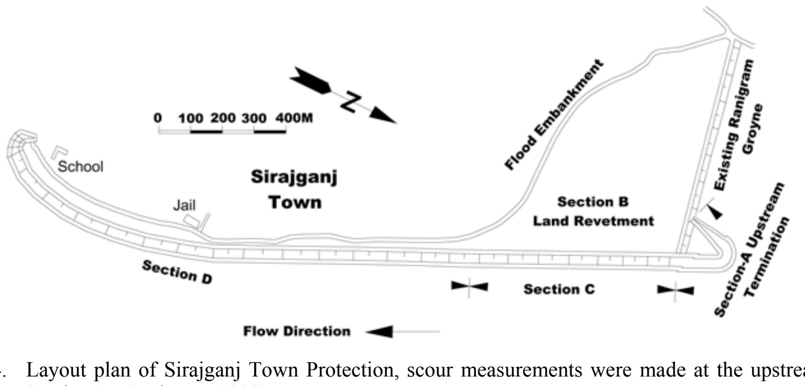
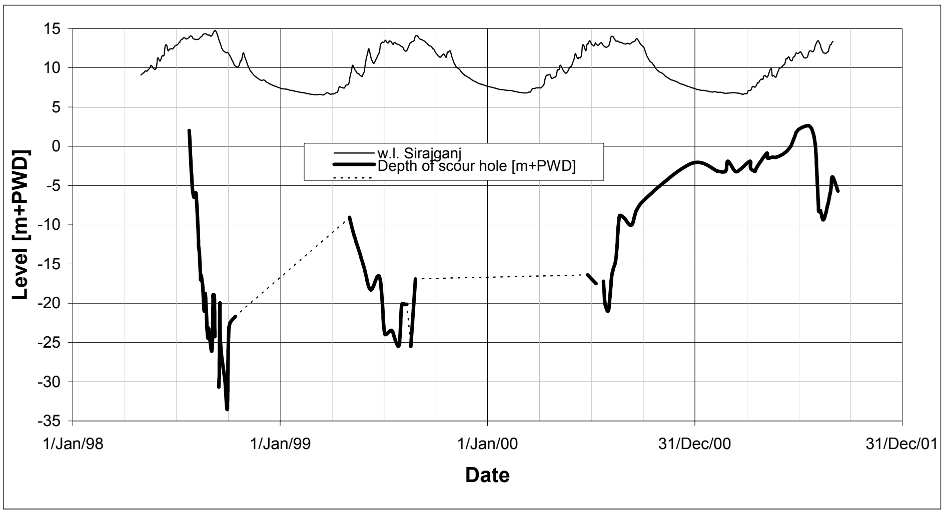


Figure 4. Layout plan of Sirajganj Town Protection, scour measurements were made at the upstream end at Section A. (Halcrow, 1998)



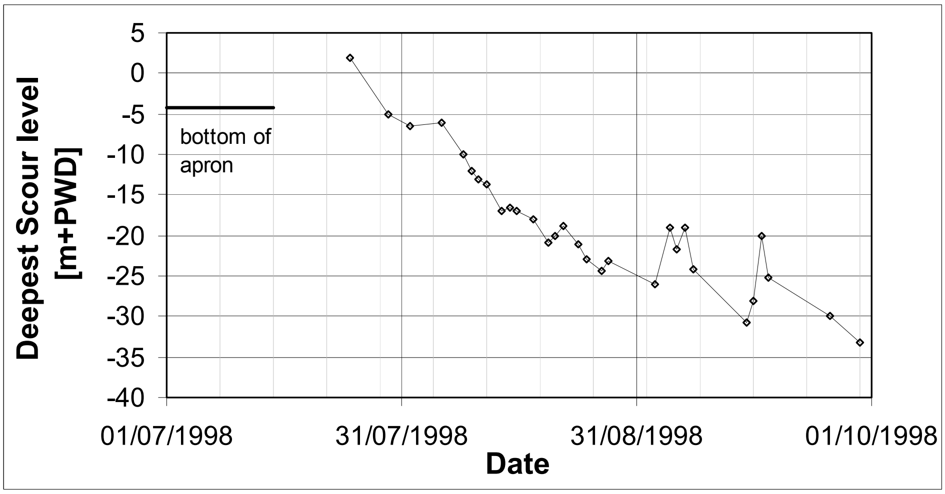


Figure 5. Development of river depth at the upstream end of Sirajganj Town Protection.

