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# Granulometric Characterisation and Distribution of Contemporary Fluvial Sediment in the Magoye River Sink, Southern Zambia

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## ABSTRACT

**The study granulometrically characterised the contemporary fluvial sediment deposited at selected cross-sections of the river using field sampling, GPS, GIS and laboratory analysis of sediment using sieves. The study calibrated what in our view, was the first-ever regression model (Phi-mm) with contextual relevance to Zambian river catchments and channels as opposed to those devised outside the African context. This model can potentially be extrapolated to immediate neighbouring catchments within the region that have similar hydrogeomorphological characteristics as the target river catchment in the study. On average, the downstream of the Magoye River bed was characterised by sediment of diverse particle sizes with those above 2 mm constituting 29% of sediment, especially near the bridge. The sediments of 1 mm diameter were also in the same magnitude. On average, the rarest occurring sediment type were those equal to or less than 0.1mm as these take long to settle due to their minute sizes. A large proportion of sediment with particle size between 2mm and >2mm settled within the first 7-8 Km from the Magoye Bridge, which also attracted high occurrence of river bed sand and stone quarrying and hence, the observed buffer zone and bed degradation. Sediment particles between 1mm and 0.5mm showed a high variable geospatial occurrence, but the latter drastically increased towards the mouth, which confirms the influence of particle size on settling time. Furthermore, sediment with grain size of 0.25mm showed a high variability across the channel bed as compared to those whose grain sizes were 0.1mm to 0.05mm, which were usually in stable equilibrium throughout the channel profile in terms of relative abundance. Their low percentage of occurrence signify their low density and high affinity to remain suspended for longer time. For instance, the only highest occurrence for sediment with grain size of 0.1mm was record around 26 km away from the bridge near the mouth where river flow power tend to be exceedingly low. This pattern, seem to suggest that, most sediment particles below 0.1mm ended up into the Kafue River as they never significantly settled on the Magoye River bed. This signals water quality issues in the receiving Kafue Flats and River. In conclusion, the granulometric study of contemporary fluvial sediment in the Magoye River provides valuable insights into the sediment dynamics and the potential implications for neighbouring river catchments in Zambia and the sub-region. The development of a regression model calibrated specifically for Zambian**

**river catchments represents a significant advancement in the understanding of sediment transport and deposition in the region. The findings reveal a complex distribution of sediment particle sizes, with implications for sediment settling times and river bed characteristics. The downstream areas near the bridge exhibit diverse sediment sizes, with larger particles dominating, highlighting the impact of proximity to the bridge on sediment characteristics. Furthermore, the study underscores the influence of particle size on sediment settling patterns, with implications for sediment transport and water quality in the Kafue River. These findings have important implications for river management and conservation efforts in Zambia and neighbouring regions, providing a valuable foundation for further research and environmental protection initiatives within the catchments.**

**Keywords:** Fluvial sediment, particle size, sediment transport, rivers.

## PHYSICAL DESCRIPTION OF THE STUDY AREA

Magoye River is located in the Southern Province of Zambia, and the specific study area is located between 15° 50' S to 15° 58' S and longitude 27°32' E to 27° 37' E. Magoye River is located partly in the District of Pemba, Monze and Mazabuka (Baumle, 2007). Magoye River flows in the Mazabuka District between Magoye Bridge and Kafue flats. The Magoye River flows northbound to the Kafue Flats before reaching the Kafue River. It has a catchment area of 2,038.2 km$^2$, the headwaters are located in Pemba around Mookamunga in Muzandu Village, Hamaundu Chiefdom (MWDS, 2021). The total length of the Magoye River from headwaters to the confluence is 167 kilometres and on the downstream alone, it is 27.6 Kilometres (Baumle, 2007). The main tributaries of the Magoye River are the Ngwezi and Nalube Rivers and Kabomba Stream. The overall peak streamflow in the Catchment was noticed during the month of March for the simulated and observed respectively.

