*IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)*
*e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 16, Issue 4 Ser. II (Jul. - Aug. 2019), PP 08-12*
*www.iosrjournals.org*

# Geometrical Parameters Measurement across River Osun, South-Western Nigeria

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***Abstract:*** *Modelling of sediment transport can be used to solve environmental and water quality problems. Sediment transport rate hinge upon hydraulic flow, upstream sediment supply and bed composition. Sediment transport has enormous effect on water quality and water management. In this study, geometrical parameters across River Osun was measured with a view to model sediment transportation in the river.*

*Geometrical data were measured for 12 months (December, 2017- December, 2018) at four sampling stations across River Osundesignated as T1-T4. Geometrical parameter includes channel geometry, slope and reach length.The river channel was divided into sub channels and the cross sectional geometrical variables such as area, wetted perimeter, channels top width were computed for each sub channel. The expressions were used to calculate the cross section in line with (Olaniyan, 2014).*

*The cross sectional area across River Osun ranges between (3.83-47.46)$m_2$/s. The slope and depth across river Osun range from (0.0032-0.0046) and (0.2-1.9)m, respectively. The estimated geometrical parameters are important for numerical modelling of sediment transport in River Osun.*

***Keywords:*** *sediment, geomrtrical parameters, river osun, sampling stations*

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Date of Submission: 08-07-2019 Date of acceptance: 23-07-2019

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## I. Introduction

The sediment conditions and lateral variation of hydraulic at a given river station can't be simulated using truly one-dimensional model. Engineers often take advantage of the non-uniform hydraulic and sediment conditions across a channel in their hydraulic design. For example, a water intake structure should be located on the concave side of a meandering bend, where the water is deep and sediment deposition is minimal. There are three types of semi-two dimensional model (Yang, 1996, Adegbola and Olaniyan, 2012).

All models that deal with in river channels share the basic notion of creating conceptions of physical reality that results in quantitative predictions. They are set of mass balance equations designed to quantitatively represent the processes that determine the erosion and/or the transport of sediment. The equations of models are based on the conservation of mass to properly account for all inputs, transportations. Out flow of the water, solids and contaminants in the surface water system. The study areas in the models are divided into grids using either finite difference or finite elements methods for solving the involved equations (Olaniyan, 2014; Yang, 1996 &Otun and Adeogun, 2010)

## II. Methodology

### Brief Description of the Study Area

River Osun is a river that flows southwards through Central Yoruba land in Southwestern Nigeria into the Lagos lagoon and the Atlantic Gulf of Guinea. The origin of River Osun is at Ekiti State ($8^0 20^{'}$N $5^0 16^{'}$E) while its mouth is at Lekki lagoon (6.563210$^0$N 4.062032$^0$E). It is one of the several rivers ascribed in local mythology to have a woman who turned into flowing water after some traumatic event frightened or angered her. Figure 1 shows the map of River Osunand the sampling points.

