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Tanzania Integrated Water, Sanitation and Hygiene (iWASH) Program

Developing Rating Curves in the Ruvu River Sub-basin

A Consultancy Report submitted to iWASH

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EXECUTIVE SUMMARY

The Florida International Research iWASH Initiative Limited commissioned this study to assess and develop rating curves in the Ruvu River Sub-basin. The work concentrated at the six key strategic stations within the Sub-basin that include: Ngerengere at Konga 1HA9A, Ngerengere at Mgude, Ruvu at Morogoro - Dar es Salaam Road 1H8, Ruvu at Kibungo 1H5, Mgeta at Mgeta 1HB2 and Mgeta at Duthumi 1HB1411. Specifically, the work reviews the existing rating curves for the existing stations on the Ruvu, update and validate cross-sections at the six strategic stations, conduct flow measurements, conduct analysis and produce new rating equations for the six strategic stations. The work utilizes the historical stage-discharge measurements and the new measurements collected during the period November 2012 to May 2013.

Results indicate that most of the stations were established in the early 1950s and discharge measurement in these stations continued until late 1980s, with no measurements between early 1990s and mid 2000s. Review of the rating relationships indicates validity of historical data up to the early 1980s for most of the stations, but cannot be used to transform gauge heights (water levels) without modification. Assessment of physical characteristics at the six key stations revealed fair hydraulic controls. Nevertheless, special attention will be required to attend some observed threats at the channel hydraulic sections.

Validation of the new developed rating curves at the key gauging stations indicate that stage-discharge relationships require updating by new current meter measurements, as for some stations the number of data points that were used to develop the rating relationships were too few. Data records reveal existence of outliers, which is likely attributable among others to use of un-calibrated current meter/sampling equipment, poor measurement techniques, inexperienced sampling technicians and/or computational errors.

The new developed rating curves revealed absence of bias for all the stations except for 1H8. Of the six stations, only three stations namely 1H5, 1HB2 and 1HB1411 passed the 'goodness of fit' test, while the rest of the stations, 1HA15, 1HA9A and 1H8 the test criterion *t* was found to be consistently greater than the critical value, leading to the rejection of the null hypothesis of the assumption of random fluctuations. Therefore, the test detected the presence of abnormal long runs of positive or negative deviations. This most likely indicates presence of systematic trend in the deviations with time, indicating that the rating curves need adjustment for a shift in control. The study recommends for a need to increase the number of measured discharges at different stages so as to increase reliability of the rating curve equations. The findings are also considered to be indicative of the situation country wide, thus it is strongly recommend that the MoW (through its WSDP and other donors) make available additional funds to enable revisiting, testing and revision of rating curves on all major rivers to ensure higher confidence in the flow measurements.

TABLE CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

ADC	Acoustic Digital Current
EFA	Environmental Flow Assessment
IUCN	International Union for Conservation of Nature
iWASH	Integrated Water Sanitation and Hygiene
JICA	Japan International Cooperation Agency
NORAD	Norwegien Agency for Development Cooperation
WADA	Water and Development Alliance
WRBWO	Wami-Ruvu Basin Water Office

1.0 INTRODUCTION

1.1 Background

The iWASH / WADA program in collaboration with the Wami-Ruvu Basin Water Office (WRBWO) carried out initial Environmental Flow Assessments (EFA) for Ruvu river system. The Water Sector Development Programme is currently financing the installation of new gauging stations, and the rehabilitation of key existing stations. To enhance the reliability of data and information generated through EFA studies, the WRBWO and the Ministry of Water recommended that rating curves for existing key stations in the Ruvu sub-basin be reviewed. Rating curves are an important ingredient in determining water flows at any specific point, and therefore in the provision of reliable flow information on which to base decisions for allocation of water. Rating curves developed in the study are expected to be instrumental in supporting ongoing EFA studies.

1.2 Current state of rating curves in Wami-Ruvu Basin

The available rating curves for the Wami-Ruvu Basin are old. Most of them were derived between 1960s and 1990s. During that time there were very few anthropogenic activities and the river control section were less impacted. In recent times, there are increased human activities that have led to more generation of sediments and deposition in the rivers. The reliability of the existing rating equations in transforming water levels to discharge is very questionable as most of them either over or underestimate the discharge. This is a big challenge to the water basin management entrusted with management and allocation of water resources based on what is available in the rivers.

In view of the existing situation and in consideration of the importance of appropriate rating curves in the basin water management, iWASH has commissioned a study to undertake a study to review the existing rating curves on some key stations. The study starts with Ruvu sub-basin and later will extend to Wami sub-basin.

1.3 Objective and scope of the assignment

The objective of the assignment is to develop rating curves in the Ruvu River Sub-basin. The work concentrated at the six key strategic stations within the sub-basin that include: Ngerengere at Konga 1HA9A, Ngerengere at Mgude, Ruvu at Morogoro –Dar es Salaam Road 1H8, Ruvu at Kibungo 1H5, Mgeta at Mgeta 1HB2 and Mgeta at Duthumi 1HB1411.

1.4 Specific Tasks

The specific tasks of the assignment include:

i. Review all existing rating curves for existing stations on the Ruvu, and assess the extent to which each station can be expected to have permanent or shifting controls

ii. Update and validate cross-sections at each of the 6 stations listed above
iii. Supervise flow measurements at each of the 6 stations for at least 5 different flow levels (low to high flows)
iv. Carry out analysis and produce new rating equations for the 6 stations
v. In the course of carrying out the activities (i) to (vi) ensure that the capacity of WRBWO staff (hydrologists and technicians) is enhanced through a well structured hands on learning process
vi. Prepare a summary report documenting the process of developing the rating curves in the Ruvu sub-basin, and detailing implications to water resources management and accuracy of existing data and information.

2.0 DESCRIPTION OF THE RUVU SUB-BASIN

The Ruvu River is one of the major rivers draining the Eastern Arc Mountains. The Ruvu sub-basin extends from Morogoro to the west of Dar es Salaam through the Coast and Dar es Salaam Regions (Figure 1), covering an area of about 17,700 km^2 of catchment which lies between latitudes 60° 05' and 70° 45' south and longitudes 37° 15' and 39° 00' east (IUCN, 2010). The Ruvu River sub-basin can be subdivided into three main sub-catchments namely, Upper Ruvu, Ngerengere and Lower Ruvu sub-catchments. The basin is mostly composed of low-lying areas along the Ruvu River and a slightly elevated hilly area with moderate undulation, which extends from west to east around Morogoro town with the exception for the Uluguru Mountains in the extreme west, which has an elevation of 2000 m above mean sea level. Isolated rolling hills are in the middle reach of the Ruvu River. The lowermost part of the river is the extreme eastern edge of the Basin, where low-lying alluvial flood-plains about 5–10 km wide are found at an elevation below 10m above mean sea level (URT/JICA, 1994).

The climate of Ruvu sub-basin varies according to the topography. The high mountain ranges of Uluguru receive more rainfall as compared to the lowland areas and rainfall is also spatially variable in the mountains. The eastern slopes of the Uluguru Mountains have mean annual rainfall in excess of 2500 mm while the western slopes of the mountains receive less (WRBWO, 2008). The Nguru-Rubeho Mountains receive between 800 and 1200mm, and the Ukaguru Mountains 1000-1800mm annually. Rainfall is much less in the plains which ranges between 800 and 1000mm near the coast but only 500-600 mm inland towards Dodoma and north of Wami sub-basin (Droogers *et al*., 2006). Generally, the high rainfall month for both highland and lowland areas is April, with mean monthly rainfall amounting to about 300 mm in the highland and about 170 mm in the lowland.

Average monthly minimum and maximum temperatures are almost the same throughout the basin; the coldest month is August (about 18°C) and the hottest month is February (about 32°C). The annual average temperature is about 26°C.

The hydrology of the catchment is influenced by the topography and climate. Most of the rivers in the sub-basin originate from the Uluguru Mountain ranges. Many rivers in the sub-basin are perennial although some dry up during the dry season and experience high flows during periods of heavy rainfall. The major tributaries into the Ruvu River are Ngerengere and Mgeta Rivers.

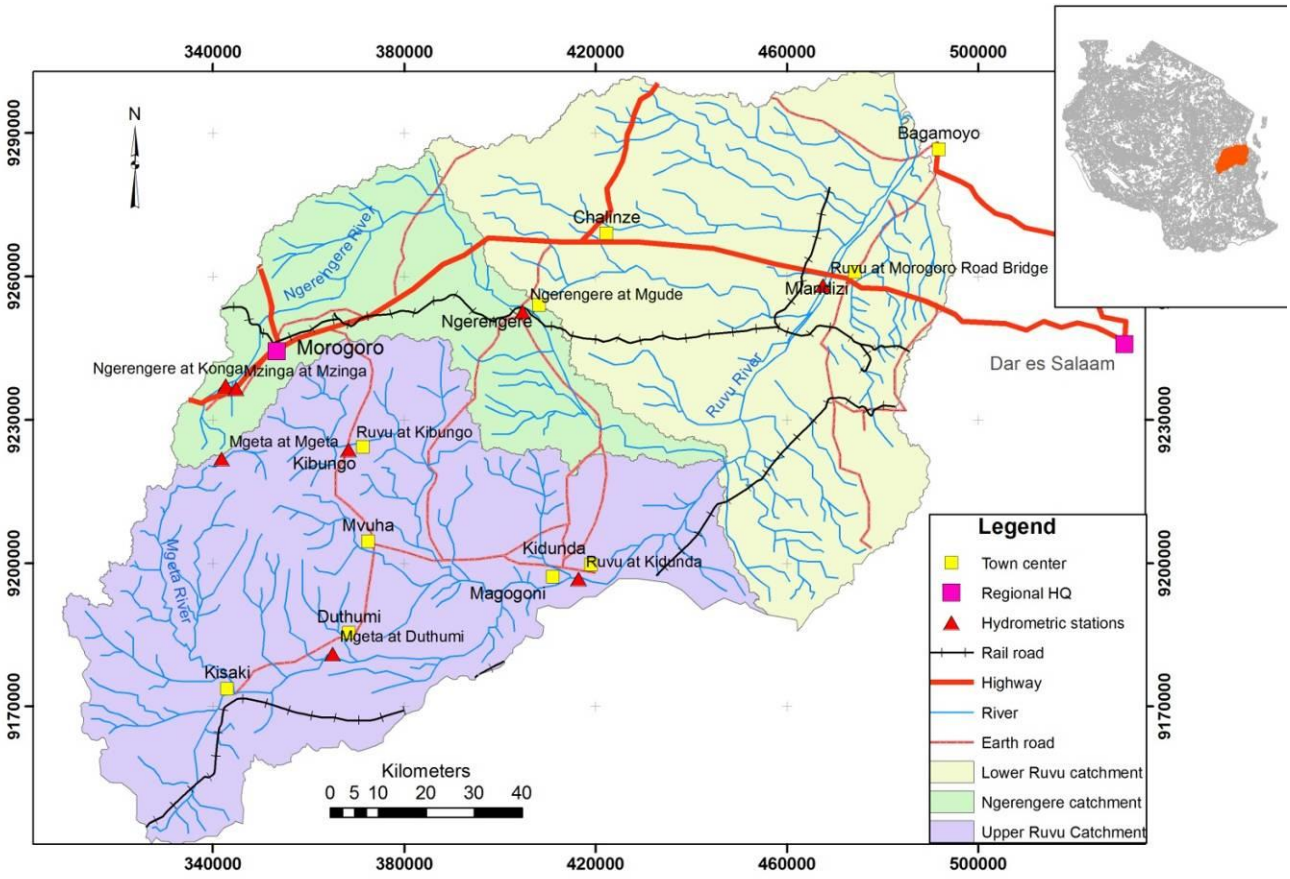

Figure 1: Ruvu Sub-basin map showing some important features

Ruvu sub-basin benefits has multiple uses and benefits a huge population including biodiversity conservation, wildlife conservation, agriculture, pastoralism, domestic and industrial activities especially in Morogoro and Dar es Salaam. The major infrastructure projects in the Ruvu sub-basin are the lower and upper Ruvu intakes for the water supply to Dar es Salaam and the Bagamoyo, Mlandizi and Kibaha villages as well as Mindu dam in Morogoro.

3.0 REVIEW OF RATING CURVES FOR EXISTING STATIONS ON THE RUVU AND STATUS OF PERMANENT OR SHIFTING CONTROLS

The available discharge measurements and gauged data at the existing gauged stations were collected from the Wami-Ruvu Basin Water Office including various reports (e.g. JICA/URT, 1994; JICA, 2012). The historical rating data were analyzed to reveal presence or absence of shift in control. The analysis was augmented by fieldwork at the six key stations. Table 1 presents status of the stations in the Ruvu sub-basin, while Table 2 presents the historical stage-discharge relationship for various stations in the sub-basin. The data indicate that most of the stations were established in the early 1950s and discharge measurement in these stations continued until late 1980s. The period from early 1990s until mid 2000s shows that there were no measurements taken. Discharge measurement commenced in 2007 at some of the stations and not covering all the stations.

Most of the rating relationships are valid up to the early 1980s and only Mgeta (1HB2) up to 1990 (Table 2). Generally, the stage-discharge relationships for most gauging stations are fitted using more than one segment with the exception of 1H10. The other observations are that the historical rating curves (Table 2) are fitted to shorter validity periods. The implications are that hydraulic controls at some gauging stations are changing over a shorter period and that the rating curves cannot be valid over a longer period. While that has been revealed, the motive for the choice of the used validity period in construction of historical rating curve is not highlighted in the document to support the above assertion. Therefore, in the absence of such information, one is tempted to assume that the shorter validity periods as used in JICA/URT (1994), (Table 2) could be a result of change in channel hydraulic control at the gauging station. Since most of the rating information is valid up to or before year 1990, the use of such curves to transform water levels to discharge is unlikely to give better results, hence necessitating developing of new stage-discharge relationships at stations. According to URT (1979), in order to have a permanent and stable stage-discharge relation, the stream channel must be capable of stabilizing and regulating the flow past the station site so that for a given stage the discharge past the station will always be the same. It is also important to note that very few rivers have absolutely stable characteristics. Thus, the calibration cannot be carried out once and for all, but has to be repeated as frequently as required by the rate of change in the stage-discharge relation (URT/NORAD, 1979).

Based on the physical characteristics at the key stations as outlined in Table 3, the gauging stations can be considered to have fair hydraulic controls. Special attention will be required to attend some observed threats at the channel hydraulic sections.

Table 1: Status of gauging stations in the Ruvu sub-basin

SN.	River Name	Station code	Location			Altitude (m)	Catchment Area (km^2)	Observation period		Discharge measurements range	Discharge measurement structure
			Name	Latitude	Longitude			Established	Status/ Closed		
1	Ruvu	1H2	Ruvu Sisal Estate	6° 48'S	38° 39'E	27	12,488	Aug. 1950	Jun. 1959	n.d	
2	Ruvu	1H3	Kidunda	7° 16'S	38° 18'E	76	6, 697	Aug. 1951	Oct. 1963	n.d	Cableway
3*	Ruvu	1H5	Kibungo	7° 1'S	37° 48'E	474	420	Oct. 1952	Operational	Oct 1952- Jun 1987; 26/3/2007-30/4/2013	Cableway
4*	Ruvu	1H8	Ruvu Bridge	6° 41' S	38° 41'E	15	15,190	Nov. 1958	Operational	11/12/1958-04-12-1981; 09-01-2007 – May 2013	Bridge
5	Ruvu	1H10	Mikula	7° 18'S	38o 10'E	80	5,870	Nov. 1965	Operational	23-08-1966 - 14-04-1989	Cableway
6	Ngerengere	1HA1A	Utari Bridge	7° 2'S	38° 22' E	90	2,840	Oct. 1950	Operational	28-01-1966 - 30-03-1985; 1990	
7	Ngerengere	1HA3	Kingolwira	6° 45'S	37° 48' E	425	690	Sep. 1950	Oct. 1963	28-05-2009 - 02-06-2010	
8	Ngerengere	1HA4	Kilimanjaro	6° 46'S	37° 42'E	457	630	Apr. 1953	Oct. 1959	n.d	
9	Ngerengere	1HA5	Kiluwa	6° 44'S	38° 06'E	198	1,646	Nov. 1953	Aug. 1967	29-07-1953 - 04-02-1969	Cableway
10	Ngerengere	1HA6	Kihonda	6° 47'S	37° 39'E	466	461	Sep. 1950	Oct. 1963	n.d	
11	Mlali	1HA7	Mlali	6° 58'S	37° 32'E	518	18.1	Oct. 1953	Oct. 1963	n.d	Cableway
12	Morogoro	1HA8	Morogoro	6° 51'S	37° 40'E	543	23.3	Mar. 1954	Operational	16-04-1960 - 28-06-2011	Cableway

13	Ngerengere	1HA9	Konga	6° 54'S	37° 37'E	530	20.5	Apr. 1954	Mar. 1960	n.d	Bridge/cableway
14*	Ngerengere	1HA9A	Konga	6° 54'S	37° 37'E	530	20.5	Nov. 1962	Operational	08-11-1962 08-05-1984; 12-01-2007-May 2013	Bridge/cableway
16	Ngerengere	1HA10	Mgera	6° 56'S	37° 34'E	518	15.4	Apr. 1954	Oct. 1963	n.d	
17	Ngerengere	1HA15	Mgude	6° 48'S	38° 09'E	95	2,370	Oct. 1968	Dec. 1975	14-10-1968 - 04-06-1992; 18-04-2008 - May, 2013	Cableway
18	Mgeta	1HB1	Kisaki	7° 28'S	37° 42'E	152	963	Nov. 1950	Dec. 1962	06-11-1950 - 24-09-1963	Bridge
19*	Mgeta	1HB2	Mgeta	7° 02'S	37° 34'E	975	101	Jun. 1954	Operational	1/6/1954-31/3/ 1988; 1/12/2006-6/5/2013	Cableway
20	Mgeta	1HB3	Bunduki	7° 02'S	37° 37'E	1,220	46	Jun. 1954	1962	15-07-2011 – May, 2013	
21	Mgeta	1HB4	Luhuela	7° 01'S	37° 38'E	1,493	5	Dec. 1954	1963	n.d	
22	Mvuha	1HC2	Mvuha	7° 12'S	37° 51'E	274	251	Apr. 1954	Operational	25-02-1954 - 10-03-1984	Cableway
23*	Mgeta	Local	Duthumi	7° 24'S	37° 46'E	473	420	2011	Operational	15-07-2011 – May 2013	Cableway

* Stations included in this study.