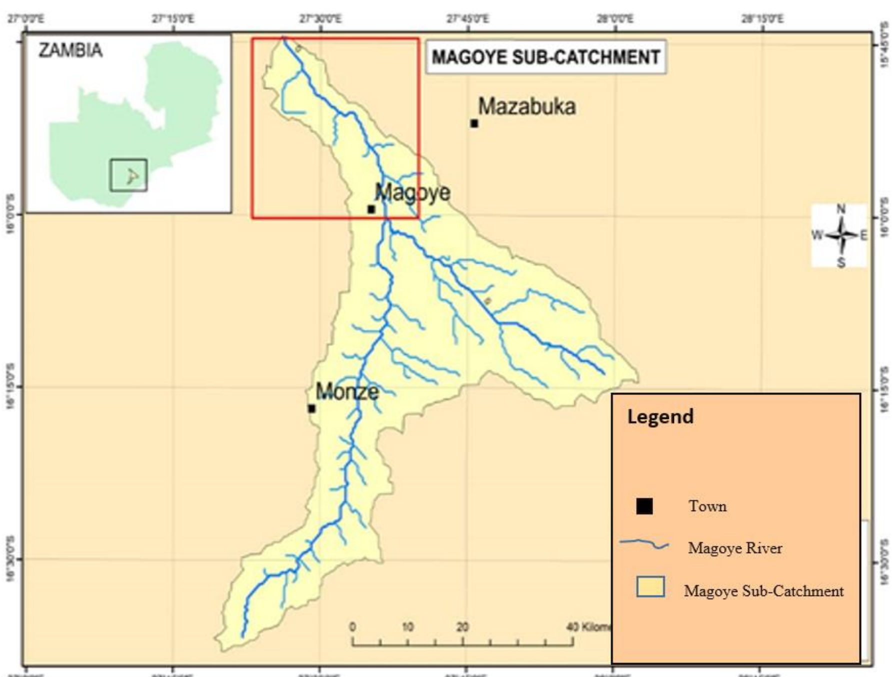


**Figure 1: Map Showing the Geographical Location of Magoye sub-Catchment.**
Source: MWDS (2021).

## DATA ANALYSIS

Bed load was analysed for particle size change using sediment sieves from the Geography Department at the University of Zambia. After particle size analysis was done, regression analysis was carried out to determine relationship between distance and changes in particles size and to extrapolate this relationship to stream power and modes of sediment transportation that are predominant downstream of the Magoye River. After particle size analysis, the type of materials transported were determined using Wentworth criteria (Table 4.4). Particle size were further analysed using descriptive statistics in form of graphs of frequencies and granulometric trend lines between the Magoye River Bridge and the mouth of the river.

**Table 1: Wentworth's classification criteria for channel bed Materials**

| Channel Material | Particle size (mm) |
|---|---|
| Cobbles | 64-80 |
| Pebbles | 5-63 |
| Granules | 2-4 |
| Very coarse sand | 1-1.99 |
| Coarse sand | 0.5-0.99 |
| Very fine sand | 0.063-0.49 |
| Silt | 0.032-0.062 |
| Clay | <0.032 |

Source: Wentworth (1922)

## ETHICAL APPROAVAL

The study was submitted for ethical clearance to the University of Zambia, Natural and Applied Sciences Research Ethics Committee (UNZA-NASREC). Confidentiality and Anonymity for participants were upheld.

## RESULTS OF THE STUDY

The study also granulometrically characterised the recent sediment deposited at selected cross sections of the river. The study calibrated the first ever regression model (Phi-mm) with a contextual relevance to Zambian river catchments and channels as opposed to those devised outside the country (Figure 5.10a). On average, the downstream of Magoye River bed was characterised by sediment of diverse particle sizes with those above 2 mm constituting 29% of sediment especially near the bridge. The sediments of 1 mm diameter were also in the same magnitude as those above. On average, the rarest occurring sediment type were those equal or less than 0.1mm as these takes long to settle due to their minute sizes (Figure 5.10b). A large proportion of sediment with particle size between 2mm and >2mm settled within the first 7-8 Km from the Bridge, which also attracted high river bed sand and stone quarrying and hence the degradation (Figure 5.10c). Sediment particles between 1mm and 0.5mm showed a high variable geospatial occurrence, but the latter drastically increase towards the mouth, which confirm influence of particle size on settling time (Figure 5.10d).