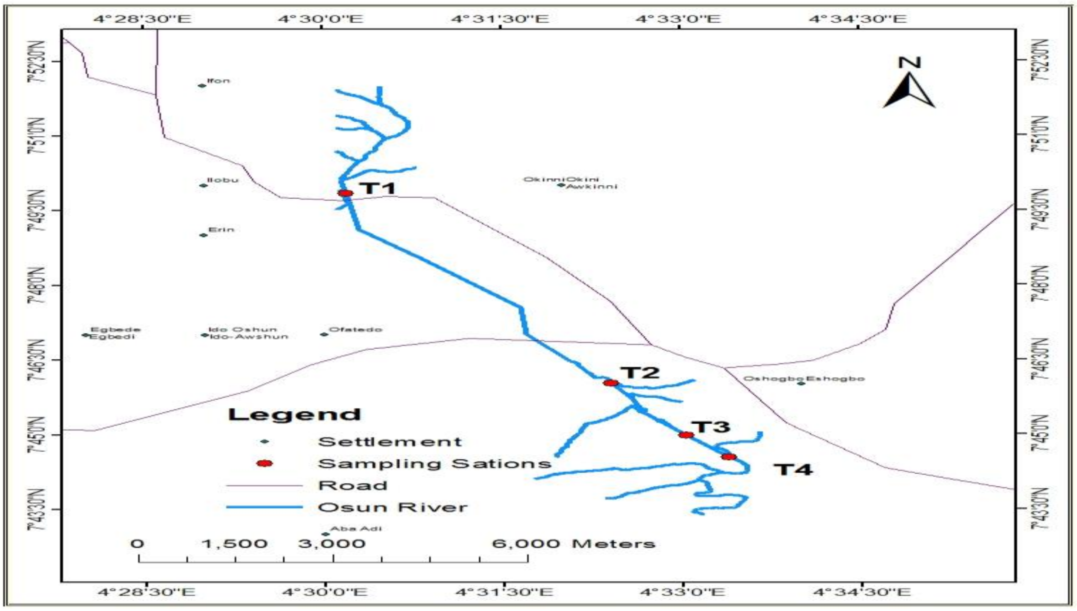


**Figure 1:** Map of the Study Area showing the Sampling Stations

The area, wetted perimeter and Top width of sub channel are estimated using equations 1-4

$$A_i = 0.5\,(y_i + y_i + i)dxi \quad (1)$$

$$A_i = \sum_{i=1}^{m} A_i \quad (2)$$

$$p_i = (d \times_1^2 + (y_i - y_{i+1})^2)^{1/2} \quad (3)$$

$$T = \sum_i^N = 1\, T_i \quad (4)$$

Where:

Ai, and Pi, = area and wetted perimeter of a subsection

Ti = top width of a sub-channel

Al, Pl, and T = Area, wetted perimeter and top width of the whole cross section, respectively:

m = number of subsections

N = number of computed sub-channels

Flow Area is the gross section of the river channel at the sampling point. The cross section of a river channel is a basic river field work skill. Equipment used for this task are: rigid calibrated rope, surveying pole for taking actual depth readily and long waterproof tape for measuring the width of the river.

The width of the river was obtained by stretching a tape from one bank the other bank at $90^0$to the course of the river. The starting and finishing points for the measurement are the points at which the dry bank meet the water. In order to avoid drag induced by the tape making contact with the flowing water, and the consequent possible increase in distance to be measured due to the likely scotching of tape into a curve, it has to be stretched at about 4m above water level. The ends of the section to be measured was determined by observation from directly above the tape at $90^0$ of the ground. Observation from directly above the tape is to ensure that the error is minimal (Olaniyan, 2014).

Also, the readings were taken at an interval of 4m. The tape was stretched from one bank to the other is to serve as a guide-to ensure that you take measurements in a straight line. It is also a convenient way of measuring the intervals between readings.A calibrated rope was immersed in the water every 4m, until the concrete cube weight end touches the bed of the river. The depth measurements from the stream were recorded.The measured depths and distance were used to draw a chart of the stream shape (Adegbola and Olaniyan, 2012&Hicking, 1995).

## III. Results And Discussion

### Depth and Width Computation

The width of the flow across River Osun in raining season is between 30 - 48m and between 12m to 32m during dry season. However, sampling station $T_2$ dried off excessively to flow width of 12m in dry season. The river is divided into segments at 4m interval for respective depth computation as shown in Table 1 and 2. The sampling station $T_2$ is the widest and deepest of all the sampling station while $T_1$ is the narrowest and shallowest with 44m and 20m width and 1.9m and 1.05m depth, respectively. However, excessive gauge of up to 4m at $T_1$ was rarely observed as a result of overflow from the neighboring reservoir.