Note: n.d = no data

Source: JICA/URT, (1994); Kashaigili, (2011).

Table 2: **Historical stage-discharge relationships at various gauging stations in the Ruvu sub-basin (JICA URT/, 1994)**

Station code	Name of Station	Available period	Q = A * H^B + C Coefficients			Limit water level (m)	Correlation Coefficient, R (%)
			A	B	C		
1H2	Ruvu Sisal Estate	1952-1959	11.0240	1.66429		2.00	95.4
			1.02973	3.54281	23	6.00	97.5
1H3	Kidunda	1952-1966	24.1237	1.03527		1.60	96.2
			6.14850	2.44617	20	6.00	91.6
1H5	Kibungo	1959 - 1970	19.1636	3.10753		1.10	98.7
			40.6208	1.25447	-20	4.50	98.5
		1971-1980	23.0633	3.49743		1.10	96.9
			33.8732	1.41340	-10	4.50	99.8
		1981-1987	20.5394	2.89784		1.10	92.6
			51.7881	1.10724	-30	4.50	98.6
1H8	Ruvu Bridge	1958-1970	8.22767	1.81509		6.11	98.8
			100.475	1.50195	-1300	8.00	95.2
		1971-1981	9.06448	1.76623		6.11	98.8
			0.00002	8.23453	160	8.00	86.4
		1982	5.01726	1.71714		6.11	99.5
		1983 - 1985	9.18824	1.80456		6.11	99.2
			25.0344	1.95137	-600	8.00	99.9
		1986 - 1989	6.72828	1.79702		6.11	88.5
			0.00151	6.27380	50	8.00	96.4
1H10	Mikula	1966 - 1984	11.448	1.896		8.00	98.0
1HA1A	Utari Bridge	1966 - 1977	3.73814	3.35047		0.80	84.1
			3.62428	1.61445	-1	4.50	99.7
		1980 -1985	7.77635	2.94829		0.80	97.7
			3.04418	1.67539	1.5	4.50	99.1

Station code	Name of Station	Available period	Coefficients			Limit water level (m)	Correlation Coefficient, R (%)
			A	B	C		
1HA5	Kiluwa	1953 - 1960	3.35462	2.24316		1.50	95.3
			3.00350	2.25029		3.00	93.7
		1961	2.39806	2.66217		1.50	99.4
			3.00350	2.25029		3.00	93.7
		1962	0.56487	6.81209		1.50	98.7
			3.00350	2.25029		3.00	93.7
		1963 - 1969	2.44482	2.8857		1.50	95.1
			3.00350	2.25029		3.00	93.7
1HA15	Mgude	1968 - 1973	4.16574	1.48870		1.50	98.5
			3.00561	2.47466		4.00	98.3
		1974 - 1977	2.46166	2.79574		1.50	96.9
			0.35630	4.42856	5	4.00	90.3
		1978 - 1979	1.63595	2.88427		1.50	95.1
			4.02192	2.41713	-5	4.00	97.5
		1980 - 1986	3.24384	2.77980		1.50	96.2
			0.23692	4.85933	8	4.00	89.4
		1987 - 1992	0.69703	2.40865		1.50	91.7
			2.87339	2.76867	-7	4.00	97.2
1HB1	Kisaki	1950 - 1986	9.57690	1.02741		0.80	94.1
			31.9738	0.63273	-20	3.00	99.2
		1960 - 1963	7.26274	1.45101		0.80	77.2
			18.6199	0.89488	-10	3.00	97.5
1HB2	Mgeta	1958 - 1986	8.88722	2.14663		0.75	97.2
			7.95385	3.68474	2	1.50	98.8
		1980 - 1990	13.9812	2.95973		0.75	98.9

			4.56838	5.55936	5	1.50	99.9

Station code	Name of Station	Available period	Coefficients			Limit water level (m)	Correlation Coefficient, R (%)
			A	B	C		
1HC2	Mvuha	1954 - 1956	6.81975	2.08840		2.00	93.8
			7.88480	1.88107		3.50	99.9
		1958 - 1980	2.25136	2.16116		2.00	75.5
			7.96119	1.86076	-20	3.50	75.8
		1981 - 1984	5.02611	2.82574		2.00	95.2
			59.5741	0.95754	-80	3.50	99.8

Table 3: Physical descriptions of the flow gauging stations at the key stations

Stn. Code	Catchment description	Station details	Observed threats on Control Section
1H5	Steep catchment of the Uluguru Mountains, well wooded with vegetation actively induced by natives	Types of gauges: Standard vertical; Benchmark: Concrete beacon on right bank near staff gauges. The BM assumed datum is at 8.283m. A hydraulic control is fairly stable open channel with cobbles, gravel, sand and debris deposition bed materials and grassy banks. The site is accessible throughout the year from Morogoro.	Deposition and development of an island at the channel cross-section leading to change from laminar to unsteady flow. Mining activities in the upstream of the gauging station accelerating sediments.
1H8	Upper part, steeply sloping catchment containing a wide range of vegetation; and lightly wooded grassland with some bushland and thickets grassland in the lowland areas.	Types of gauges: Standard vertical; Benchmark: Concrete beacon on left bank near staff gauges. The BM assumed datum is at 6.77m. A hydraulic control is fairly stable open channel with mixed clay bed and grassy banks. The site is accessible throughout the year from Morogoro and Dar es Salaam.	No major threats except minor erosions on the left bank following cattle watering.
1HB2	Upper steeply sloping catchment containing a wide range of vegetation	Types of gauges: standard vertical; Benchmark: is a concrete beacon on right bank near staff gauges and benchmark assumed datum is at 4.150m. A hydraulic control is permanent formed by rock outcrop and rapids about 18 meters downstream of the gauge; The site is accessible throughout the year using Mgeta road from Morogoro.	Erosion especially on the right bank. (*Stabilization of bank to avoid erosion will be necessary*)
1HA9A	Steep catchment of the Uluguru Mountains, with wide range of vegetation	Types of gauges: Standard vertical; Benchmark: Concrete beacon on left bank near staff gauges. The BM assumed datum is at 5.60m. A hydraulic control is fairly stable open channel with clay bed and grassy banks. The site is accessible throughout the year from Morogoro-Mzinga earth road.	Sedimentation following increased human activities in the upstream

1HA15	Catchment containing a wide range of vegetation largely influenced by human activities	Types of gauges: Standard vertical; Benchmark: Concrete beacon on left bank near staff gauges. The BM assumed datum is at 6.265m. A hydraulic control is fairly stable open channel with clay bed and grassy banks. The site is accessible throughout the year from Ngerengere earth road.	Erosion and deposition at the hydraulic control section following livestock crossing at the gauging station. *(This require special care to stop livestock crossings at the section and other human activities (e.g. brick making) near the river banks in the upstream)*
IHB1411	Upper part, steeply sloping catchment containing a wide range of vegetation; and lightly wooded grassland with some bushland and grassland in the lowland areas.	Types of gauges: Standard vertical; Benchmark: Concrete beacon on left bank near staff gauges. The BM assumed datum is at 5.573m. A hydraulic control is fairly stable open channel with clay bed and grassy banks. The site is mainly accessible in the dry season from Morogoro-Kisaki earth road	Erosion and deposition at the hydraulic control section following people fetching water and crossing at the section and livestock watering in the upstream of the channel hydraulic section.

4.0 UPDATING AND VALIDATION OF CROSS-SECTIONS

4.1 Check survey

The surveys were conducted at the key stations to check for the validity of the cross section and whether the gauges had been disturbed since the previous check survey. In this case wherever there were errors, corrections were made accordingly. The results of the check survey are provided in Table 4, while other details are provided in Appendix 1. During the process of check survey, the angle irons had the correction slots improved to be longer in order to allow more movements for corrections in future check surveys.

Table 4: Results of Check Survey

Stn. Code	Description
1H5	Ruvu River at Kibungo- gauges numbers: 3.00-4.00m, 400-5.00 and 500-6.00m needed big adjustments which entailed dismantling and rebuilding. Observed a developed island at the channel hydraulic section and recommended to be removed in order to allow the flow hydro-dynamic processes to take place. This was dug-out and section cleared to reduce its effects on the uniform flow at the measuring site.
1H8	Found to be in good order, no adjustment.
1HB2	An error was found between gauge plate number 0.0 to 1.00m and 1.00 to 2.00m, for which the 1.00 to 2.00m gauge was re-erected to comply with the appropriate levels of the range of the existing gauges.
1HA9A	A misleading error for the gauge plate that used to be considered 0.0 to 1.00m, but for which in reality it was 0.0 - 0.50m, but on top it used to read 1.00m. This error was noted and rectified and the gauge ranges now read 0.0-0.50m as the first gauge, second gauge reads 0.50- 1.00, 3rd 1.00-2.00, 4th 2.00-3.00, 5th 3.00-400m and the last 4.00-500m. The total gauge range is up to 5.50m instead of 6.00m. Such errors might have had implications on the previously recorded water levels at the sections and subsequently on the computed discharges. Reviewing of historical water levels since last check survey was recommended.
1HA15	The gauges 1.00-2.00, 2.00-300m and 3.00-4.00m were adjusted. Gauge no. 0.0-1.00 was found to be submerged in sand by 0.38m that is while the water level was 0.88. Actual depth was 0.50m. The banks at this station were found to be actively degraded by livestock movement across the measuring section. Recommend installing a signpost to bar the trespassing at section. Furthermore, the authorities, especially the village government should be informed. This station is important because its location may be taken to represent a larger part catchment of the Ngerengere River Catchment before its confluence with Ruvu river.

IHB1411	With the exception of fallen tree and logs that had to be removed and the site cleared to allow free movement of water through, no adjustment on the gauges as were found to be okay. The hydraulic control section was found to be susceptible to increased human activities on river banks as well as livestock watering. Special attention will be required to halt such activities in the river banks in particular at the channel hydraulic control section.

4.2 River Gauging Section Cross-section survey

The surveying of river gauging section cross-sections followed standard procedures using a dumpy level machine. Among others, the essence of defining these cross-sections is to help in the process of developing and checking reliability of rating curves. It was revealed that there exists no historical gauging section cross-sections at the key stations and if they were, the documents containing data were at large. Therefore, this work could be considered a first attempt to establish and document river gauging cross-sections at the gauging stations. The results for the six key stations are presented in Figures 2 through 7, and Appendix 2.

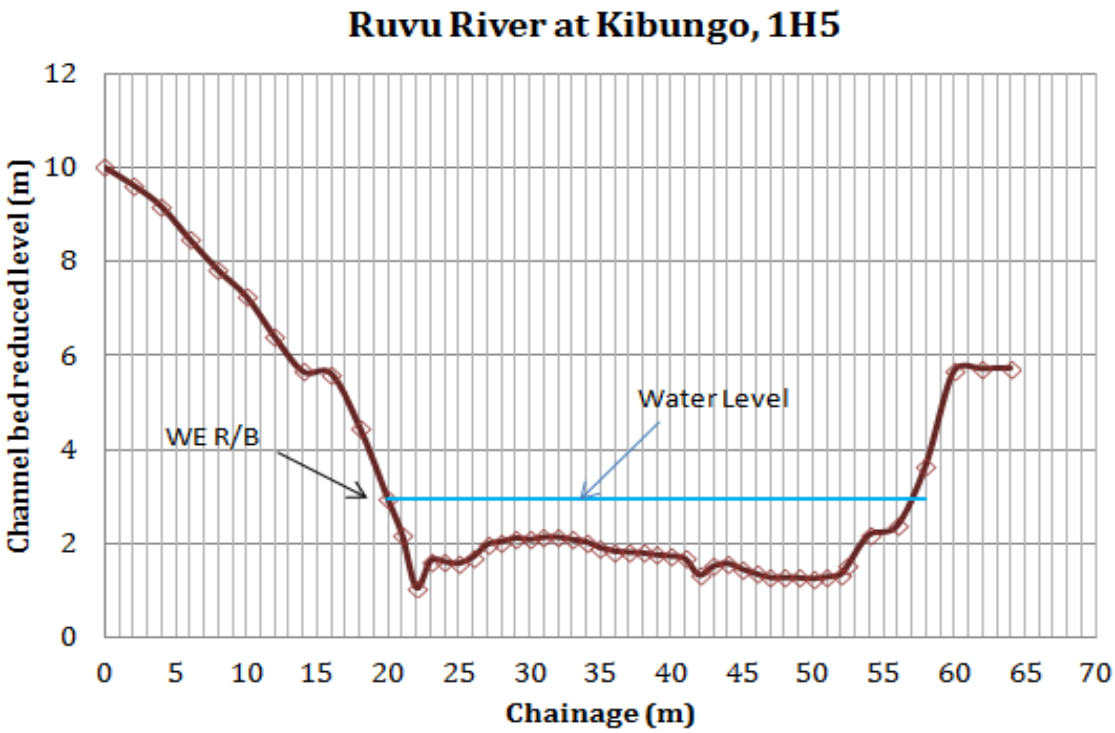

Figure 2: Gauging section cross-section for Ruvu River at Kibungo station (1H5)

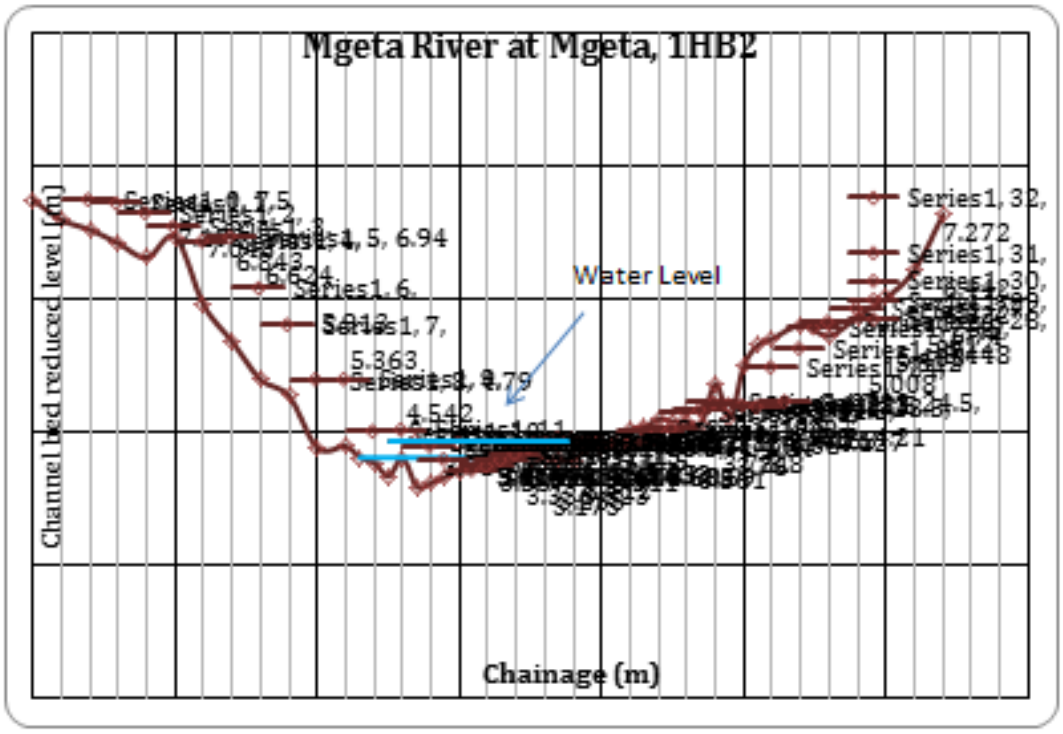

Figure 3: Gauging section cross-section for Mgeta River at Mgeta station (1HB2)

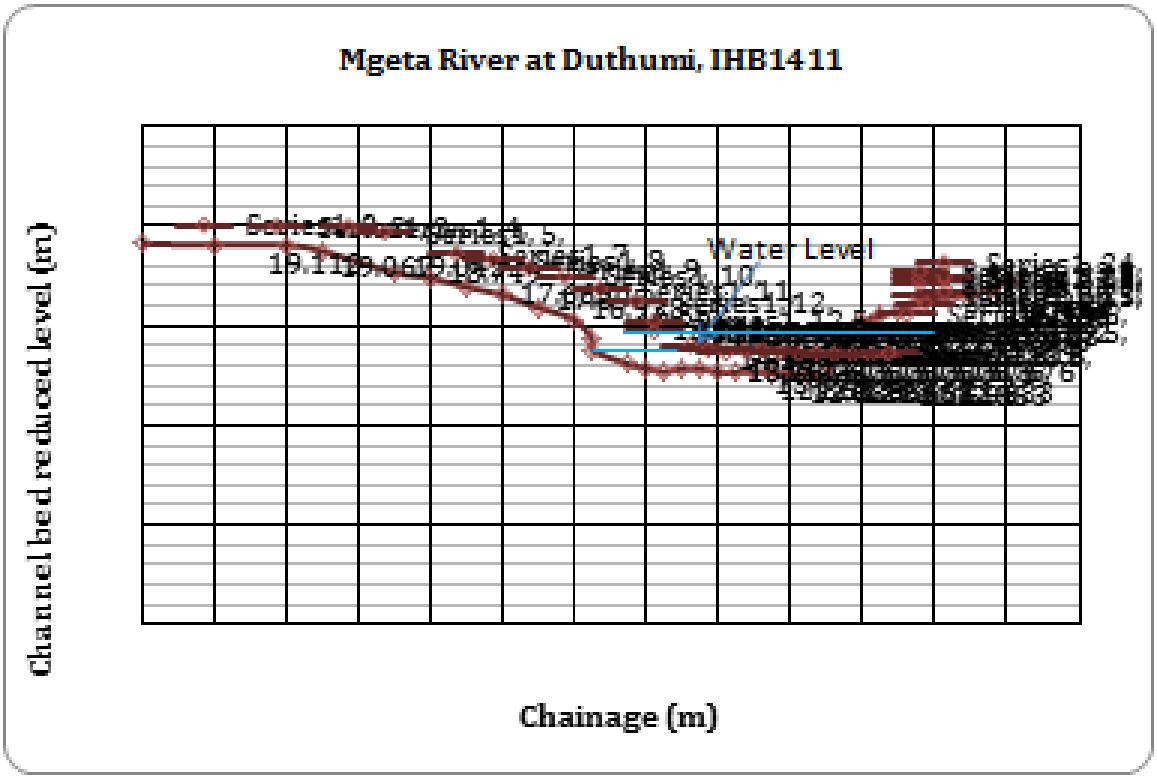

Figure 4: Gauging section cross-section for Mgeta River at Duthumi station (IHB1411)