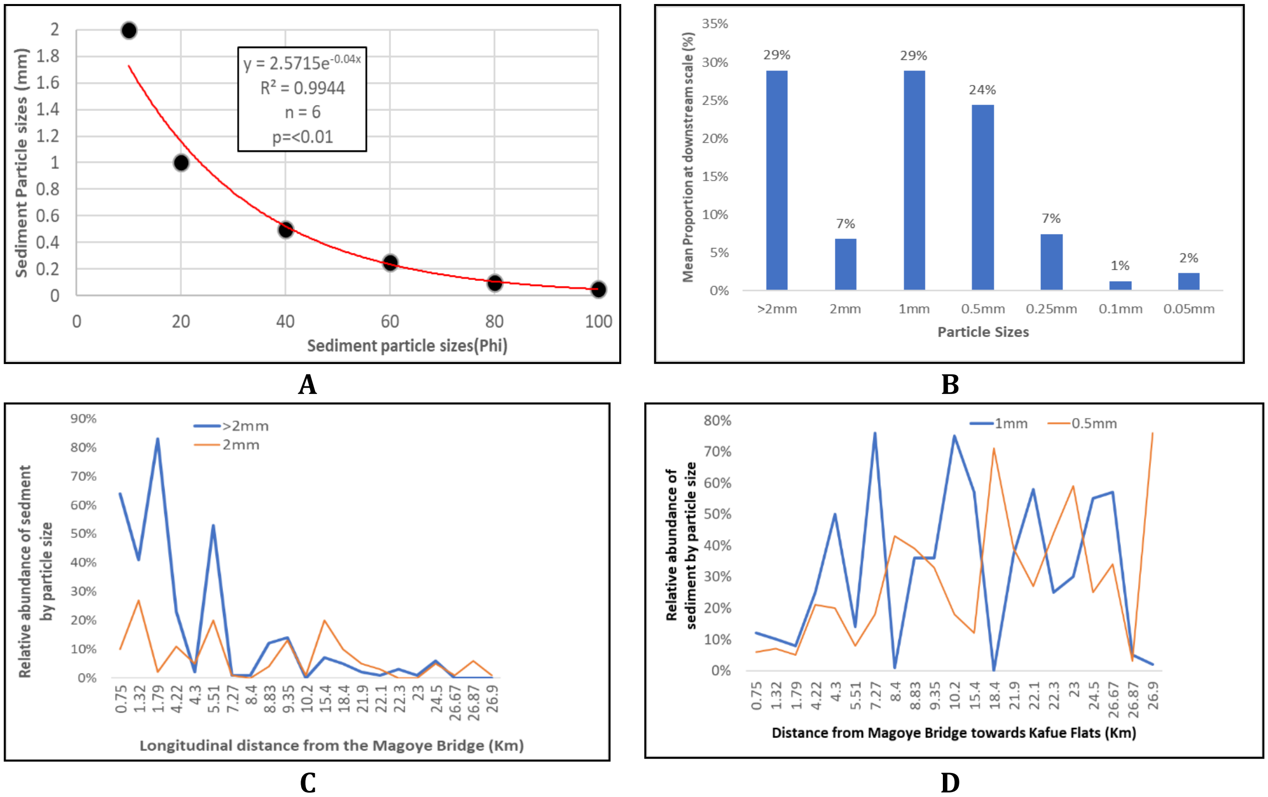


**Figure 2: (a) Relationship between sediment particle sizes in phi and mm (b) average occurrence of sediment by particle size, (c-d) relative abundance and distribution of sediment by particle sizes and distance. Source: (Field data, 2022).**

Furthermore, sediment with grain size of 0.25mm showed a high variability across the channel bed as compared to those whose grain sizes were 0.1mm to 0.05mm, which were usually in stable equilibrium throughout the channel profile in terms of relative abundance. Their low percentage of occurrence signify their low density and high affinity to remain suspended for longer time. For instance, the only highest occurrence for sediment with grain size of 0.1mm was record around 26 km away from the bridge near the mouth where river flow power exceedingly low (Figure 5.11. This pattern, seem to suggest that, most sediment particles below 0.1mm ended up into the Kafue River as they never significantly settled on the Magoye River bed. This signals water quality issues in the receiving Kafue Flats and River. Moreover, details on drastic changes in relative abundance of occurrence of sediments can be appreciated in Figure 5.12, which shows qualitative impression of how sediment grain sizes for each sampling point varied relative to others farther away from the Bridge. Figure 5.12 generally and quantitatively shows that the earlier sections of the channel bed were predominantly characterized by pebbles, cobbles (>2mm) whereas the latter end around the mouth were characterized by fine sand and silt as per Wentworth sediment grain size criteria.

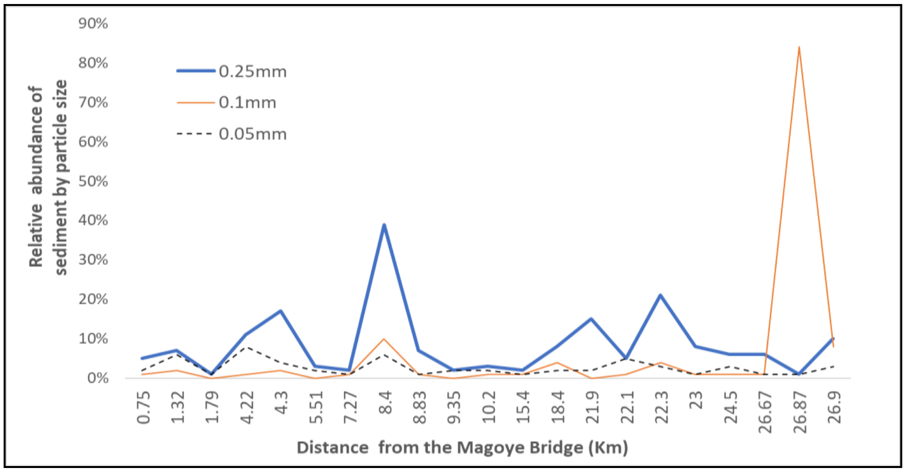


**Figure 3: Distribution of sediment with grain size between 0.05 and 0.25 mm on the dry bed of the Magoye River from the Bridge to the mouth**