**Table 1:** Dry Season Width and Depth Computation at Sampling Stations

| Distance (cm) | Depth (cm) | | | |
|---|---|---|---|---|
| | **T1** | **T2** | **T3** | **T4** |
| 0 | 0 | 0 | 0 | 0 |
| 400 | 35 | 20 | 20 | 35 |
| 800 | 40 | 30 | 35 | 60 |
| 1200 | 65 | 28 | 40 | 80 |
| 1600 | 75 | 0 | 20 | 20 |
| 2000 | 80 | | 0 | 0 |
| 2400 | 85 | | | |
| 2800 | 60 | | | |
| 3200 | 40 | | | |
| 3600 | 0 | | | |

**Table 2:** Rain Season Width and Depth Computation at Sampling Stations

| Distance (cm) | Depth (cm) | | | | |
|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ | |
| | 0 | | 0 | 0 | 0 |
| 400 | 90 | 100 | 80 | 40 | |
| 800 | 130 | 170 | 130 | | 80 |
| 1200 | 150 | 190 | 150 | 105 | |
| 1600 | 170 | 170 | 120 | 70 | |
| 2000 | 170 | 170 | 90 | 40 | |
| 2400 | 150 | 140 | 50 | 0 | |
| 2800 | 130 | 120 | 0 | 0 | |
| 3200 | 100 | 120 | 0 | 0 | |
| 3600 | 50 | 100 | 0 | 0 | |
| 4000 | 0 | 80 | | | |
| 440050 | | | | | |
| 4800 | 0 | | | | |

## Cross Sectional Flow Area (CFA)

Cross sectional area was determined by making slice through River Osun as shown in Figure 1 -4 and it was calculated by multiplying the area of each squares in the slices by its number. Slices through River Osun at $T_1$ and $T_4$ as shown in Figure 1 - 4 show there is little difference between cross sectional area in dry season and rain season while there is huge difference between flow cross sectional area in $T_2$ and $T_3$ as shown in slice through River Osun.

The calculated flow areas for rain and dry season are show in Table 3-4, respectively. The

flow area across River Osun in dry season ranges between 3.83m$^2$ – 19.2m$^2$ while it ranges between 13.5m$^2$ and 47.5m$^2$. The highest flow area in dry season was recorded at upstream while the lowest was recorded at midstream. Also, the highest flow area in rain season was recorded at midstream while the lowest was recorded at downstream.

**Table 3:** Rain Season Cross-sectional Flow Area Computation at Sampling Stations

| **Station** | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
|---|---|---|---|---|
| **Area (cm$^2$)** | 453,040 | 474,640 | 249,360 | 135,120 |

**Table 4:** Dry Season Cross-sectional Flow Area Sampling Stations Computation

| **Station** | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
|---|---|---|---|---|
| **Area (cm$^2$)** | 453,040 | 474,640 | 249,360 | 135,120 |