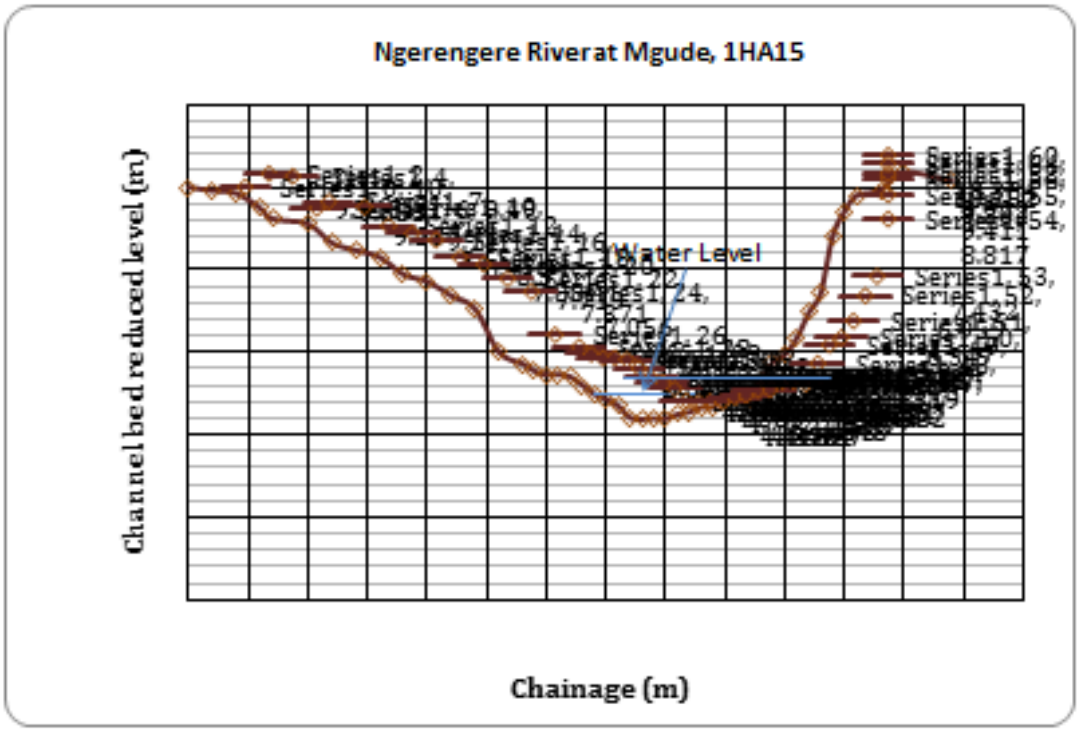

Figure 5: Gauging section cross-section for Ngerengere River at Mgude station

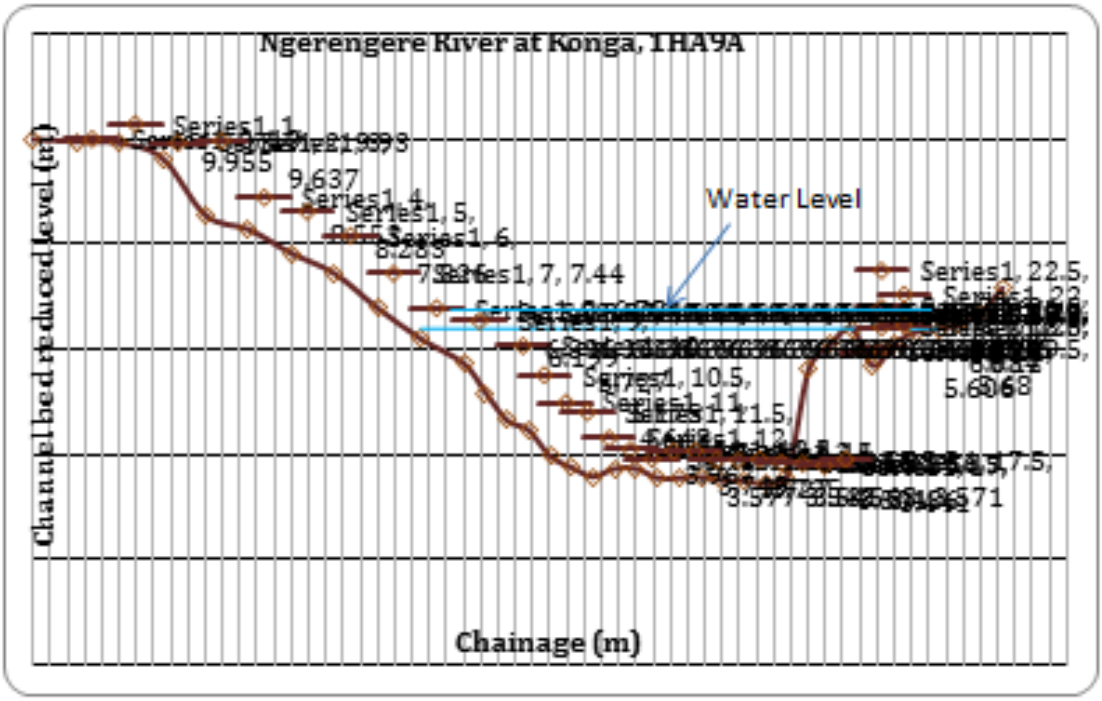

Figure 6: Gauging section cross-section for Ngerengere River at Konga station

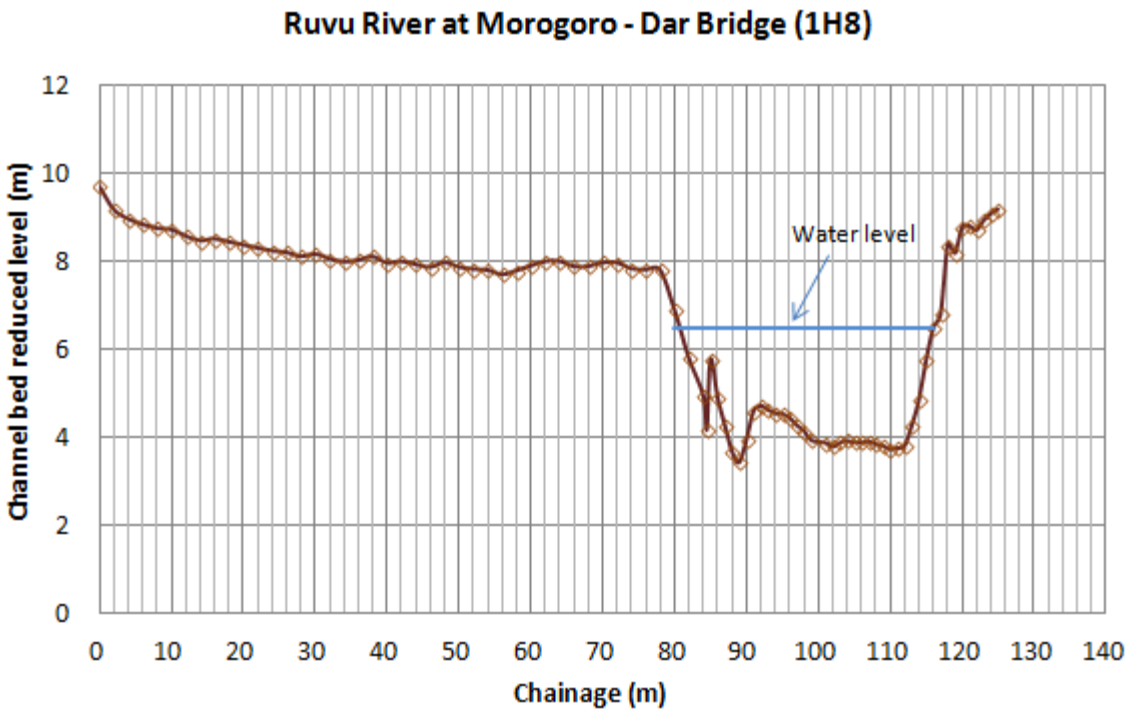

Figure 7: Gauging section cross-section for Ruvu River at Morogoro-Dar Bridge station

5.0 DISCHARGE MEASUREMENTS

5.1 Fieldwork period and discharge measurements

The discharge measurements were conducted between December 2012 to June 2013. This period characterize a wide range of flow variability from low flow to high flow which is suitable for rating curve development. WMO (1980) point out that if the discharge measurements cover the entire range of stage experienced during a period of time when the stage-discharge relation is stable, there is little problem in defining the discharge rating for that period.

The measurements of river flows were carried out using three discharge measurement methods; Propeller Type Current Meter, Acoustic Digital Current (ADC) Meter and Float methods. Detailed account on these methods could be found in (Kashaigili, 2011; Valimba, 2007). The make use of different methods to estimate discharge enabled triangulation of the estimated discharges at a particular gauging station and thus increasing confidence on the measured values. A summary of the measured discharge at the six key stations is provided as Appendix 3.

5.2 Historical discharge measurements

The available historical discharge measurements dates back to 1950s and continued being collected until late 1980s and early 1990. Restart of measurements at some stations as earlier mentioned was in year 2007. All the collected historical discharge measurements for the key stations are listed in Appendix 4.

6.0 ANALYSIS AND PRODUCTION OF NEW RATING CURVE

6.1 Overview on rating curves

Both historical and new stage - discharge measurements at the six gauging stations were analysed. The qualitative and quantitative methods were used to assess validity and reliability of the rating curves. Qualitative analysis entailed review of rating plots of the current meter measurements from various periods in history. Quantitatively, statistical performance indicators were used to assess the reliability of the rating curves in the validation process.

Validation of a rating curve is required both after the relationship has first been fitted and subsequently when new gaugings have been carried out, to assess whether these indicate a change in rating. Validation is also used to assess the reliability of historical ratings. Current meter gauging is carried out with variable frequency depending on previous experience of the stability of the control and of the rating curve (DHV Consultant, 1999). As a minimum it is recommended that six gaugings per year are carried out even with a station with a stable section and previously gauged over the full range of level. At unstable sections many more gaugings are required. The deviation of such check gaugings from the previously established relationship is computed and any bias assessed to determine whether they belong to the same population as the previous stage-discharge relationship.

DHV Consultant, (1999) point out that graphical and numerical tests are designed to show whether gaugings fit the current relationship equally and without bias over the full range of flow and over the full time period to which it has been applied. If they do not, then a new rating should be developed but taking into account the deficiencies noted in validation.

The analysis emphasizes identification of data outliers and gauge shifts. An outlier is an observation that lies outside the overall pattern of a distribution (Moore and McCabe, 1999), denoting presence some sort of problem (Ndomba, 2007), mainly on the channel controls. Ndomba (2007) considers an outlier to a case which does not fit the model under study, or an error in measurement, and points

out that statistics derived from data sets that include outliers will often be misleading, but cautioned that deletion of outlier data is a controversial practice frowned on by many scientists and science instructors. Although mathematical criteria provides an objective and quantitative method for data rejection, it does not make the practice more scientifically or methodologically sound, especially in small data sets or other situations in which a normal distribution cannot be assumed. Rejection of outliers is more acceptable in areas of practice where the underlying model of the process being measured and the usual distribution of measurement error are confidently known. Accordingly, outliers usually demand special attention, since they may indicate problems in sampling or data collection or transcription. Alternatively, an outlier could be the result of a flaw in the assumed theory, calling for further investigation by the researcher (Ndomba, 2007).

Another important aspect is the investigation of shifts in the discharge rating. According to Rantz, (1982), shifts in the discharge rating reflect the fact that stage-discharge relations are not permanent but vary from time to time, either gradually or abruptly, because of changes in the physical features that form the control for the station. If a specific change in the rating stabilizes to the extent of lasting for more than a month or two, a new rating curve is usually prepared for the period of time during which the new stage-discharge relation is effective. If the effective period of a specific rating change is of shorter duration, the original rating curve is usually kept in effect, but during that period shifts or adjustments are applied to the recorded stage, so that the “new” discharge corresponding to a recorded stage is equal to the discharge from the original rating that corresponds to the adjusted stage (Ndomba, 2007).

Rantz, (1982) noted that if a group of consecutive measurements subsequently plot to the right or left of the average rating curve, it is usually clearly evident that a shift in the rating has occurred. An exception to that statement occurs where the rating curve is poorly defined and undefined in the range of discharge covered by the subsequent measurements; in that circumstance, the indication is that the original rating curve was in error and requires revision (Rantz, 1982). Stage-discharge relations are usually subject to minor random fluctuations resulting from the dynamic force of moving water, and because it is virtually impossible to sort out those minor fluctuations, a rating curve that averages the measured discharges within close limits is considered adequate (Rantz, 1982). Furthermore, it is recognized that discharge measurements are not error-free, and consequently an average curve drawn to fit a group of measurements is probably more accurate than any single measurement that is used to define the average curve (Rantz, 1982).

Based on data from Ruvu River at bridge (1H8), the rating curve presented in Figure 8 (a&b) is used to illustrate some preceding overviews on rating curve analysis. The data points in Figure 8 represent different periods of measurements. From Figure 8, it be noted that there very few outlier outside the overall pattern of the distribution as indicated. The data sets for succeeding periods (2008-2011 and 2012-2013) coincide well within the historical distribution. The data reveal a break in log transformed

data points at gauge height greater 5.34m, Figure 8(b) revealing change in channel section and start of flood plain. This suggests that two segment fitting curve for this station are needed.

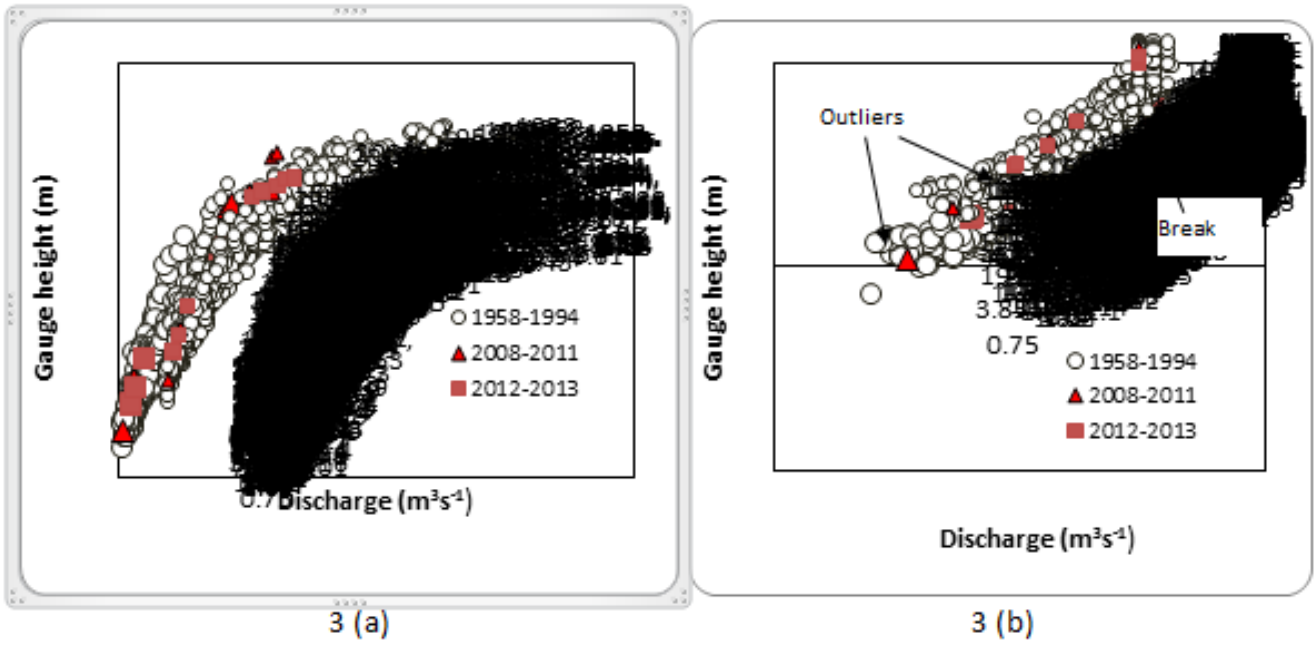

Figure 8: a) Scatter plot of discharge versus gauge height for Ruvu River at Morogoro-Dar Bridge (1H8) gauging station; b) Log transformed data points of discharge against gauge height at same station.

6.2 The developed rating curves

The new rating equations were developed using Curve Expert software. The software optimizes the rating equation parameters (K, Ho and n) using an inbuilt optimization algorithm. The standard error of estimate, SE and the correlation coefficients are used as a performance indicator (Table 5).

Table 5: The new developed flow rating curve

Sno.	Gauging station code	Rating curve parameters (Q = K*(H-Ho)^n			Standard Error (SE)	Correlation Coefficient (R^2) %	Gauge height range, H (m)
		K	Ho	n			
1	1H5	34.3332	0.2655	0.8477	2.499	97.9	0 - 9
2	1HB2	19.8464	0.33895	1.16239	0.521	96.1	0 - 5
3	Duthumi	4.46541	-0.54018	1.75102	4.155	98.0	0 - 5
4	1HA15	2.90394	0.01624	2.50094	3.066	94.8	0 - 5
5	1HA9A	0.13151	-0.83164	3.68335	0.416	94.4	0 - 6
6	1H8	9.14891	0.09618	1.74165	2.91	95.2	0 - 5

		0.07367	0	4.48278	58.0	83.0	5 - 7

6.3 Required number of Discharge Measurement for Establishing a Reliable Rating Curve

The required number of discharge measurements in order to obtain a reliable rating curve may be calculated from the formula (URT/NORAD, 1979):

$$n > \left(\frac{2S_D}{E}\right)^2$$ …… (Equation 1)

Where,

n = number of required measurements

S_D = standard deviation in percent ($2S_D$ is allowable width of scatter band). It is calculated separately for each range of stage having a separate control, and the test is applied separately to each range.