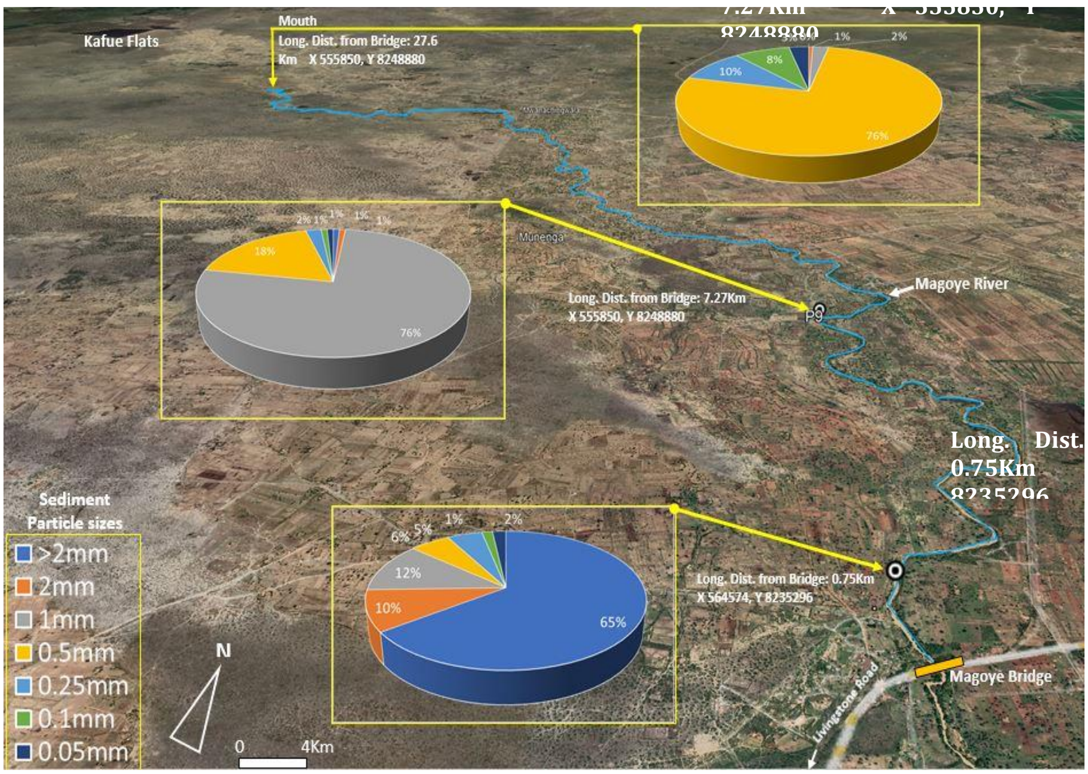


**Figure 4: Sample Illustration of Sediment Granulometric Characterization at Different Cross Sections of The Downstream of The Magoye River.**

Field Data (2022)

## Relationship Between Sediment Depth and Sediment Volume on The Downstream

The study also estimated the volume of sediment that had accumulated on the bed of the river slightly after the Magoye small weir up to the mouth. Results show a very heavy burden of sediments on the riverbed amounting to over 5 Million Cubic Metres (5MCM) spread across 460,000 m$^2$ of dry bed surface area. This implies a high erosion and transportation processes from not only the immediate area, but from the upstream of the entire catchment at large. It also means that the downstream was experiencing large scale deposition especially towards the mouth as the stream flow power reduce leading to large scale bed aggradation, loss of storage capacity and flooding in low lying areas near the mouth (Figure 5.8a-b).

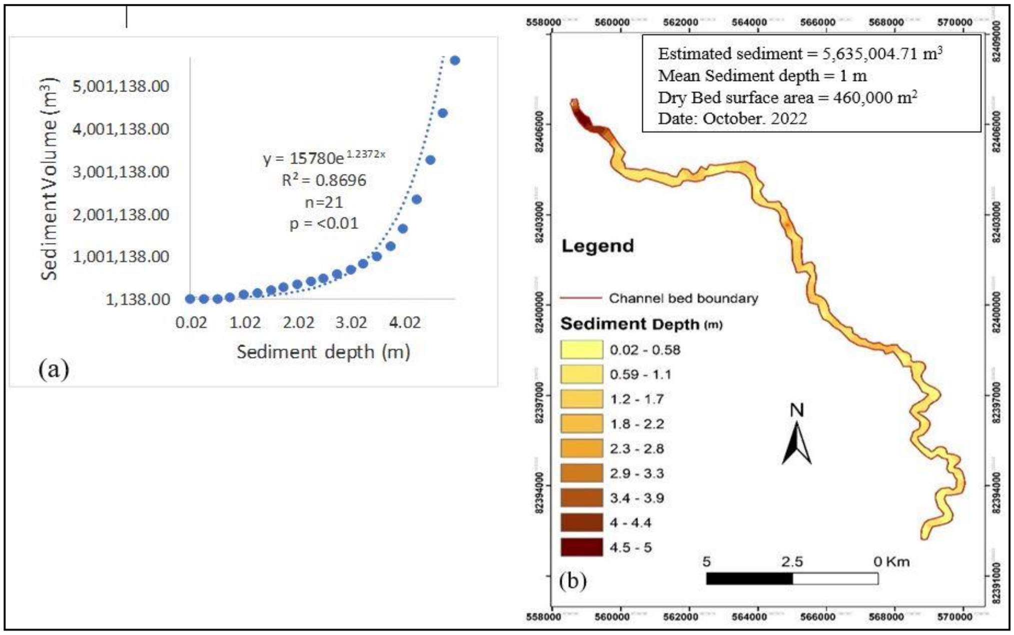


**Figure 5: (a) Relationship between sediment depth and sediment volume; (b) Sediment accumulation map, downstream of Magoye river channel. (Field data, 2022).**