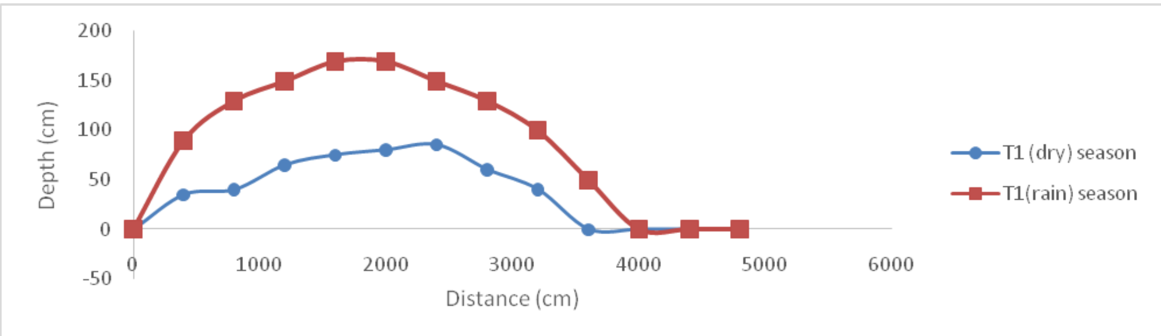


**Figure 1:** Slice through River Osun at $T_1$ for Dry and Rain Season

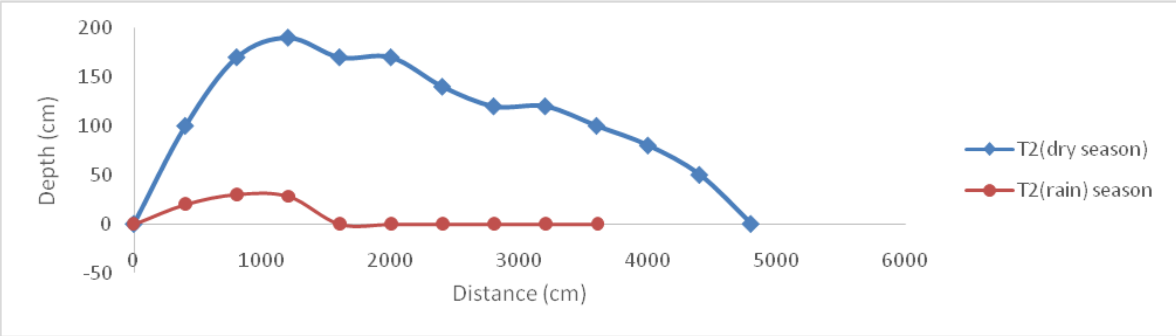


**Figure 2:** Slice through River Osun at $T_2$ for Dry and Rain Season

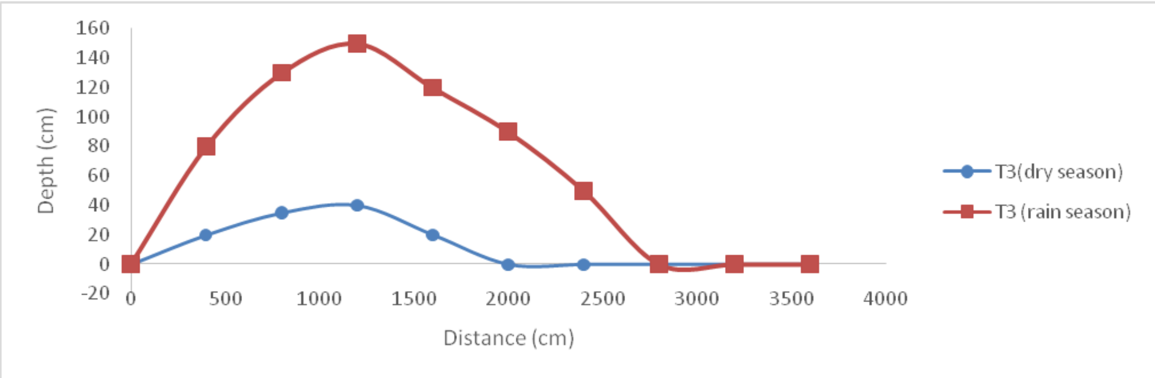


**Figure 3:** Slice through River Osun at $T_3$ for Dry and Rain Season

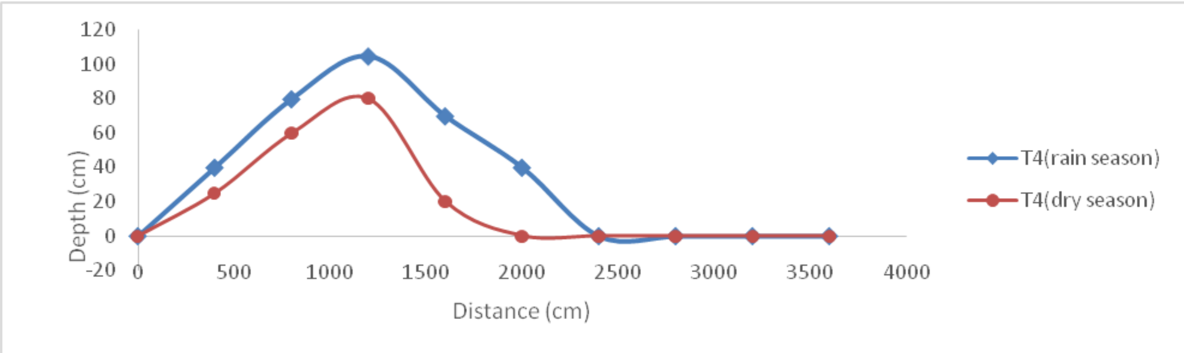


**Figure 4:** Slice through River Osun at $T_4$ for Dry and Rain Season

**Wetted Perimeter:** Wetted perimeter is the true length of the curve representing the slices across River Osun as shown in Figure 1-4. The calculated wetted perimeter is in agreement with the conclusion of (Knighton, 1998) which says, when a channel is much wider than its depth, the wetted perimeter can be approximately equals to its width.The wetted perimeter is relatively low in midstream at dry season, its average at midstream is 0.113m while the highest value was recorded at the upstream. It's important to note that the difference between wetted perimeter obtained in dry season and rain season at both upstream and downstream is relatively low compare to the difference between the wetted perimeters obtained in midstream. Table 5 and 6 show the respective wetted perimeter in dry and rain season.

**Table 5:** Wetted Perimeter at Dry Season

| **Distance (cm)** | **Wetted Perimeter (cm)** | | | |
|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
| 0 | 0 | 0 | 0 | 0 |
| 400 | 401.53 | 400.50 | 400.50 | 400.78 |
| 800 | 400.03 | 400.12 | 400.28 | 401.53 |
| 1200 | 400.78 | 400.00 | 400.04 | 400.50 |
| 1600 | 400.12 | 400.98 | 400.50 | 404.47 |
| 2000 | 400.03 | 0 | 0 | 0 |
| 2400 | 400.78 | 0 | 0 | 0 |
| 2800 | 400.78 | 0 | 0 | 0 |

| | | | | |
|---|---|---|---|---|
| 3200 | 400.50 | 0 | 0 | 0 |
| 3600 | 402.00 | 0 | 0 | 0 |
| | 3605.80 | 1601.60 | 2001.82 | 2007.78 |