E = a specified precision expressed as a percentage, usually 5%

Table 6 presents the required number of measurements with variation in width of scatter band, E being taken as 5% (URT/NORAD, 1979):

Table 6: Required number of measurements with variation in width of scatter band

Width of scatter band, 2SD (%)	Minimum number of measurements, n
10	6
15	9
20	16
25	25
30	36

According to (URT/NORAD, 1979), it is recommended that ***n should never be less than 6 for any one interval of the range***. It is also provided that the reliability of the estimated rating curves and of the deviations of the measured discharges from the rating curves may generally be assessed by the concept of the acceptance region for the observations. Therefore, a pair of curves drawn, one on each side of the rating curve and each at a distance of two standard deviations (*2SD*), are called control curves and define the 95% acceptance region. That is, 95% out of every hundred (or nineteen

out of every twenty) measurements should be between the control curves. A single measurement lying far outside the (say *3SD*) is most probably the result of faulty gauging equipment or of poor measuring practices (URT/NORAD, 1979). In the event where two or more consecutive points, either chronologically or over a range in stage, appear to be well on one side of a control curve, a change of the stage-discharge relation has probably occurred. Therefore, owing to shift in the station control, a new rating curve is required and the calibration of the station must be repeated.

Table 7 presents a summary on data points used to develop rating curves against the statistically derived number of required measurements. It should be noted that as per the requirements, the number of data points used to develop rating curve, N, should be greater than statistically derived number of required measurements, *n* (Table 7), and that *n* should never be less than 6 for any one interval of the range (URT/NORAD, 1979).

Table 7: Required number of discharge measurements for establishing a reliable rating curve

Gauging station	Data points used N	Percentage Standard Deviation, SD	Width of scatter band, 2SD	Number of required measurements, n	Stage ranges, H (m)	Remarks
1H5	36	34.7	69.4	770	0 - 9	Condition *unfulfilled*
1HB2	119	33.9	67.8	735	0 - 5	Condition *unfulfilled*
1HB1411	22	25.8	51.5	425	0 - 5	Condition *unfulfilled*
1HA15	494	112.8	225.6	8141	0 - 5	Condition *unfulfilled*
1HA9A	32	74.2	148.5	3528	0 - 5.5	Condition *unfulfilled*
1H8	745	26.5	53.0	450	0 - 5.35	Condition fulfilled
	286	17.7	35.4	201	5.35-7.0	Condition fulfilled

From Table 7, only 1H8 out of the six gauging stations passed the test, and thus the rating data points are considered sufficient based on this test (Table 7). This is likely attributed to the lower percentage standard deviation (SD) and greater number of data points (N) used to develop the rating curve equation for both high and low flow segments. Nevertheless, passing the reliability test for the required number of data points does not mean that the rating curves are okay and free from bias and random fluctuations or goodness of fit.

6.4 Rating curve validation

A number of methods are available in the literature to check the reliability of discharge rating curves. DHV Consultant, (1999) categorizes them into two namely, graphical validation and numerical validation tests.

6.4.1 Graphical validation tests

The graphical validation tests are considered the most effective method of validation. These include the following:

- Stage/discharge plot with the new gaugings
- Period/flow deviation scattergram
- Stage/flow deviation scattergram
- Cumulative deviation plot of gaugings
- Stage/discharge plots with gaugings distinguished by season

However, judgments based on graphical displays are often indicative rather than prescriptive - a judgment on the part of the data processor is still required (DHV Consultant, 1999). In the subsequent sections some of the above tests are illustrated using 1H8 rating data.

Stage - discharge plot with new gaugings

The simplest means of validating the rating curve with respect to subsequent gaugings is to plot the existing rating curve with the new check gaugings. This is shown in the example for Station 1H8. New discharge measurements are plotted against existing rating curve established for the period 1958-1990 (Figure 9). Qualitatively, the data show a good fit to the new rating curve.

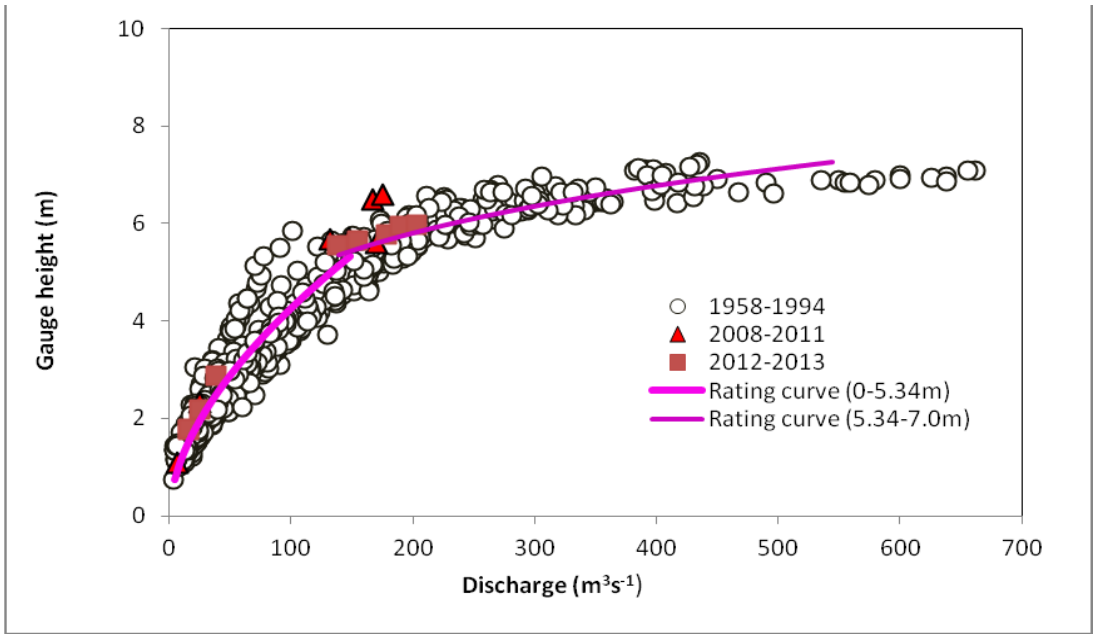

Figure 9: Period discharge measurements for Ruvu River at Morogoro Dar road plotted against the new rating curve

Stage - flow deviation diagram

Figure 10 present a scatter diagram of percentage deviation against gauge heights. From the plot it can be noted that at lower ranges of stage, the relationship is biased. This is likely a result of change in section control, thus necessitating developing of new rating curves.

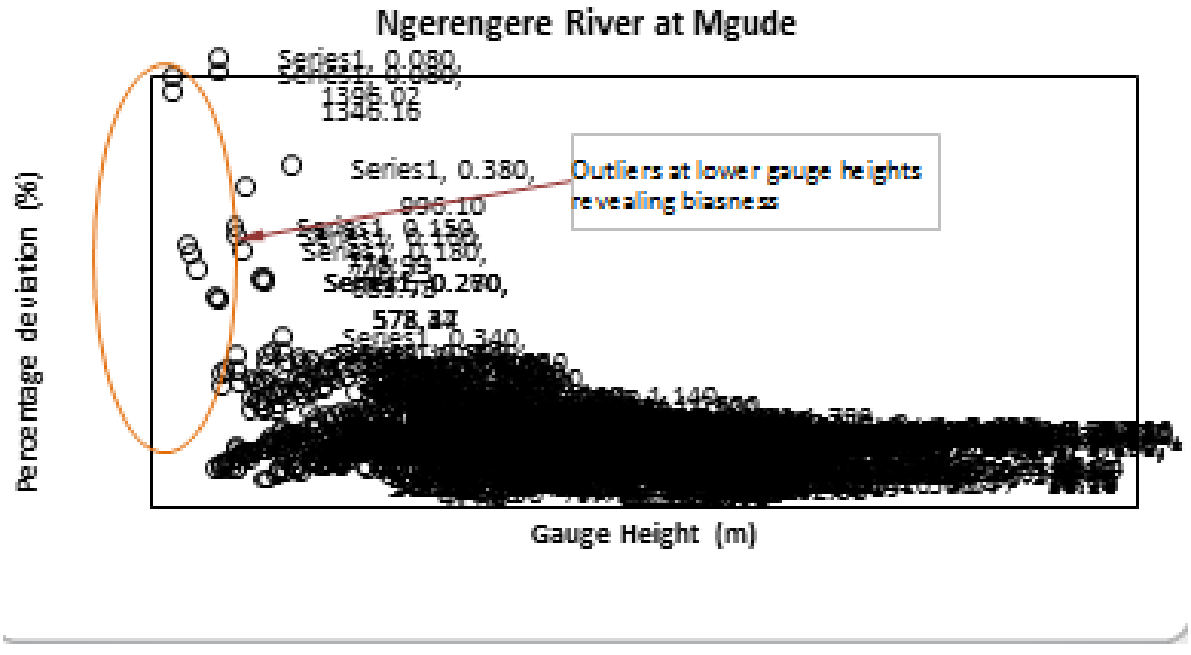

Figure 10: Stage-flow deviation scatter diagram for Ngerengere River rating curve (old) at Mgude station

The subsequent plots provide the relationships between historical discharge measurements and the recent measurements for different the study gauging station in the Ruvu sub-basin.

i) Ruvu River at Kibungo, 1H5

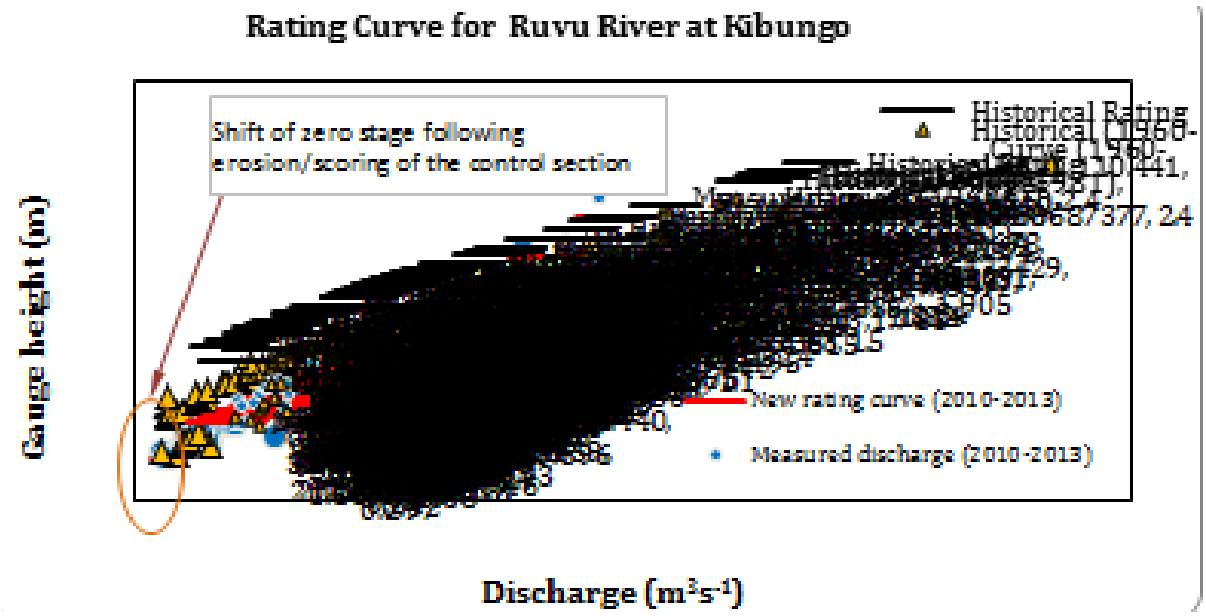

Figure 11: Rating curve for Ruvu River at Kibungo station established based on historical discharge measurement data for the period 1960 to 1981 inset with new measurements

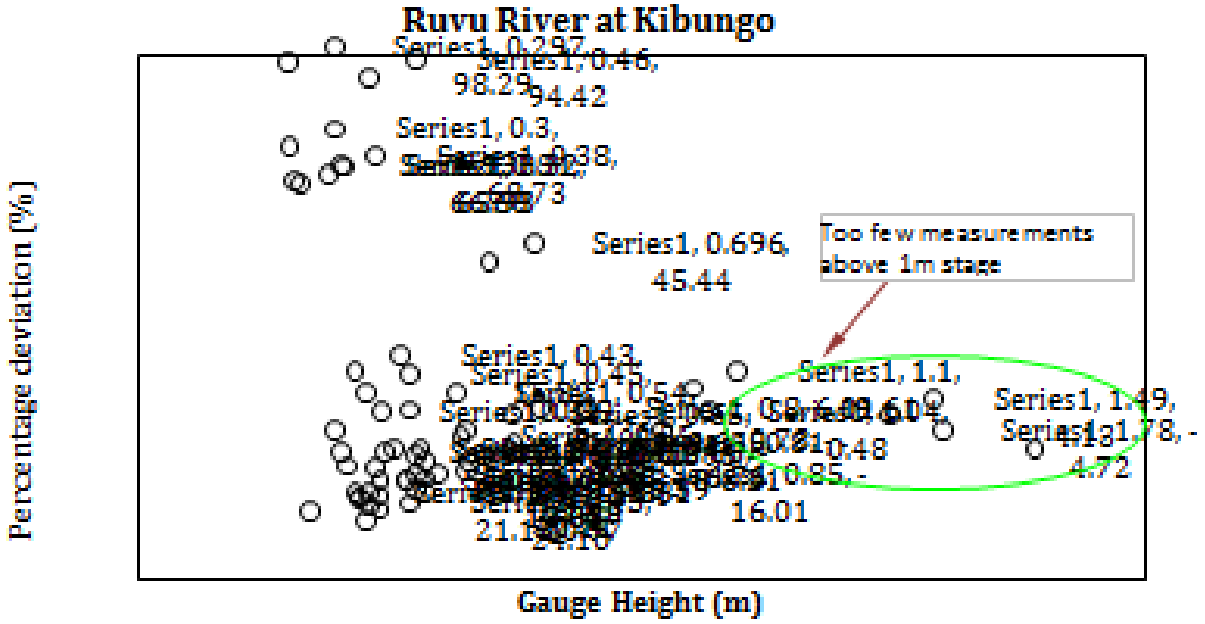

Figure 12: Stage-discharge deviation scatter diagram for Ruvu River at Kibungo station –new rating curve

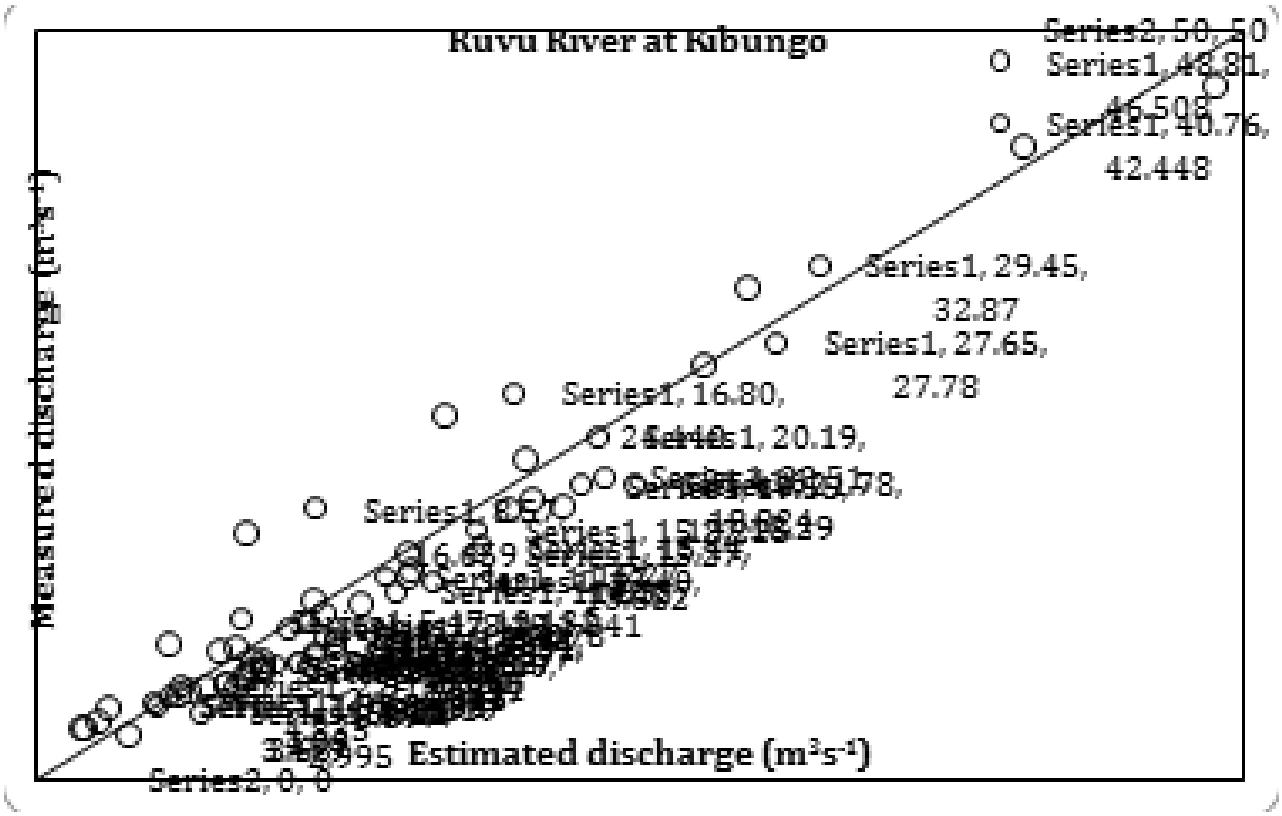

Figure 13: Comparison between estimated and measured discharges for Ruvu River at Kibungo

ii) Mgeta River at Mgeta

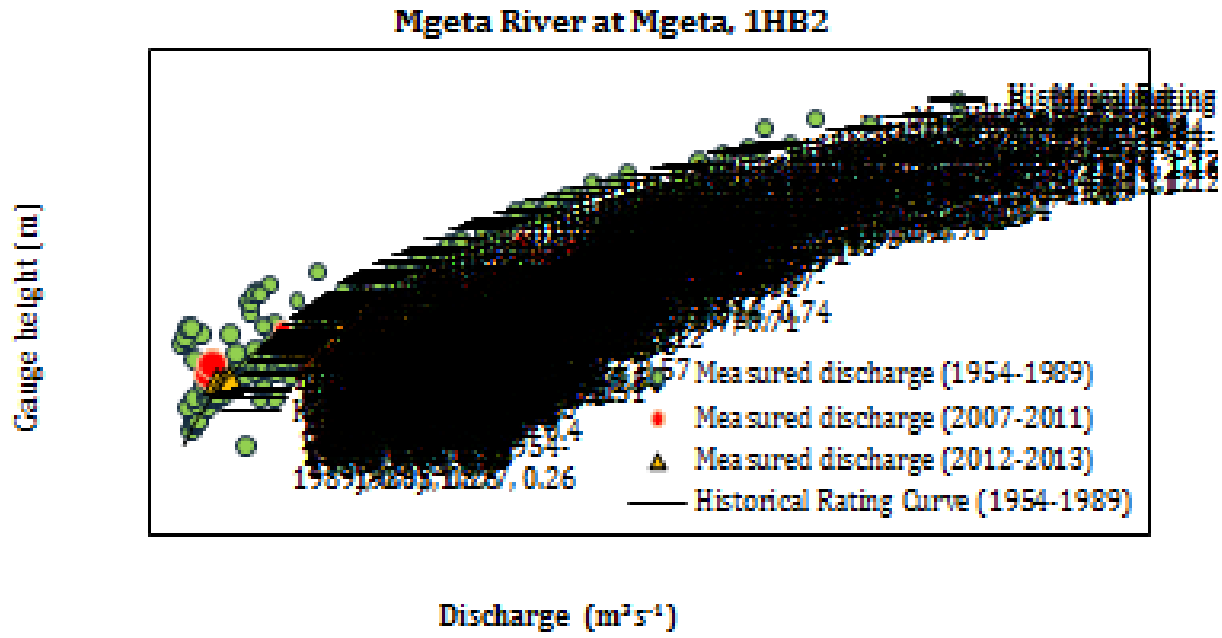

Figure 14: Rating curve for Mgeta River at Mgeta station established based on historical discharge measurement data for the period 1954 to 1989, inset with recent measurements