## DISCUSSION OF RESULTS

The most imposing was excessive siltation of the river channel bed leading to drastic loss of flowing water-holding capacity. This, coupled with large scale sand mining in the buffer zone triggered heavy burden of sediment on the riverbed amounting to over 5 million Cubic Metres (MCM) spread across 460,000 m$^2$ of dry bed surface area. This was as a result of high erosion and transportation processes from not only the degraded buffer zone with loose soils, but also from the upstream of the entire catchment at large where agricultural land had taken up vegetation cover leading to large scale sediment deposition on the downstream and especially towards the mouth. Earlier studies by scholars such as GRZ, (2019); Muchanga (2020), Sichingabula (2021) confirm that such high magnitudes of siltation are usually a function of destructive activities (especially agriculture and sand mining) happening in the entire catchment and buffer zone as indicated in the earlier section. Magoye Catchment has transitioned from positive to negative water balance with -86.368Mm$^3$/year, revealed by Tena *et al.* (2021).

The sediment that accumulated on the downstream of the Magoye River channel were of varied sizes over space and distance from the Magoye Bridge. Accumulated sediment was clastic in nature produced by the physical disaggregation of pre-existing rocks during weathering and mechanical erosion (Panchuk, 2016). Sandy group of sediment was the most predominant (Panchuk, 2016) and, this explains why sand mining is very common on the downstream of the river channel. To this effect, socioeconomic challenges and water crises were not the only variables that triggered excess sand mining, but also the geological nature of parent rocks, which supplied the clastic sandy sediment over time. The most uncommon sediment type was very fine sand and silt (0.1mm-0.05) (Panchuk, 2016; Gadisa and Madega, 2021) as these take long to settle due to their minute sizes (Figure 5.10b) and most likely, these found their way into the Kafue flats and the Kafue River. According to Sichingabula (1999), such classes of sediment usually carry chemicals and depending on the nature of the chemicals they contain, they may be either detrimental or useful to the receiving hydrologic system and biodiversity.

However, 0.1mm to 0.05mm sediment were usually in stable equilibrium throughout the channel profile in terms of relative abundance. Their low percentage of occurrence indicate their tendency to remain suspended for longer time due to low density compared to water (Leopold *et al*., 1957; Sichingabula, 1999). For instance, the only highest occurrence for sediment with grain size of 0.1mm was recorded around 26 km away from the bridge near the mouth where according to Mueller (1965), flow velocities tend to be extremely low for further transportation of sediment. Whereas the upstream of the Magoye River, was getting clustered with reservoirs, the downstream was becoming drier and silted due to lack of outlet valves on most of the reservoirs on the upper catchment (Sichingabula *et al*., 2014; MWDS, 2021).

Generally, the downstream of Magoye River channel was characterized by different geomorphic features such as sand bars, meanders of different types with some having potential to evolve into oxbow lakes, very low gradient and slope percentage punctuating high settling of sediment of different type and size with sandy sediment as the most commonly distributed. The river had arguably evolved from being a single naturally uniform river into being Reservoir River upstream and Sandbank River on the downstream due to anthropogenic influence of dams. As of 2022, the river was classified to be highly sinuous heavily inundated with sediment.

In conclusion, the fact that, human activities in the wider catchment context was predicting the human activities within the buffer zone was clear indicator of poor implementation of the law regarding the protection of the buffer zone. The river channel was severely silted as exemplified by more than 5 Million $m^3$ of sediment overlaid over the 27.6Km stretch from the Magoye Bridge to the mouth.

## Appendix I: Technical Data on Sediment Particles Weights for Granulometric Analysis

| Sample Field ID | X | Y | Distance from Bridge (Km) | ELEVATION (M) | Initial Weight of Phi 10 Sieve (g) | Phi10 Sieve + Sediment (g) | Sediment weight (g) |
|---|---|---|---|---|---|---|---|
| 11 | 565006 | 8239957 | 0.77 | 1001 | 91 | 384 | 293.00 |
| 10 | 555983 | 8248577 | 8.4 | 992 | 91 | 93 | 2.00 |
| 3a | 558193 | 8247114 | 22.3 | 994 | 91 | 92 | 3.50 |
| 3b | 564574 | 8235296 | 0.75 | 1003 | 91 | 267 | 176.00 |
| 2 | 558441 | 8247201 | 21.9 | 991 | 91 | 96 | 5.00 |
| A | 565482 | 8237646 | 4.3 | 1003 | 91 | 95 | 4.00 |
| MBIYA | 565458 | 8237603 | 4.22 | 1000 | 91 | 122 | 31.00 |
| MAGOYE | 560414 | 8246203 | 18.4 | 997 | 91 | 95 | 4.00 |
| P4 | 564884 | 8235696 | 1.32 | 1005 | 91 | 195 | 104.00 |
| M4 | 557874 | 8246988 | 23 | 994 | 91 | 92 | 1.00 |
| P9 | 56439 | 8239027 | 7.27 | 998 | 91 | 93 | 2.00 |
| M6 | 556719 | 8247382 | 24.5 | 991 | 91 | 102 | 11.00 |
| P17 | 564266 | 8241031 | 9.35 | | 91 | 126 | 35.00 |
| M10 | 555850 | 8248880 | 26.9 | 992 | 91 | 105 | 14.00 |
| TP | 565262 | 8235907 | 1.79 | 1006 | 91 | 562 | 471.00 |
| MAGOYE2 | 561526 | 8244206 | 15.4 | 997 | 91 | 100 | 9.00 |
| TB | 558400 | 8247131 | 22.1 | 987 | 91 | 93 | 2.00 |
| P15 | 564567 | 8240852 | 8.83 | | 91 | 127 | 36.00 |
| P5 | 564378 | 8238351 | 5.51 | | 91 | 265 | 174.00 |
| P17 | 564269 | 8241441 | 10.2 | | 91 | 91 | 0.00 |
| M9 | 555985 | 8248439 | 26.67 | 988 | 91 | 91 | 0.00 |