**Table 6:** Wetted Perimeter at Rainy Season

| **Distance (cm)** | **Wetted Perimeter (cm)** | | | |
|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
| 0 | 0 | 0 | 407.92 | 402.00 |
| 400 | 410.00 | 412.31 | 403.11 | 402.00 |
| 800 | 402.00 | 405.25 | 400.50 | 400.78 |
| 1200 | 400.50 | 400.50 | 401.12 | 401.53 |
| 1600 | 400.50 | 400.50 | 401.12 | 401.12 |
| 2000 | 400.00 | 400.00 | 402.00 | 402.00 |
| 2400 | 400.50 | 401.12 | 403.11 | 0 |
| 2800 | 400.50 | 400.50 | 0 | 0 |
| 3200 | 401.12 | 400.00 | 0 | 0 |
| 3600 | 403.11 | 400.50 | 0 | 0 |
| 4000 | 403.11 | 400.50 | 0 | 0 |
| 4400 | 0 | 401.12 | 0 | 0 |
| 4800 | 0 | 403.11 | 0 | 0 |
| ∑ | 4021.34 | 4825.41 | 2818.89 | 2409.43 |

## IV. Conclusion And Recommendations

The following conclusions were drawn from the present study:

(i) The cross sectional area across River Osun ranges between (3.83-47.46)$m_2$/s.

(ii) The slope and depth across river Osun range from (0.0032-0.0046) and (0.2-1.9)m, respectively.

### Recommendations for Further Study

The following recommendations were drawn from the present study:

(i) Considering the cross-sectional area on River Osun, preventive measure should be taken by the appropriate authority to reduce the sedimentation in River Osun.

(ii) Routine maintenance of waterways in Nigeria in other to provide easy access of researchers in taking field measurement for morphological studies.

## Acknowledgement

The authors acknowledge Tertiary Education Trust Fund TETFund and Authorities of LadokeAkintola University of Technology, Ogbomoso for the Institution Based Research (IBR) grant (PV No: 00082805) to carry out this research.

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Olaniyan, O.S. “Geometrical Parameters Measurement across River Osun, South- Western Nigeria.” IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) , vol. 16, no. 4, 2019, pp. 08-12