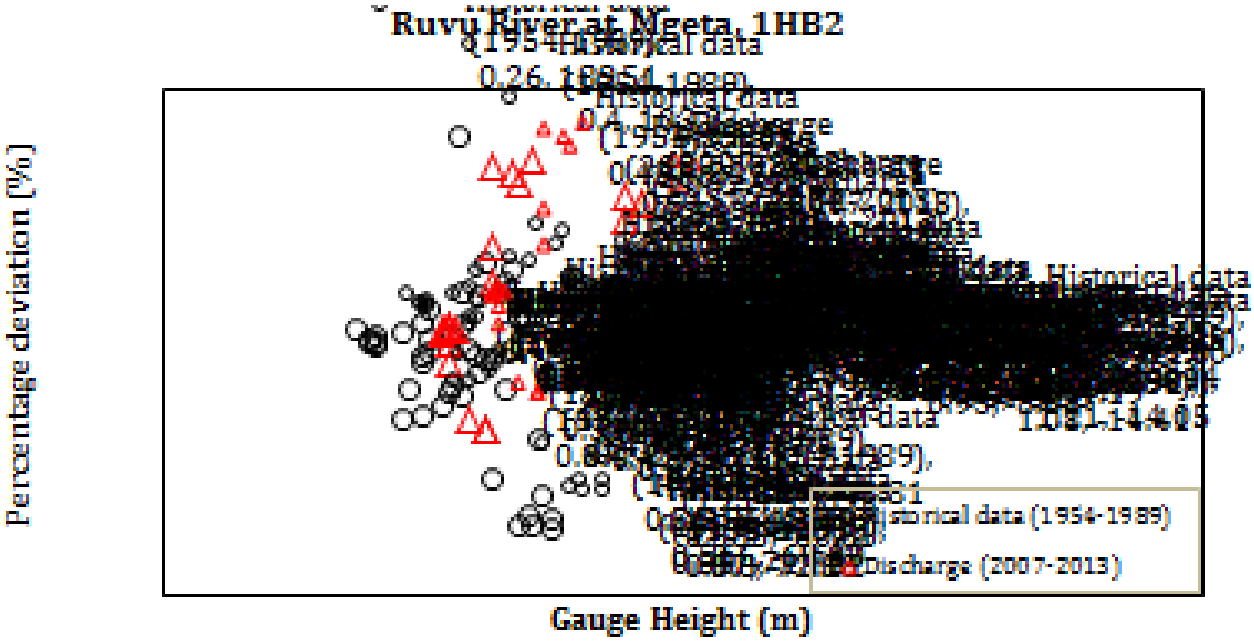

Figure 15: Stage-discharge deviation scatter diagram for Mgeta historical rating curve data and new gaugings

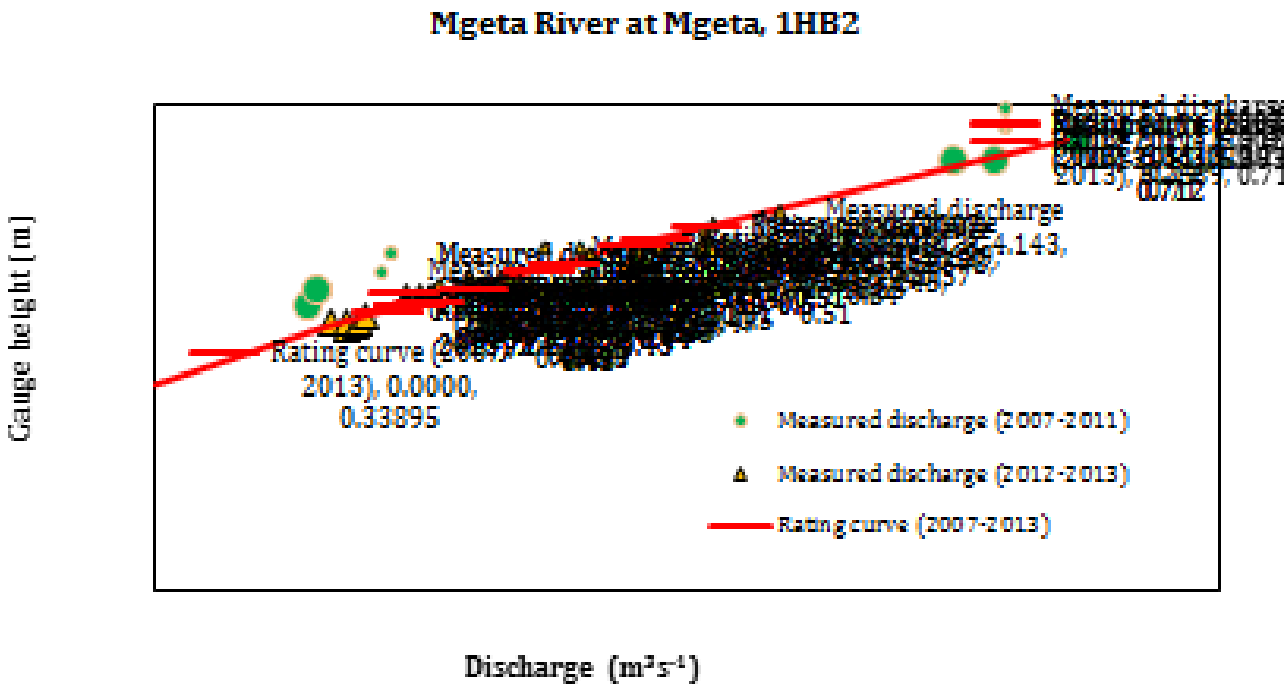

Figure 16: New rating curve for Mgeta River at Mgeta

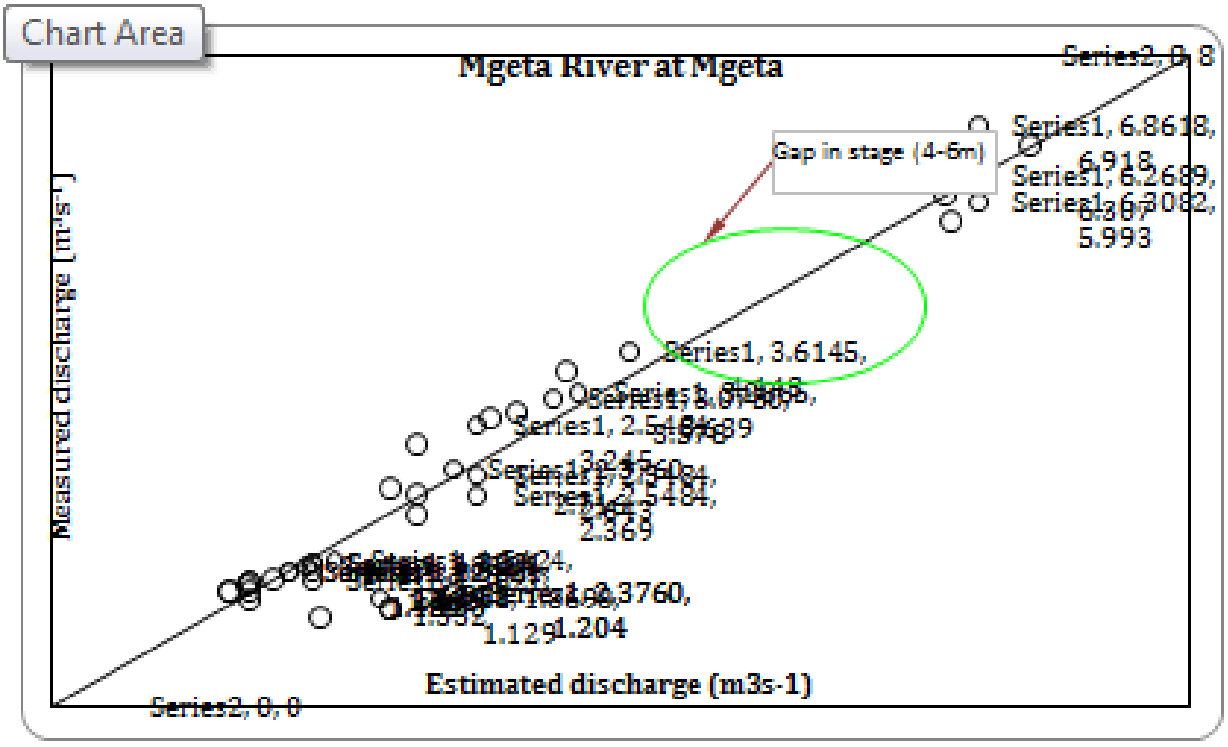

Figure 17: Comparison between estimated and measured discharges for Mgeta River at Mgeta using a new fitted rating curve

iii) Mgeta River at Duthumi

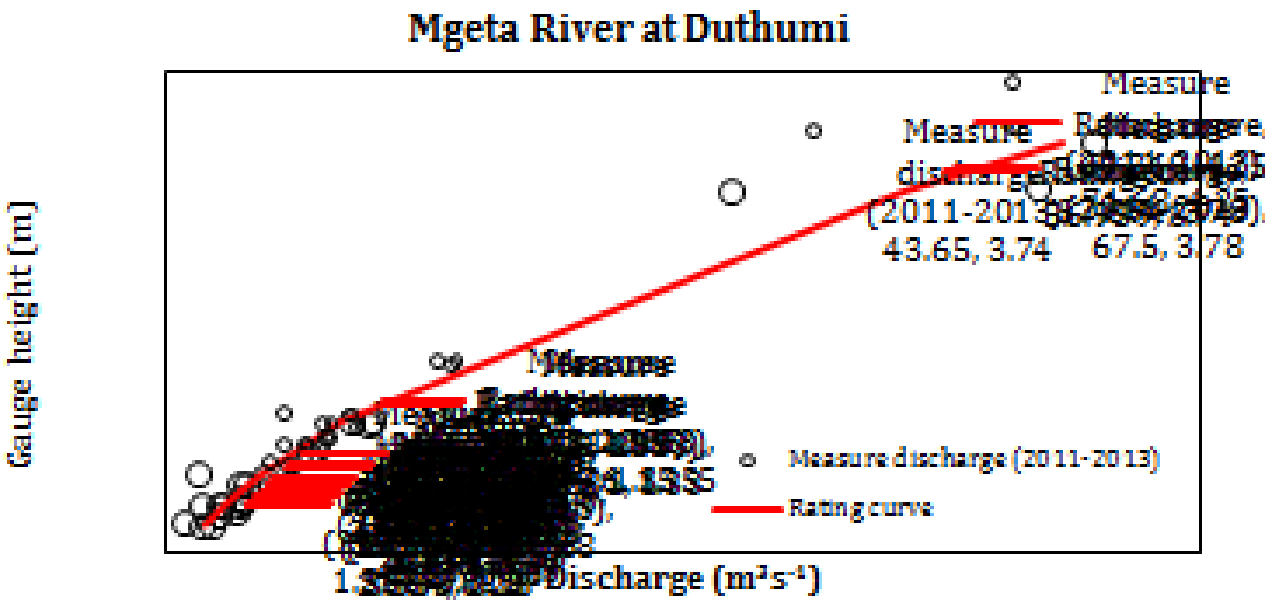

Figure 18: Rating curve for Mgeta River at Duthumi station (2011-2013)

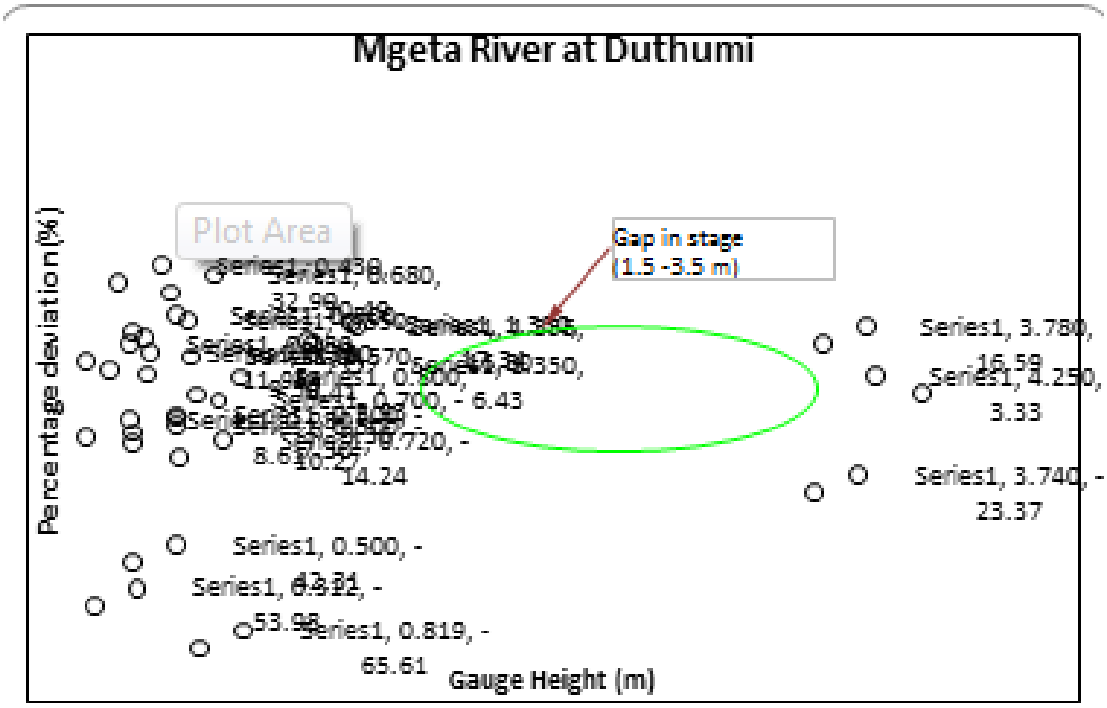

Figure 19: Stage-discharge deviation scatter diagram for Mgeta River rating curve at Duthumi station