**A: Phi 10**

| Sample Field ID | X | Y | Distance from Bridge (Km) | ELEVATION (M) | Initial Weight of Phi 20 (g) | Phi20 + Sediment (g) | Sediment weight (g) |
|---|---|---|---|---|---|---|---|
| 11 | 565006 | 8239957 | 0.77 | 1001 | 94 | 115 | 21 |
| 10 | 555983 | 8248577 | 8.4 | 992 | 94 | 94.5 | 0.5 |
| 3a | 558193 | 8247114 | 22.3 | 994 | 94 | 95 | 1 |
| 3b | 564574 | 8235296 | 0.75 | 1003 | 94 | 120 | 26 |
| 2 | 558441 | 8247201 | 21.9 | 991 | 94 | 106 | 12 |
| A | 565482 | 8237646 | 4.3 | 1003 | 94 | 103 | 9 |
| MBIYA | 565458 | 8237603 | 4.22 | 1000 | 94 | 109 | 15 |
| MAGOYE | 560414 | 8246203 | 18.4 | 997 | 94 | 102 | 8 |
| P4 | 564884 | 8235696 | 1.32 | 1005 | 94 | 160 | 66 |
| M4 | 557874 | 8246988 | 23 | 994 | 94 | 94 | 0 |
| P9 | 56439 | 8239027 | 7.27 | 998 | 94 | 96 | 2 |
| M6 | 556719 | 8247382 | 24.5 | 991 | 94 | 104 | 10 |
| P17 | 564266 | 8241031 | 9.35 | | 94 | 125 | 31 |
| M10 | 555850 | 8248880 | 26.9 | 992 | 94 | 95 | 1 |
| TP | 565262 | 8235907 | 1.79 | 1006 | 94 | 107 | 13 |
| MAGOYE2 | 561526 | 8244206 | 15.4 | 997 | 94 | 122 | 28 |
| TB | 558400 | 8247131 | 22.1 | 987 | 94 | 98 | 4 |
| P15 | 564567 | 8240852 | 8.83 | | 94 | 105 | 11 |
| P5 | 564378 | 8238351 | 5.51 | | 94 | 157 | 63 |
| P17 | 564269 | 8241441 | 10.2 | | 94 | 95 | 1 |
| M9 | 555985 | 8248439 | 26.67 | 988 | 94 | 95 | 1 |

**B: Phi 20**

| Sample Field ID | X | Y | Distance from Bridge (Km) | ELEVATION (M) | Initial Weight of Phi 40 (g) | Phi40 + Sediment (g) | Sediment weight (g) |
|---|---|---|---|---|---|---|---|
| 11 | 565006 | 8239957 | 0.77 | 1001 | 90 | 107 | 17 |
| 10 | 555983 | 8248577 | 8.4 | 992 | 90 | 91 | 1 |
| 3a | 558193 | 8247114 | 22.3 | 994 | 90 | 150 | 60 |
| 3b | 564574 | 8235296 | 0.75 | 1003 | 90 | 122 | 32 |
| 2 | 558441 | 8247201 | 21.9 | 991 | 90 | 178 | 88 |
| A | 565482 | 8237646 | 4.3 | 1003 | 90 | 172 | 82 |
| MBIYA | 565458 | 8237603 | 4.22 | 1000 | 90 | 123 | 33 |
| MAGOYE | 560414 | 8246203 | 18.4 | 997 | 90 | 90 | 0 |
| P4 | 564884 | 8235696 | 1.32 | 1005 | 90 | 114 | 24 |
| M4 | 557874 | 8246988 | 23 | 994 | 90 | 137 | 47 |
| P9 | 56439 | 8239027 | 7.27 | 998 | 90 | 269 | 179 |
| M6 | 556719 | 8247382 | 24.5 | 991 | 90 | 200 | 110 |
| P17 | 564266 | 8241031 | 9.35 | | 90 | 178 | 88 |
| M10 | 555850 | 8248880 | 26.9 | 992 | 90 | 94 | 4 |
| TP | 565262 | 8235907 | 1.79 | 1006 | 90 | 133 | 43 |
| MAGOYE2 | 561526 | 8244206 | 15.4 | 997 | 90 | 167 | 77 |
| TB | 558400 | 8247131 | 22.1 | 987 | 90 | 179 | 89 |
| P15 | 564567 | 8240852 | 8.83 | | 90 | 196 | 106 |
| P5 | 564378 | 8238351 | 5.51 | | 90 | 135 | 45 |
| P17 | 564269 | 8241441 | 10.2 | | 90 | 232 | 142 |
| M9 | 555985 | 8248439 | 26.67 | 988 | 90 | 198 | 108 |