The 100-year flood level is 15.75 m+PWD. The deepest scour observed was at –33 m+PWD, which is about 48 m below 100-year flood level. Table 1 summarizes some observations.

Table 1. Erosion and deposition rates at Sirajganj.

River	Erosion Per day	Vertical erosion In total	Deposition Per day	Deposition Per day
Sirajganj	5.3 1.1	5.3 m in 1 days 15 m in 14 days	3.4	11 m in 3 days

The development of scour at the bank protection work at Bahadurabad was less intensive than at Sirajganj because the structure is aligned more parallel to the bank (Figure 6).

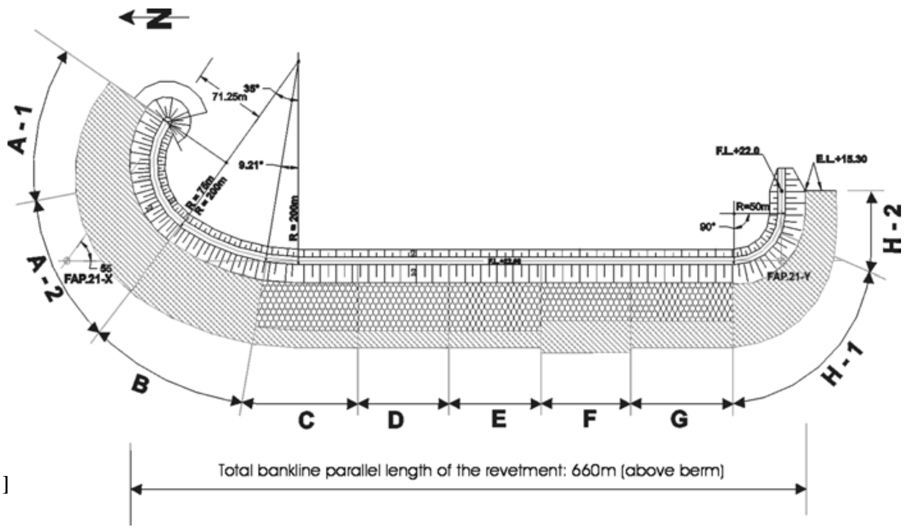


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Figure 6. Plan view of Bahadurabad test revetment. (FAP 21, 2001)

The 100-year flood level at Bahadurabad is 21 m+PWD. The deepest observed scour was at –14 m+PWD, which results in a maximum water depth of 35 m below 100-year flood level (Figure 7).

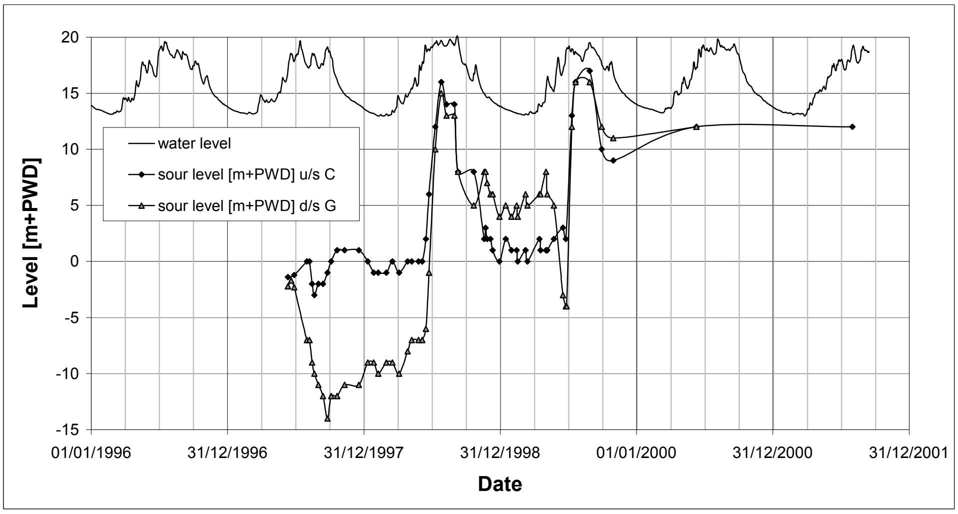

Figure 7. Development of river depth at upstream and downstream end of Bahadurabad.

Table 2 summarizes some extreme erosion and deposition values.

Table 2. Erosion and deposition rates at Bahadurabad.