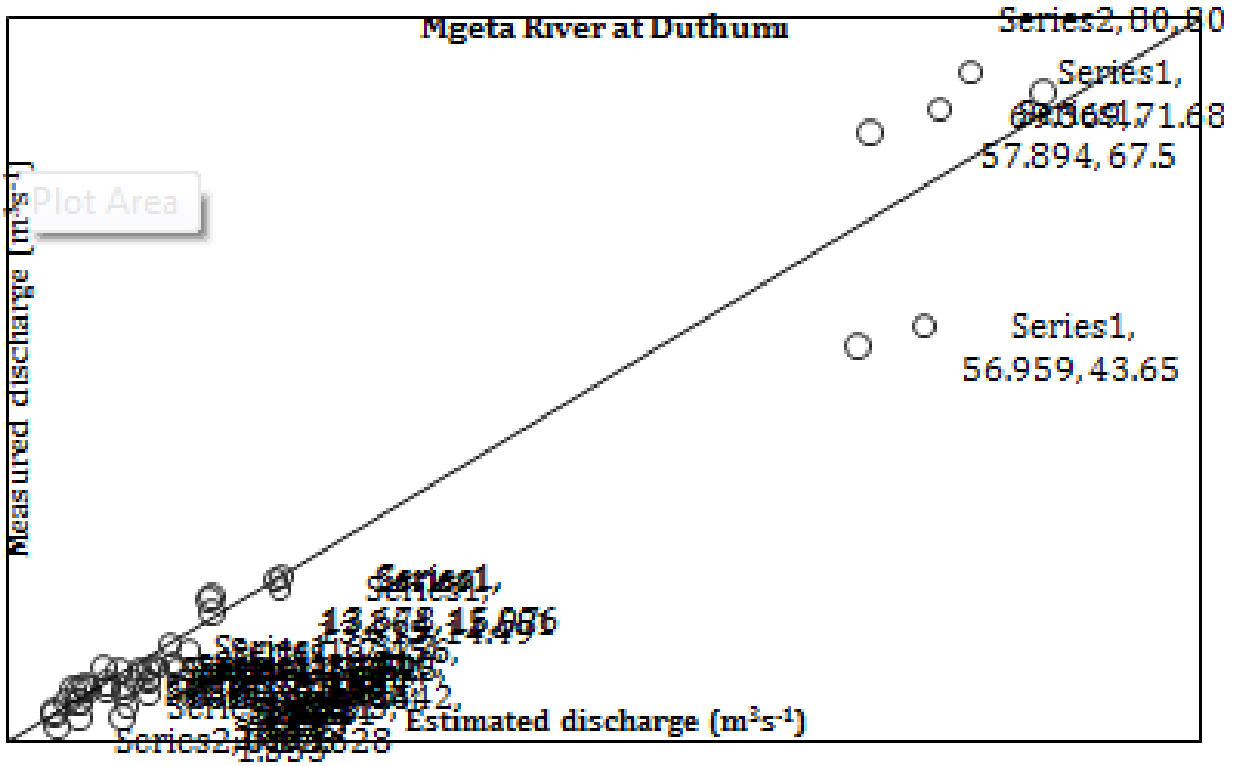

Figure 20: Comparison between estimated and measured discharges for Mgeta River at Duthumi using a new fitted rating curve (2011-2013)

iv) Ngerengere River at Mgude

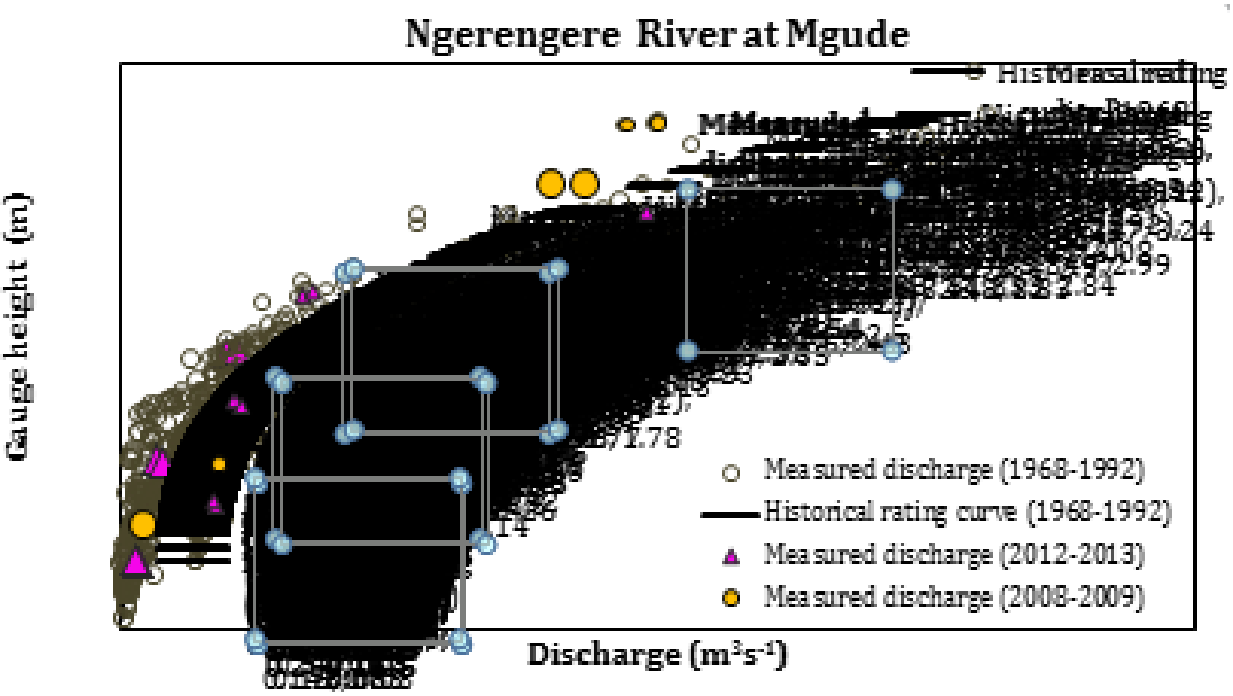

Figure 21: Old rating curve for Ngerengere River at Mgude station

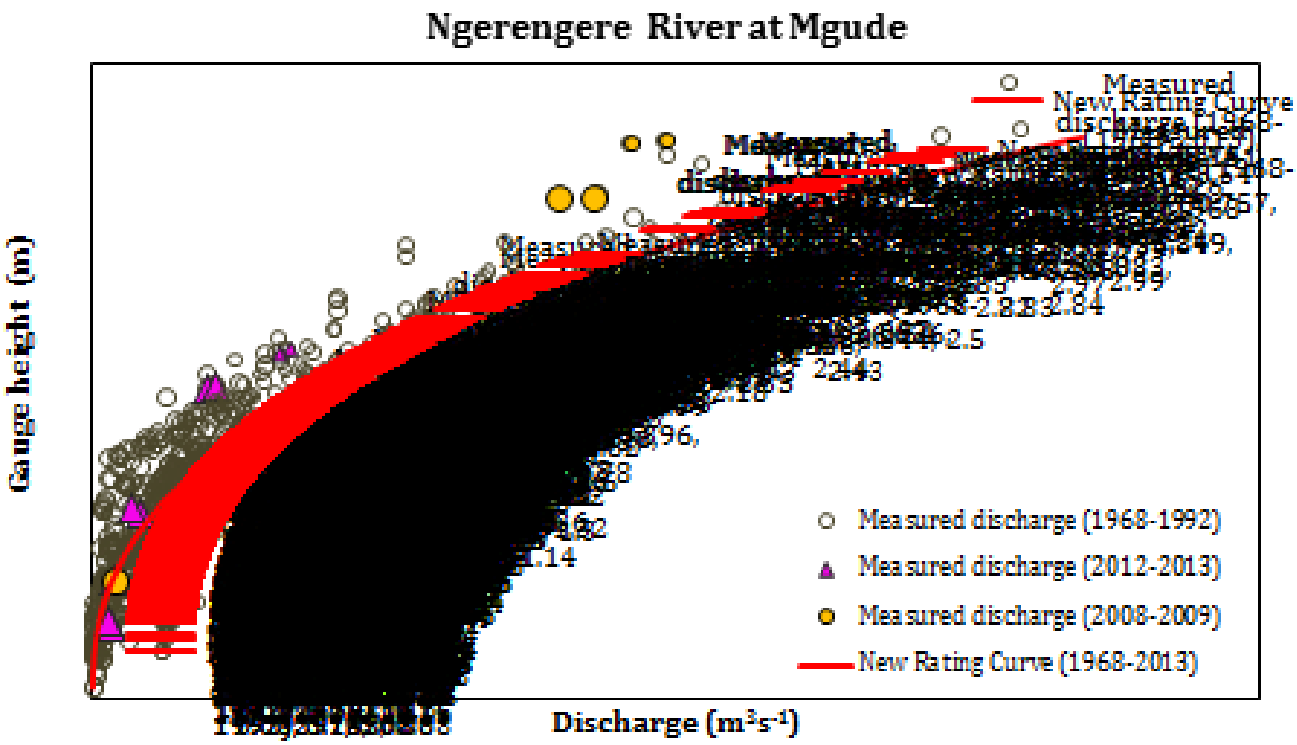

Figure 22: Fitted rating curves for Ngerengere River at Mgude station

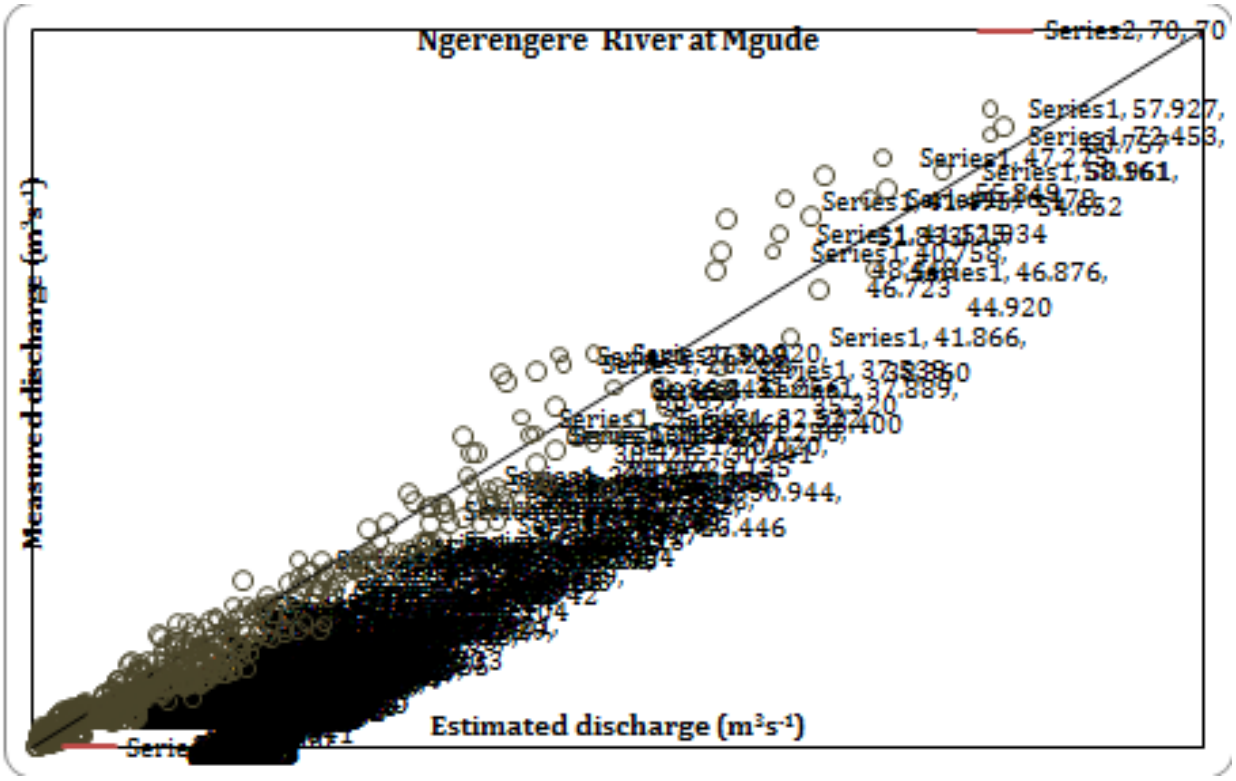

Figure 23: Comparison between estimated and measured discharges for Ngerengere River at Mgude station using a new fitted rating curve

v) Ngerengere River at Konga

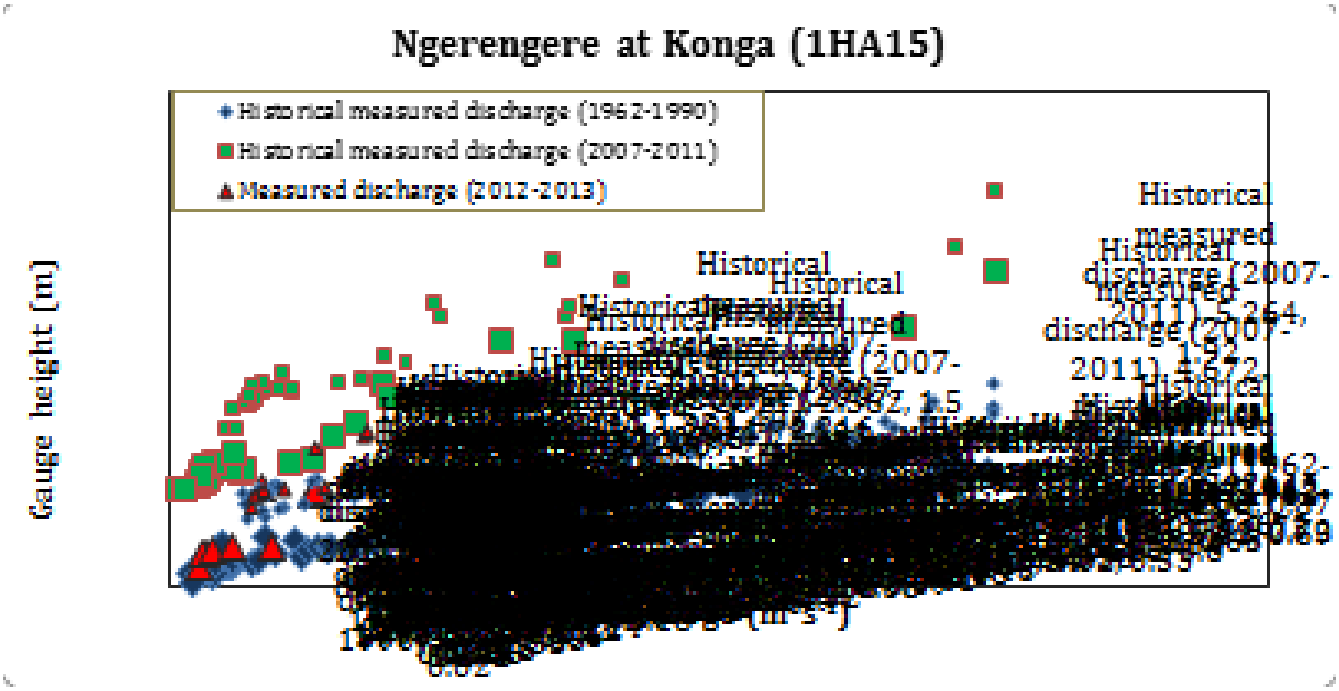

Figure 24: Plot of historical measurements (1962-1990) and recent measurements during the period 2007-2011 and 2012-2013 (The data reveal inconsistency possibly due to shift in section control).

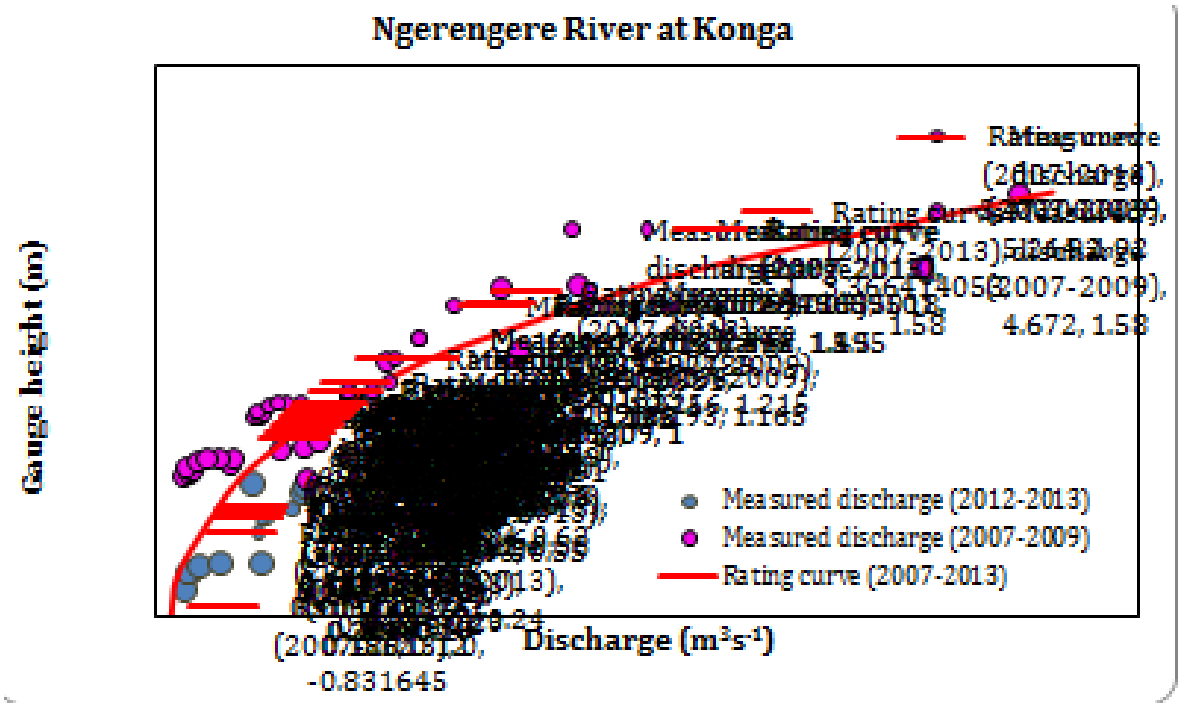

Figure 25: New rating curve for Ngerengere River at Konga station (2007-2013)

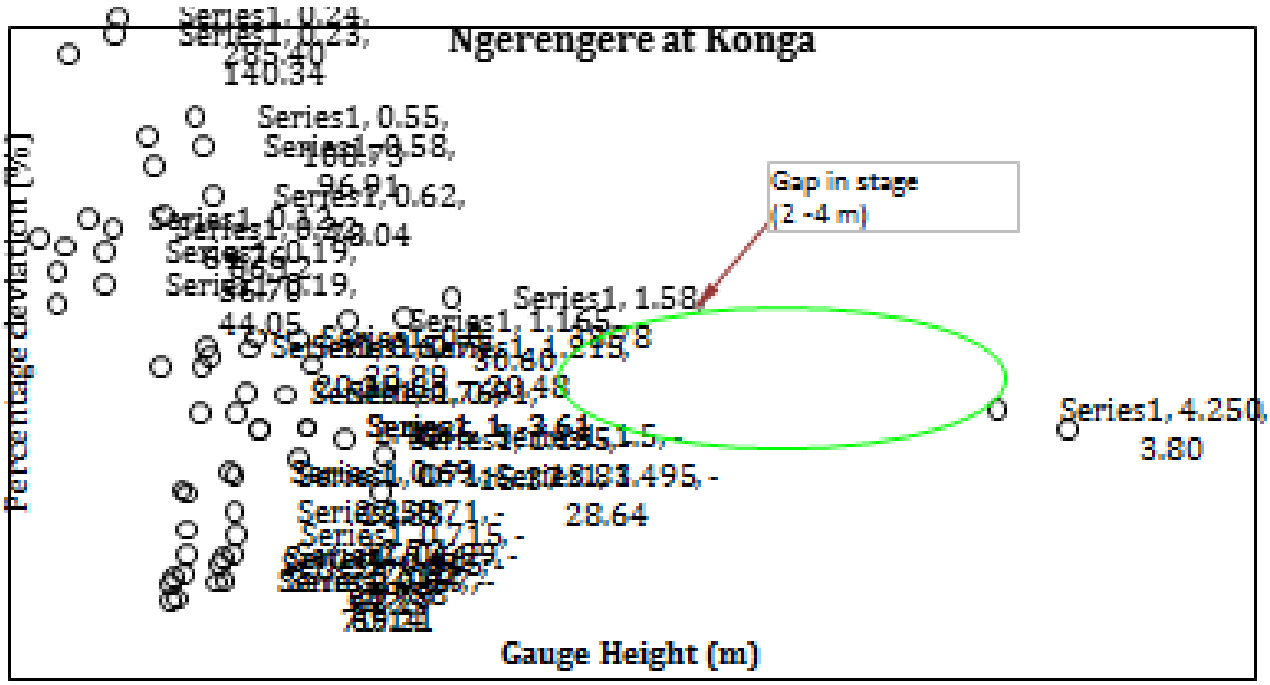

Figure 26: Stage-flow deviation scatter diagram for Ngerengere River rating curve at Konga station