**C: Phi 40**

| Sample Field ID | X | Y | Distance from Bridge (Km) | ELEVATION (M) | Initial Weight of Phi 60 (g) | Phi60 + Sediment (g) | Sediment weight (g) |
|---|---|---|---|---|---|---|---|
| 11 | 565006 | 8239957 | 0.77 | 1001 | 87 | 99 | 12 |
| 10 | 555983 | 8248577 | 8.4 | 992 | 87 | 161 | 74 |
| 3a | 558193 | 8247114 | 22.3 | 994 | 87 | 194 | 107 |
| 3b | 564574 | 8235296 | 0.75 | 1003 | 87 | 102 | 15 |
| 2 | 558441 | 8247201 | 21.9 | 991 | 87 | 181 | 94 |
| A | 565482 | 8237646 | 4.3 | 1003 | 87 | 120 | 33 |
| MBIYA | 565458 | 8237603 | 4.22 | 1000 | 87 | 115 | 28 |
| MAGOYE | 560414 | 8246203 | 18.4 | 997 | 87 | 147 | 60 |
| P4 | 564884 | 8235696 | 1.32 | 1005 | 87 | 106 | 19 |
| M4 | 557874 | 8246988 | 23 | 994 | 87 | 183 | 96 |
| P9 | 56439 | 8239027 | 7.27 | 998 | 87 | 129 | 42 |
| M6 | 556719 | 8247382 | 24.5 | 991 | 87 | 136 | 49 |
| P17 | 564266 | 8241031 | 9.35 | | 87 | 167 | 80 |
| M10 | 555850 | 8248880 | 26.9 | 992 | 87 | 220 | 133 |
| TP | 565262 | 8235907 | 1.79 | 1006 | 87 | 114 | 27 |
| MAGOYE2 | 561526 | 8244206 | 15.4 | 997 | 87 | 104 | 17 |
| TB | 558400 | 8247131 | 22.1 | 987 | 87 | 129 | 42 |
| P15 | 564567 | 8240852 | 8.83 | | 87 | 197 | 110 |
| P5 | 564378 | 8238351 | 5.51 | | 87 | 112 | 25 |
| P17 | 564269 | 8241441 | 10.2 | | 87 | 120 | 33 |
| M9 | 555985 | 8248439 | 26.67 | 988 | 87 | 152 | 65 |

**D: Phi 60**

| Sample Field ID | X | Y | Distance from Bridge (Km) | ELEVATION (M) | Initial Weight of Phi 80 (g) | Phi80 + Sediment (g) | Sediment weight (g) |
|---|---|---|---|---|---|---|---|
| 11 | 565006 | 8239957 | 0.77 | 1001 | 85 | 90 | 5 |
| 10 | 555983 | 8248577 | 8.4 | 992 | 85 | 152 | 67 |
| 3a | 558193 | 8247114 | 22.3 | 994 | 85 | 136 | 51 |
| 3b | 564574 | 8235296 | 0.75 | 1003 | 85 | 98 | 13 |
| 2 | 558441 | 8247201 | 21.9 | 991 | 85 | 121 | 36 |
| A | 565482 | 8237646 | 4.3 | 1003 | 85 | 113 | 28 |
| MBIYA | 565458 | 8237603 | 4.22 | 1000 | 85 | 100 | 15 |
| MAGOYE | 560414 | 8246203 | 18.4 | 997 | 85 | 92 | 7 |
| P4 | 564884 | 8235696 | 1.32 | 1005 | 85 | 103 | 18 |
| M4 | 557874 | 8246988 | 23 | 994 | 85 | 97 | 12 |
| P9 | 56439 | 8239027 | 7.27 | 998 | 85 | 90 | 5 |
| M6 | 556719 | 8247382 | 24.5 | 991 | 85 | 96 | 11 |
| P17 | 564266 | 8241031 | 9.35 | | 85 | 91 | 6 |
| M10 | 555850 | 8248880 | 26.9 | 992 | 85 | 102 | 17 |
| TP | 565262 | 8235907 | 1.79 | 1006 | 85 | 91 | 6 |
| MAGOYE2 | 561526 | 8244206 | 15.4 | 997 | 85 | 88 | 3 |
| TB | 558400 | 8247131 | 22.1 | 987 | 85 | 93 | 8 |
| P15 | 564567 | 8240852 | 8.83 | | 85 | 106 | 21 |
| P5 | 564378 | 8238351 | 5.51 | | 85 | 95 | 10 |
| P17 | 564269 | 8241441 | 10.2 | | 85 | 90 | 5 |
| M9 | 555985 | 8248439 | 26.67 | 988 | 85 | 96 | 11 |