River	Erosion Per day	Vertical erosion In total	Deposition Per day	Deposition Per day
Upstream Section C	0.6	6 m in 10 days	0.7	11 m in 16 days
Downstream Section G	0.7	2 m in 3 days	1.15	16 m in 14 days

1.3. *Two Examples of Scour Developments at Spurs*

Scour data from different types of spurs are available from two locations along the Brahmaputra / Jamuna River: at the permeable spur field at Kamarjani and at Sariakandi at three hard points, both at the right bank. The permeable spurs at Kamarjani are shown in Figure 8, the measurements in Figure 9.

Figure 8. Permeable spurs at Kamarjani.

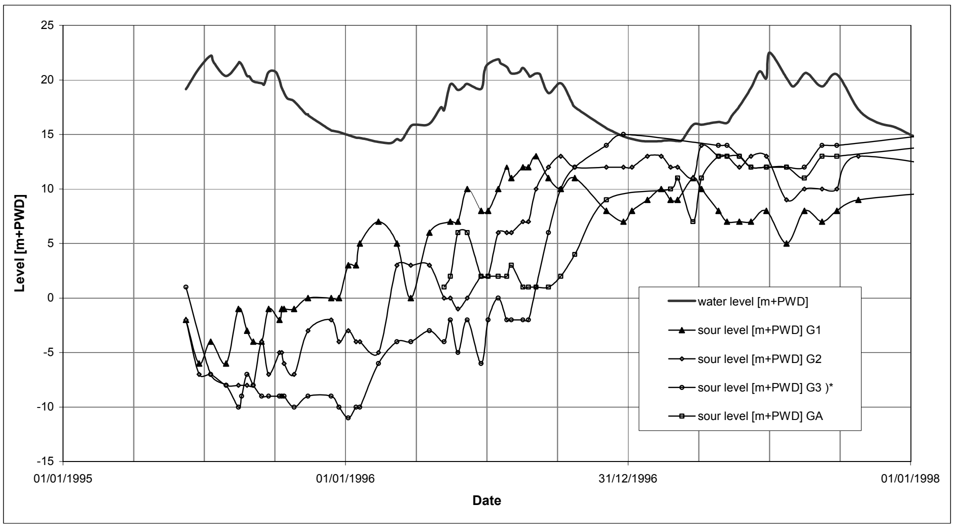

Figure 9. Development of river depth at the groyne field in Kamarjani.

The maximum depth, measured at Kamarjani was –11 m+PWD, which results in a water depth of 35 m from the 100-year flood level of 22.9 m+PWD.

The three “hard points” at Sariakandi are shown in Figure 10 the measurements in Figure 11.

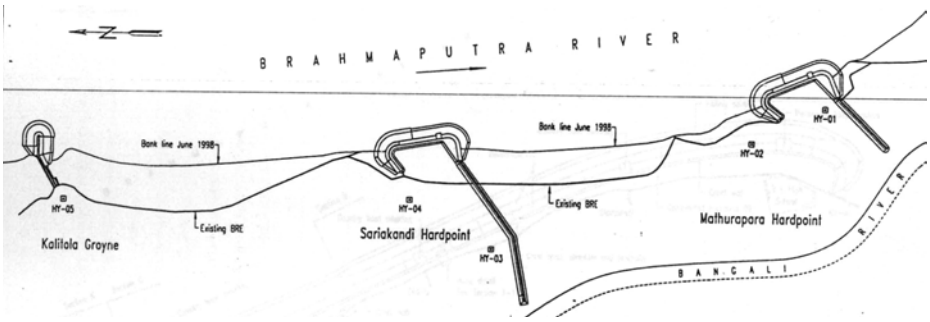

Figure 10. Layout of the three ‘hard points’ at Sariakandi.