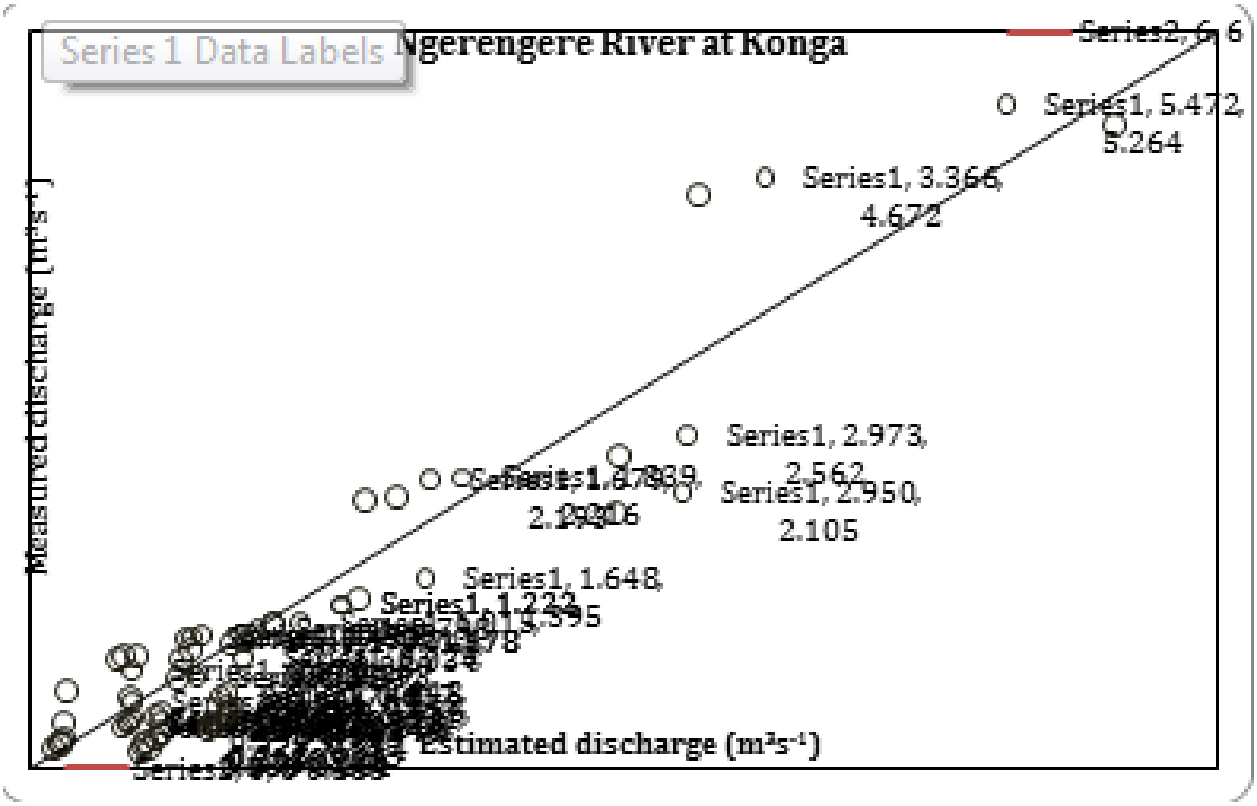

Figure 27: Comparison between estimated and measured discharges for Ngerengere River at Konga station using a new fitted rating curve

vi) Ruvu River at Morogoro-Dar es Salaam Bridge

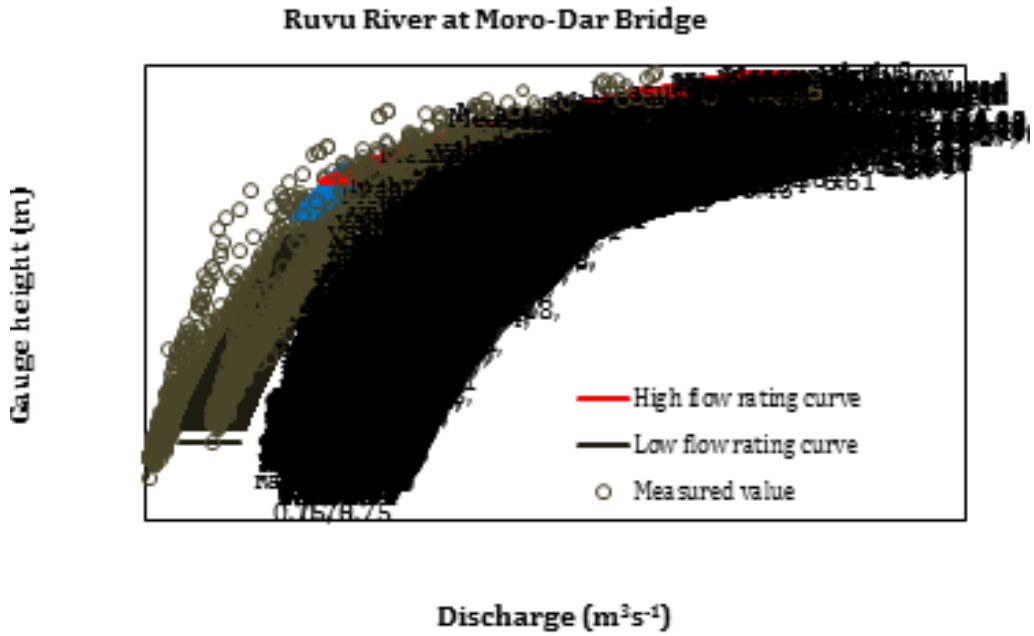

Figure 28: Historical rating curves and measured discharge for Ruvu River at Moro-Dar Road Bridge

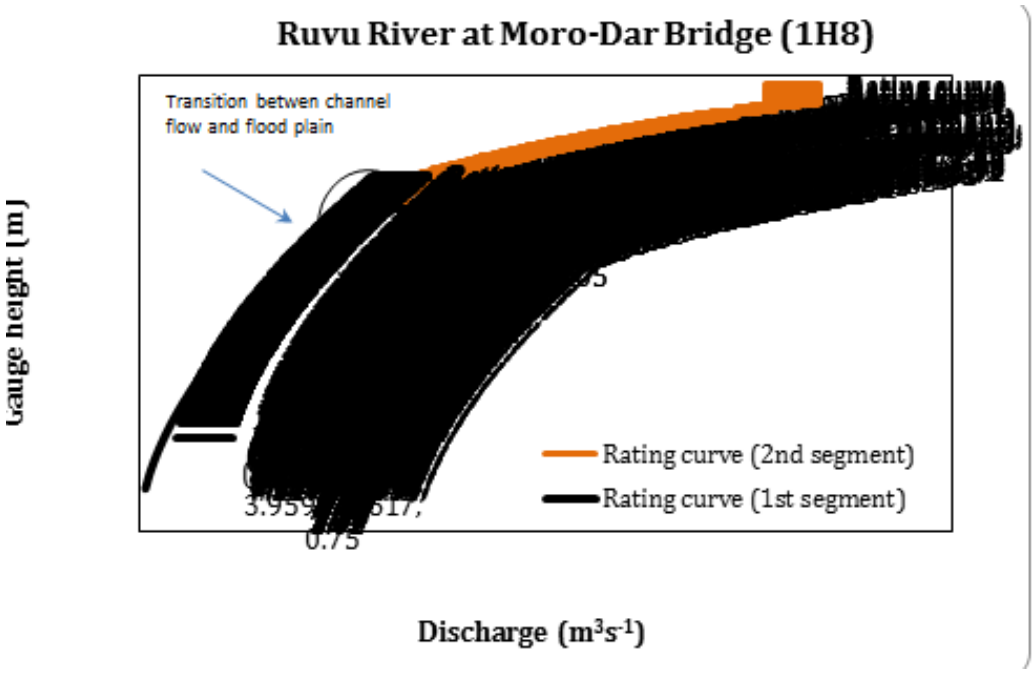

Figure 29: Fitted rating curves for different flow ranges for Ruvu River at Moro-Dar Road Bridge

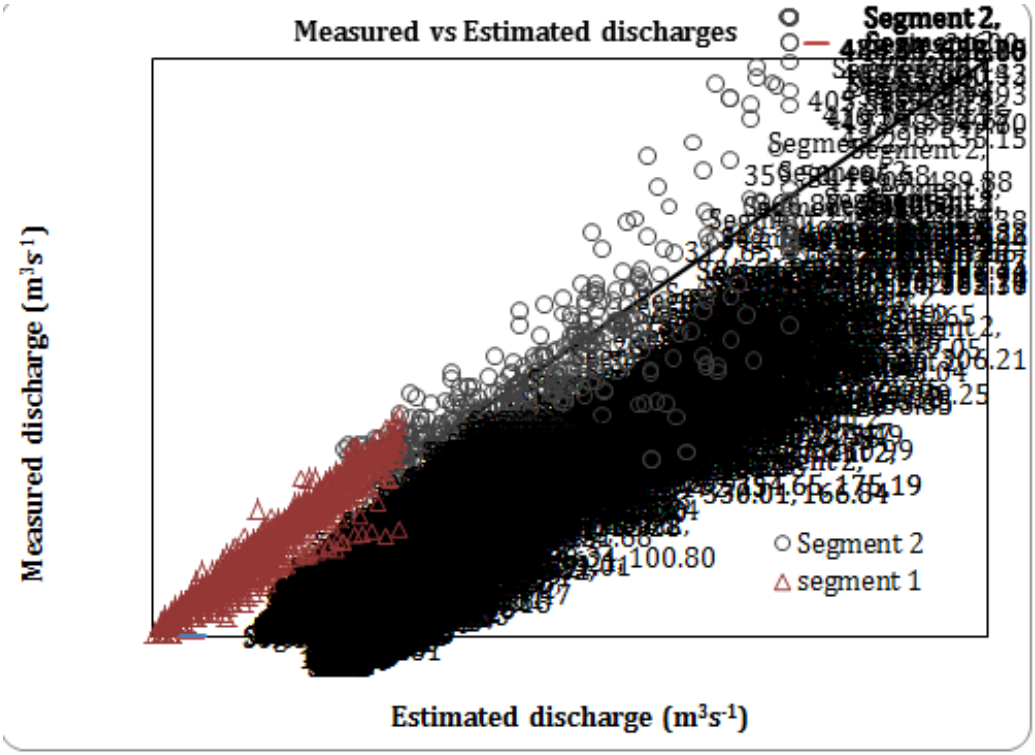

Figure 30: Comparison between estimated and measured discharges for Ruvu River at Morogoro – Dar es Salaam Bridge (1960-2013).

6.4.2 Numerical validation tests

Literature (e.g. URT/NORAD, 1979; DHV Consultant, 1999) provide methods for conducting statistical validation of the rating curves. The two criteria are commonly used to test a rating curve for absence of bias (URT/NORAD, 1979):

i) The average of the percentage differences between the measured discharges and the discharges estimated by means of the rating curve should not be significantly different from zero. This is tested using t-test.

ii) The number of positive and negative deviations of measured discharges from the rating curve should be evenly distributed, i.e. the difference in number of pluses and minuses should not be more than can be explained by chance fluctuations. This is tested by sign test.

Cautions are given that the two tests are only applicable for stations where the stage-discharge relation is permanent and not affected by variable backwater or highly unsteady flow conditions.

URT, (1979) further recommends that after the rating curve has been checked for absence of bias, it should next be checked for shifts in control. The errors due to shifting controls would be a systematic nature. This is checked by the run of sign test to reveal goodness of fit.

Test for absence from bias in signs

A well-balanced rating curve must ensure that the number of positive and negative deviations of the observed values from the rating curve is evenly distributed (DHV Consultant, 1999). That is, the difference in number between the two should not be more than can be explained by chance fluctuations. The test is employed to see if the curve has been established in a balanced manner so that the two sets of discharge values, observed and estimated (from the curve), may be reasonably supposed to represent the same population (DHV Consultant, 1999).

This test is performed by counting observed points falling on either side of the curve. If *Qm* is the observed value and *Qc* the estimated value, then the expression, *Qm* - *Qc* , should have an equal chance of being positive or negative (DHV Consultant, 1999). In other words, the probability of *Qm* - *Qc* being positive or negative is 0.5. Hence, assuming the successive signs to be independent of each other, the sequence of the differences may be considered as distributed according to the Binomial law *(p+q) N*, where N is the number of observations, and p and q, are the probabilities of occurrence of positive and negative values are 0.5 each. The expected number of positive signs is positive signs is Np. Its standard deviation is $\sqrt{Npq}$. The "t" statistic is then found by dividing the difference between the actual number of positive signs N_1 and expected number of positive signs Np by its standard deviation $\sqrt{Npq}$.

$$t = \frac{|N_1 - N_p| - 0.5}{\sqrt{Npq}}$$ ……. (Equation 2)

The resulting value is compared with the critical value of "t" statistic for 5% significance level for the degrees of freedom equal to the total number of stage discharge data. *If the value of the critical "t" statistic is more than that obtained for the observed data then it can be considered that the data does not show any bias with respect to sign of the deviations between observed and computed discharges* (DHV Consultant, 1999).

Test for absence from bias in values

This test is designed to see if a particular stage discharge curve, on average, yields significant under estimates or over estimates as compared to the actual observations on which it is based. (see for example Figure 10 for stage-flow deviation scattergrams). The percentage differences are first worked out as (DHV Consultant, 1999):

$$P = 100\,(Qm - Qc)/Qc$$ ..... (Equation 3)

If there are N observations and $P_1, P_2, P_3, \ldots, P_N$ are the percentage differences and P_{av} is the average of these differences, the standard error, *Se,* of P_{av} is given by:

$$Se = \sqrt{\frac{(\sum_{i=1}^{N} P_i - P_{av})^2}{N(N-1)}}$$ ..... (Equation 4)

The average percent P_{av} is tested against its standard error to see if it is significantly different from zero. The "t" statistic for in this case is computed as:

$$t = (P_{av} - 0) / Se$$ ..... (Equation 5)

If the critical value of "t" statistic for 5% significance level and N degrees of freedom is greater than the value computed above then it may be considered that there is no statistical bias in the observed values with respect to their magnitudes as compared with that obtained by the rating curve. The percentage differences have been taken as they are comparatively independent of the discharge volume and are approximately normally distributed about zero mean value for an unbiased curve (DHV Consultant, 1999).

The run of sign test – the Goodness of fit test

Due to changes in the flow regime, it is possible that long runs of positive and/or negative deviations are obtained at various stages. This may also be due to inappropriate fitting of the rating curve. This test is carried out for long runs of positive and negative deviations of the observed values from the stage-discharge curve. The test is designed to ensure a balanced fit in reference to the deviations over different stages (DHV Consultant, 1999).

The test is based on the number of changes of sign in the series of deviations (observed value minus expected or computed value). First of all, the signs of deviations, positive or negative, in discharge measurements in ascending order of stage are recorded. Then starting from the second sign of the series, "0" or "1" is placed under sign if the sign agrees or does not agree respectively with the sign immediately preceding it. For example,

\+ - + + + + - - - - + + + + -

1 1 0 0 0 1 0 0 0 1 0 0 0 1

If there are N numbers in the original series, then there will be (*N – 1*) numbers in the derived series 11000100010001. If the observed values are regarded as arising from random fluctuations about the values estimated from the curve, the probability of a change in sign could be taken to be 0.5.

However, this assumes that the estimated value is the median rather than the mean. If *N* is fairly large, a practical criterion may be obtained by assuming successive signs to be independent (i.e. by assuming that they arise only from random fluctuations), so that the number of "1"s (or "0"s) in the derived sequence of (*N – 1*) members may be judged as a binomial variable with parameters (*N – 1*) and 0.5. From the above derived series, the actual number of changes of sign is noted. The expected number of changes of sign is computed by multiplying total possible numbers (i.e. *N –1*) with the probability of change of sign (i.e. 0.5). The statistical significance of the departure of the actual number of change of signs from the expected number is known by finding the "t" statistic as follows:

$$t = \frac{|N' - (N-1)p| - 0.5}{\sqrt{(N-1)pq}} \quad \text{..... (Equation 6)}$$

where N' denotes the actual number changes of sign.

If the critical value of "t" statistic, for (*N – 1*) degrees of freedom, is more than that computed above then it can be considered to be having adequate goodness of fit (DHV Consultant, 1999). Otherwise, the results will indicate that there is significant bias in the fitted curve with respect to long runs of positive or negative deviations.

In this study, three testing criteria namely paired t-test, the sign test, and the run of sign test were applied. As highlighted above, the first two criteria are commonly used to test a rating curve for absence of bias, and the last one tests a rating curve for random fluctuations or goodness of fit. The null hypotheses of "no bias" and "non-random fluctuations" fail to be rejected when the test criterion, t is less than corresponding t - table value at 5% level of significance. The results of statistical validation of the developed rating curves are presented in Tables 8 and 9. Generally, the results in Table 8 suggest an absence of bias in the newly developed rating curves for all the stations except for 1H8. From Table 9, three stations namely 1H5, 1HB2 and 1HB1411 passed the goodness of fit test. The rest of the stations, 1HA15, 1HA9A and 1H8 the test criterion t is consistently greater than the critical value, leading to the rejection of the null hypothesis of the assumption of random fluctuations. Therefore, the test detected the presence of abnormal long runs of positive or negative deviations. This most likely indicates there is a systematic trend in the deviations with time, indicating that the rating curves need adjustment for a shift in control.