**E: Phi 80**

| Sample Field ID | X | Y | Distance from Bridge (Km) | ELEVATION (M) | Initial Weight of Phi 100 (g) | Phi100 + Sediment (g) | Sediment weight (g) |
|---|---|---|---|---|---|---|---|
| 11 | 565006 | 8239957 | 0.77 | 1001 | 85 | 87 | 2 |
| 10 | 555983 | 8248577 | 8.4 | 992 | 85 | 102 | 17 |
| 3a | 558193 | 8247114 | 22.3 | 994 | 85 | 95 | 10 |
| 3b | 564574 | 8235296 | 0.75 | 1003 | 85 | 89 | 4 |
| 2 | 558441 | 8247201 | 21.9 | 991 | 85 | 85 | 0 |
| A | 565482 | 8237646 | 4.3 | 1003 | 85 | 89 | 4 |
| MBIYA | 565458 | 8237603 | 4.22 | 1000 | 85 | 87 | 2 |
| MAGOYE | 560414 | 8246203 | 18.4 | 997 | 85 | 88 | 3 |
| P4 | 564884 | 8235696 | 1.32 | 1005 | 85 | 89 | 4 |
| M4 | 557874 | 8246988 | 23 | 994 | 85 | 86 | 1 |
| P9 | 56439 | 8239027 | 7.27 | 998 | 85 | 87 | 2 |
| M6 | 556719 | 8247382 | 24.5 | 991 | 85 | 86 | 1 |
| P17 | 564266 | 8241031 | 9.35 | | 85 | 84 | -1 |
| M10 | 555850 | 8248880 | 26.9 | 992 | 85 | 85 | 0 |
| TP | 565262 | 8235907 | 1.79 | 1006 | 85 | 86 | 1 |
| MAGOYE2 | 561526 | 8244206 | 15.4 | 997 | 85 | 86 | 1 |
| TB | 558400 | 8247131 | 22.1 | 987 | 85 | 87 | 2 |
| P15 | 564567 | 8240852 | 8.83 | | 85 | 88 | 3 |
| P5 | 564378 | 8238351 | 5.51 | | 85 | 86 | 1 |
| P17 | 564269 | 8241441 | 10.2 | | 85 | 86 | 1 |
| M9 | 555985 | 8248439 | 26.67 | 988 | 85 | 87 | 2 |

**F: Phi 100**

| Sample Field ID | X | Y | Distance from Bridge (Km) | ELEVATION (M) | Initial Weight of Phi 120 (g) | Phi120 + Sediment (g) | Sediment weight (g) |
|---|---|---|---|---|---|---|---|
| 11 | 565006 | 8239957 | 0.77 | 1001 | 53 | 56 | 3 |
| 10 | 555983 | 8248577 | 8.4 | 992 | 53 | 64 | 11 |
| 3a | 558193 | 8247114 | 22.3 | 994 | 53 | 60 | 7 |
| 3b | 564574 | 8235296 | 0.75 | 1003 | 53 | 58 | 5 |
| 2 | 558441 | 8247201 | 21.9 | 991 | 53 | 57 | 4 |
| A | 565482 | 8237646 | 4.3 | 1003 | 53 | 59 | 6 |
| MBIYA | 565458 | 8237603 | 4.22 | 1000 | 53 | 64 | 11 |
| MAGOYE | 560414 | 8246203 | 18.4 | 997 | 53 | 55 | 2 |
| P4 | 564884 | 8235696 | 1.32 | 1005 | 53 | 67 | 14 |
| M4 | 557874 | 8246988 | 23 | 994 | 53 | 54 | 1 |
| P9 | 56439 | 8239027 | 7.27 | 998 | 53 | 55 | 2 |
| M6 | 556719 | 8247382 | 24.5 | 991 | 53 | 59 | 6 |
| P17 | 564266 | 8241031 | 9.35 | | 53 | 57 | 4 |
| M10 | 555850 | 8248880 | 26.9 | 992 | 53 | 58 | 5 |
| TP | 565262 | 8235907 | 1.79 | 1006 | 53 | 56 | 3 |
| MAGOYE2 | 561526 | 8244206 | 15.4 | 997 | 53 | 55 | 2 |
| TB | 558400 | 8247131 | 22.1 | 987 | 53 | 61 | 8 |
| P15 | 564567 | 8240852 | 8.83 | | 53 | 57 | 4 |
| P5 | 564378 | 8238351 | 5.51 | | 53 | 58 | 5 |
| P17 | 564269 | 8241441 | 10.2 | | 53 | 57 | 4 |
| M9 | 555985 | 8248439 | 26.67 | 988 | 53 | 55 | 2 |

**G: Phi 120**