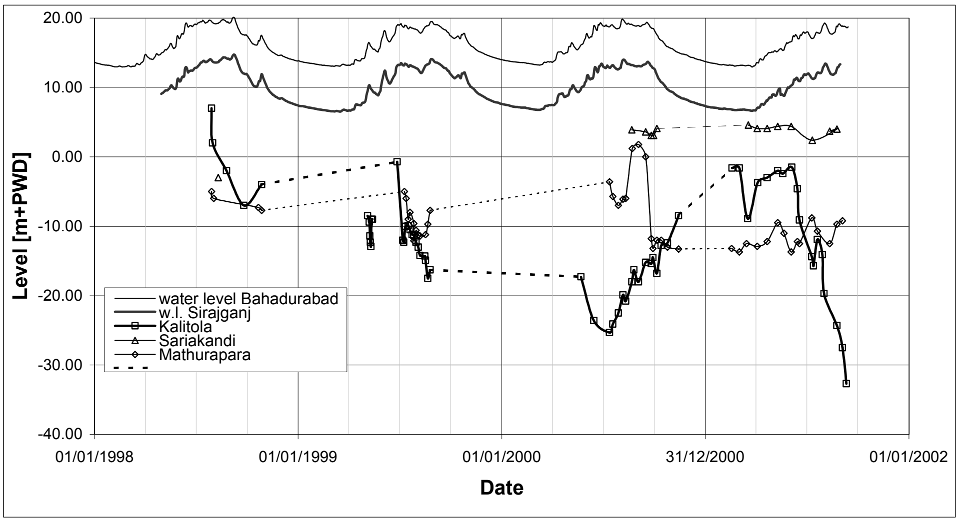

Figure 11. Development of river depth at the ‘hard points’ at Sariakandi.

Some extreme measured erosion and deposition figures are shown in Table 3:

Table 3. Erosion and deposition rates at Sariakandi “hard points”

River	Erosion Per day	Vertical erosion In total	Deposition Per day	Deposition Per day
Kalitola	2.5 0.8	5 m in 2 days 13 m in 10 days	3.9	3.9 m in 1 day
Sariakandi	Negligible	2 m in 38 days	0.2	1 m in 6 days
Mathurapara	1.2	12 m in 10 days	0.6	7 m in 12 days

4 Conclusion - Preliminary Design Data for Bank Protection Structures

This article attempts to compile some basic design data from long-term monitoring at several sites with different types of structures along the Brahmaputra / Jamuna River.

Observed river depths can reach up to 50 m below the 100-year flood levels in the vicinity of some structures. (In other places in Bangladesh river depths of up to 70 m were measured at protected banks.) Bank revetments of limited length do not necessarily perform better than spurs or groins because of the tendency of the rivers to outflank protective works, resulting in progressively exposed upstream corners. We suggest the following tentative design depths for structures in the Brahmaputra/Jamuna River:

Table 4. Tentative design depths for bank protection work in the Brahmaputra / Jamuna sand-bed river.

Type of structure	Depth (m) below 100-year flood level
Unprotected bank	25
Revetment parallel to bank	35
Protruding protection	50
High spurs	50

Figure 12 presents a summary of extreme erosion and deposition data measured in the Brahmaputra/Jamuna in Bangladesh. These data could provide (i) the basis for initial designs, (ii) an indication of planning for the time between different river surveys along protective works and (iii) indicate the response time in case of exceptional scouring.

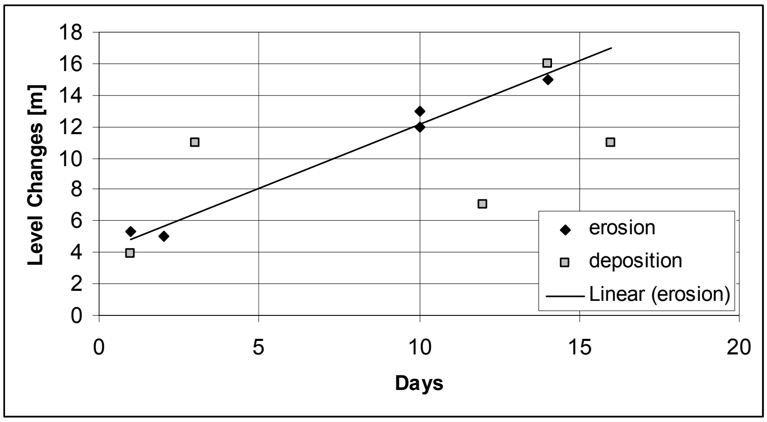

Figure 12. Measured extreme scouring and deposition.

Finally, the authors like to invite readers to contribute data to broaden and update the existing database.

References

ADB Consultants (2001). “Jamuna-Meghna River Erosion Mitigation Project, Phase I Flood Monitoring” *prepared for Bangladesh Water Development Board.*

Fap 21 (2001) “Bank Protection and River Training (AFPM) Pilot Project, Final Project Evaluation Report” *prepared for Bangladesh Water Development Board.*

Halcrow (1998), “Engineer’s Review and Action Plan Report on Damages in 1998 Monsoon” *prepared for Bangladesh Water Development Board.*