Table 8: Result of sign test (*a test for bias*)

S/N	Gauging station code	Total number of observations, *N*	Number of positive signs, *n1*	Expected number of positive signs, *np*	Standard error of np, SE	Test criterion, t	Critical t-value from T-Table at 5% level of significance	Remarks
1	1H5	36	16	18.0	3.0	1.463	1.96	Unbiased
2	1HB2	119	70	59.5	5.45	0.567	2.101	Unbiased
3	1HB1411	22	13	11	2.35	0.285	2.08	Unbiased
4	1HA15	494	301	247	11.11	1.570	1.96	Unbiased
5	1HA9A	32	17	16	2.83	0.177	1.96	Unbiased
6	1H8	286	125	143	8.456	2.188	1.96	Biased

Table 9: Result of run of sign test (*a goodness of fit test*)

S/N	Gauging station code	Total number of observations, *n*	Number of positive signs, *n1*	Expected number of changes in sign, *(n-1)p*	Standard error of (n-1)p, SE	Test criterion, t	Critical t-value from T-Table at 5% level of significance	Remarks
1	1H5	36	15	17.5	2.96	1.014	1.96	Non- random fluctuations
2	1HB2	119	49	59	5.43	1.93	2.101	Non- random fluctuations
3	1HB1411	22	11	10.5	2.29	0	2.08	Non- random fluctuations
4	1HA15	494	195	246.5	11.1	4.68	1.96	Random fluctuation, needs adjustment for shift in controls
5	1HA9A	32	8	15.5	2.78	-2.87	1.96	Random fluctuation, needs adjustment for shift in controls
6	1H8	286	119	142.5	8.441	2.84	1.96	Random fluctuation, needs adjustment for shift in controls

7.0 CONCLUSION AND RECOMMENDATIONS

7.1 Conclusions

Available historical stage-discharge measurements and existing rating curves for existing stations on the Ruvu have been collected. The data indicate that most of the stations were established in the early 1950s and discharge measurement in these stations continued until late 1980s. The period from early 1990s until mid 2000s shows that there were no measurements taken. Discharge measurement commenced in 2007 at some of the stations and not covering all the stations. Review of the rating relationships indicates validity up to the early 1980s for most of the stations and cannot be used to transform gauge heights (water levels) without modification. Based on the physical characteristics at the key stations, the gauging stations can be considered to have fair hydraulic controls. Special attention will be required to attend some observed threats at the channel hydraulic sections.

Cross-section survey at the key gauging stations was conducted and new plots produced. Check surveys were also conducted at key stations to adjust the gauges. Five out of the six key gauging stations were found to be out of range and were adjusted to the required reduced levels and related information documented. Discharge measurements were conducted between December 2012 and June 2013. Together with few prior measurements conducted since mid 2000s and some historical observations for some key gauging stations, new rating curves at the key gauging stations have been developed and evaluated through qualitative and quantitative methods assess validity and reliability of the rating curves. Results indicate that stage-discharge relationships require updating by new current meter measurements as for some stations the number of data points that were used to develop the rating relationships were too little. Outliers have been revealed in data records and this among others could be a result of use of un-calibrated current meter/sampling equipment, poor measurement techniques, inexperienced sampling technicians and/or computational errors.

The results revealed absence of bias in the newly developed rating curves for all the stations except for 1H8. The three stations namely 1H5, 1HB2 and 1HB1411 passed the goodness of fit test, while the rest of the stations, 1HA15, 1HA9A and 1H8 the test criterion t was found to be consistently greater than the critical value, leading to the rejection of the null hypothesis of the assumption of random fluctuations. Therefore, the test detected the presence of abnormal long runs of positive or negative deviations. This most likely indicates presence of systematic trend in the deviations with time, indicating that the rating curves need adjustment for a shift in control.

7.2 Recommendations

The findings from this study revealed a number of issues as presented in the document and the following are the recommendations towards improving estimates from rating curves for enhanced water resources management in the Ruvu sub-basin and the country as a whole:

i. The current meter equipment used have not been calibrated for long time and surpassed the recommended 25 measurements after which calibration should have been done. Therefore, there is a need to undertake calibration to minimize equipment errors and thus reduce the likeliness of outliers. Since the calibration of measuring of current meter could be considered a requirement country wide, establishment of calibration facility/tank is vital; and this is recommended to be housed at the Ministry of Water.

ii. The number of new current meter measurements used in developing the new rating curves for some stations were too few. Therefore, concerted effort is needed to increase the number of measured discharges at different stage so as to increase reliability of the rating curve equations.

iii. The three gauging stations (1H5, 1HB2 and 1HB1411) passed the goodness of fit and the bias test but failed on the required number of measurements for establishing a reliable rating curve. To improve the reliability of rating curves, more measurements are inevitable. In view of this, the following short, medium and long-term strategies are recommended for the WRBWO:

Short term:

- Continue with flow measurement at different ranges of flow stages. This also applies to medium and long-term strategies.
- Capacity building on rating curve development among the Water Basin Office Officials
- Calibrate the current meter(s)
- Conduct check survey before and after rain seasons

Medium term:

- Resurvey and ensure stability of the control sections
- Conduct check survey before and rain season

Long term:

- Ensure stability of the control sections
- Check and validate rating curves.

iv. The two gauging stations (1HA15 and 1HA9A) passed the biasness test, but failed the goodness of fit test and the required number of measurements for establishing a reliable rating curve. Therefore, in order to improve the reliability of rating curves, more measurements will be required as well as all the issues listed under (iii above) for short, medium and long-term strategies.

v. The station 1H8 passed the required number of discharge measurements for establishing a reliable rating, but failed the bias and the goodness of fit tests, implying a change on the stage-discharge relationship. Therefore, together with the recommendation (iii), there will be a need to develop new rating curve based on new measurements and the calibration of the station.

vi. The findings of study provide a sample test case of the rating curve situation in the Ruvu sub-basin. It is therefore recommended to the WRBWO to check and validate all the other existing stations' rating curves. For new stations, flow measurements should be conducted at variable stages to enable development of the rating curves. Surveying and documentation of the gauging sections cross-section and control sections will be paramount.

vii. The findings of this study are indicative of the situation country-wide. The study has revealed that discharge measurement continued until late 1980s and there are no or very few measurements done in the sub-basin from early 1990s until mid 2000s. This is indeed a situation in most of the basins in Tanzania, thus rendering most of the historical rating curves unsuitable for transforming post-1980s/90s stage data to discharge. Therefore, more financial resources will be needed to support development and validation of the rating curves. It is therefore recommended that the MoW through its WSDP and other donors make available additional funds to enable revisiting, testing and revision of rating curves on all major rivers in order to ensure higher confidence in the flow measurements.

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APPENDICES

Appendix 1: Check survey data

1. Ruvu River at Kibungo, 1H5

BS	IS	FS	IH	RL (m)	Error (m)	Remarks/ Gauge Range (m)	Reduced Level after adjustment of plates (m)
2.249			10.532	8.283		BM	
	1.532			9.000	0.00	8-9	9.0
	2.525			8.007	0.007	7-8	8.0
	3.528			7.004	0.004	6-7	7.0
	4.530			6.002	0.002	5-6	6.0
0.489		4.565	6.456	5.967		CP	
	1.506			4.950	0.05	4-5	5.0
	2.538			3.918	0.082	3-4	4.0
	3.585			2.871	0.13	2-3	3.0
	4.505			1.951	0.049	1-2	2.0
2.682		4.971	4.167	1.485		CP	
		3.149		1.018	0.018	0-1	1.0

2. Mgeta River at Mgeta, 1HB2

BS	IM	FS	IH	RL (m)	Error (m)	Remarks/ Gauge Range (m)	Reduced Level after adjustment of plates (m)
1.127			5.277	4.150		BM	
	0.278			4.999	0.001	4-5	5.0
	1.281			3.996	0.004	3-4	4.0
	2.278			2.999	0.001	2-3	3.0
	3.278			1.999	0.001	1-2	2.0
	4.278			0.999	0.001	0-1	1.0

3. Mgeta River at Duthumi, IHB1411

BS	IS	FS	IH	RL (m)	Error (m)	Remarks/ Gauge Range (m)	Reduced Level after adjustment of plates (m)
3.798		4.749	5.726	5.573		BM	
	4.73			0.996	0.004	0-1	1.0
	3.73			1.996	0.004	1-2	2.0
	2.724			3.002	0.002	2-3	3.0
	1.718			4.008	0.008	3-4	4.0
	0.718			5.008	0.008	4-5	5.0
2.627		1.677					

4. Ngerengere River at Konga, 1HA9A

BS	IS	FS	IH	RL (m)	Error (m)	Remarks/ Gauge Range (m)	Reduced Level after adjustment of plates (m)
0.835			6.435	5.600		TBM	
	0.394			6.041	0.041	5-6	5.5
	1.392			5.043	0.043	4-5	5.0
	2.433			4.002	0.002	3-4	4.0
	3.418			3.017	0.017	2-3	3.0
	4.508			1.927	0.073	1-2	2.0
3.245		4.880	4.800	1.555		CP	
	3.755			1.045	0.045	0-1	1.0

5. Ngerengere River at Mgude, 1HA15

BS	IS	FS	IH	RL (m)	Error (m)	Remarks/ Gauge Range (m)	Reduced Level after adjustment of plates (m)
0.224			6.489	6.265		BM	
	1.490			4.999	0.001	4-5	5.0
	2.490			3.999	0.001	3-4	4.0
	3.490			2.999	0.001	2-3	3.0
3.652		4.861	5.280	1.628		cp	
	3.280			2.000	0.000	1-2	2.0
		4.280		1.000	0.000	0-1	1.0

6. Ruvu River at Morogoro-Dar es Salaam Bridge, 1H8

BS	IS	FS	IH	RL (m)	Error (m)	Remarks/ Gauge Range (m)	Reduced Level after adjustment of plates (m)
0.36			7.13	6.77		BM	
	0.03			7.1	0.1	6-7	7.0
	1.089			6.041	0.041	5-6	6.0
0.478		2.07	5.538	5.06	0.06	4-5/CP	5.0
	1.479			4.059	0.059	3-4	4.0
	2.484			3.054	0.054	2-3	3.0
3.482		3.478	5.542	2.06	0.06	1-2	2.0
						Gauge plate no. 1 overtopped by water	

Appendix 2: River cross sections survey data

1. Ruvu River at Kibungo, 1H5

BS	I/S	FS	HI	RL	Chainage (m)	REMARKS
0.106			10.106	10	0	TBM
	0.478			9.628	2	
	0.938			9.168	4	
	1.638			8.468	6	
	2.292			7.814	8	
	2.855			7.251	10	
	3.715			6.391	12	
	4.450			5.656	14	
0.23		4.492	5.844	5.614	16	ON CONCRETE CP
	1.378			4.466	18	
	2.902			2.942	20	
	3.665			2.179	21	WER/B
	4.782			1.062	22	
	4.211			1.633	23	
	4.232			1.612	24	
	4.266			1.578	25	
	4.132			1.712	26	
	3.865			1.979	27	
	3.804			2.040	28	
	3.731			2.113	29	
3.852		3.758	5.938	2.086	30	CP
	3.805			2.133	31	
	3.802			2.136	32	
	3.852			2.086	33	
	3.900			2.038	34	
	4.028			1.910	35	CENTRE
	4.102			1.836	36	
	4.121			1.817	37	
	4.140			1.798	38	
	4.180			1.758	39	
	4.205			1.733	40	
	4.261			1.677	41	
	4.610			1.328	42	
	4.422			1.516	43	
	4.362			1.576	44	
	4.480			1.458	45	
	4.580			1.358	46	

	4.660			1.278	47	
	4.661			1.277	48	
4.761		4.668	6.031	1.270	49	CP
	4.782			1.249	50	
	4.744			1.287	51	
	4.695			1.336	52	
	4.499			1.532	52.5	
	3.848			2.183	54	
	3.652			2.379	56	
	2.382			3.649	58	
2.068		0.365		5.666	60	
2.02		0.305		5.726	62	
		0.295		5.736	64	

2. Mgeta River at Mgeta, 1HB2

BS	I/S	FS	HI	RL	DST	REMARKS
0.558			8.058	7.5	0	TBM
	0.866			7.192	1	
	1.010			7.048	2	
	1.215			6.843	3	
	1.434			6.624	4	
	1.118			6.940	5	
	2.145			5.913	6	
	2.695			5.363	7	
	3.268			4.790	8	
	3.516			4.542	9	
	4.300			3.758	10	
	4.275			3.783	11	
	4.444			3.614	11.5	WER/B
	4.521			3.537	12	
	4.722			3.336	12.5	
	4.460			3.598	13	
	4.885			3.173	13.5	
	4.825			3.233	14	
	4.735			3.323	14.5	
	4.646			3.412	15	
4.264		4.547	7.775	3.511	15.5	
	4.168			3.607	16	
	4.125			3.650	16.5	
	4.142			3.633	17	
	4.170			3.605	17.5	

	4.174			3.601	18	
	4.185			3.590	18.5	
	4.214			3.561	19	
	3.994			3.781	19.5	
	4.015			3.760	20	
	3.975			3.800	20.5	
	3.735			4.040	21	
	3.695			4.080	21.5	
	3.586			4.189	22	
	3.612			4.163	22.5	
	3.625			4.150	23	
	3.648			4.127	23.5	
	3.052			4.723	24	
2.420		3.565	6.630	4.210	24.5	
	1.622			5.008	25	
	1.318			5.312	25.5	
	1.225			5.405	26	
	1.018			5.612	27	
3.934		1.182	9.382	5.448	28	
	3.642			5.740	29	
	3.360			6.022	30	
	2.940			6.442	31	
		2.110		7.272	32	

3. Mgeta River at Duthumi, IHB1411

BS	I/S	FS	HI	RL	Chainage (m)	REMARKS
0.715			19.827	19.112	0	TBM
	0.760			19.067	2	
	0.785			19.042	4	
	1.078			18.749	5	
	2.162			17.665	7	
	2.432			17.395	8	
	2.889			16.938	9	
	3.275			16.552	10	
	3.935			15.892	11	
	4.516			15.311	12	
1.14		4.988	15.979	14.839		CP
1.252		1.692	15.539	14.287	12.5	
	1.779			13.760	12.5	WE L/B
	1.966			13.573	12.5	
	2.460			13.079	13.5	

	2.678			12.861	14	
	2.850			12.689	14.5	
	2.700			12.839	15	
	2.702			12.837	15.5	
	2.879			12.660	16	CENTRE
2.921		2.882	15.578	12.657	16.5	CP
	2.898			12.680	17	
	2.965			12.613	17.5	
	2.980			12.598	18	
	3.025			12.553	18.5	
	2.895			12.683	19	
	0.960			14.618	19.5	
	0.382			15.196	20	
1.969		0.07	17.477	15.508	20.5	CP
	1.725			15.752	21	
	1.285			16.192	21.5	
	1.078			16.399	22	
	1.010			16.467	22.5	
	0.942			16.535	23	
	0.701			16.776	23.5	
		0.245		17.232	24	LAST POINT

4. Ngerengere River at Konga, 1HA9A

BS	I/S	FS	HI	RL	Chainage (m)	REMARKS
0.715			10.715	10.000	0	TBM
	0.760			9.955	1	
	0.785			9.930	2	
	1.078			9.637	3	
	2.162			8.553	4	
	2.432			8.283	5	
	2.889			7.826	6	
	3.275			7.440	7	
	3.935			6.780	8	
	4.516			6.199	9	
1.140		4.988	6.867	5.727	10	
1.252		1.692	6.427	5.175	10.5	
	1.779			4.648	11	
	1.966			4.461	11.5	
	2.460			3.967	12	
	2.678			3.749	12.5	
	2.850			3.577	13	

	2.700			3.727	13.5	
	2.702			3.725	14	
	2.879			3.548	14.5	
2.921		2.882	6.466	3.545	15	
	2.898			3.568	15.5	
	2.965			3.501	16	
	2.980			3.486	16.5	
	3.025			3.441	17	
	2.895			3.571	17.5	
	0.860			5.606	18	
	0.382			6.084	18.5	
1.009		0.070	7.405	6.396	19	WE R/B
	1.725			5.680	19.5	
	1.285			6.120	20	
	1.078			6.327	20.5	
	1.010			6.395	21	
	0.942			6.463	21.5	
	0.701			6.704	22	
		0.245		7.160	22.5	

5. Ngerengere River at Mgude, 1HA15

BS	I/S	FS	HI	RL	Chainage (m)	REMARKS
0.52			10.52	10	0	TBM
	0.602			9.918	2	
	0.665			9.855	4	
	1.030			9.490	6	
	1.283			9.237	7	
	1.410			9.110	10	
	1.868			8.652	12	
	2.049			8.471	14	
	2.210			8.310	16	
	2.633			7.887	18	
	2.801			7.719	20	
	3.149			7.371	22	
	3.464			7.056	24	
	4.510			6.010	26	
	4.800			5.720	28	
2.66		4.973	8.207	5.547	29	
	2.758			5.449	30	
	2.747			5.460	31	
	2.800			5.407	32	

	3.002			5.205	33	
3.39		3.22	8.377	4.987	34	CP
	3.512			4.865	35	WE L/B
	3.675			4.702	36	
	3.962			4.415	37	
	4.001			4.376	38	CENTRE
	3.976			4.401	39	
	3.990			4.387	40	
	3.879			4.498	41	
	3.829			4.548	42	
	3.710			4.667	43	
	3.700			4.677	44	
	3.508			4.869	45	
	3.493			4.884	46	
	3.555			4.822	47	
	3.058			5.319	48	
4.302		2.612	10.067	5.765	49	
	4.123			5.944	50	
	3.720			6.347	51	
	3.108			6.959	52	
	2.635			7.432	53	
1.042		1.872	9.237	8.195	CP	
2.282		0.42	11.099	8.817	54	
	1.688			9.411	55	
1.485		1.66	10.924	9.439	CP	
	1.122			9.802	56	
	1.002			9.922	58	
	0.56			10.364	60	
			0.772	10.152	64	

6. Ruvu River at Morogoro –Dar es Salaam Bridge, 1H8

BS	I/S	FS	HI	RL	Chainage (m)	REMARKS
0.190			9.890	9.7	0	BM
	0.712			9.178	2	
	0.926			8.964	4	
	1.052			8.838	6	
	1.139			8.751	8	
	1.169			8.721	10	
	1.315			8.575	12	
	1.419			8.471	14	
	1.375			8.515	16	

BS	I/S	FS	HI	RL	Chainage (m)	REMARKS
	1.448			8.442	18	
	1.512			8.378	20	
	1.586			8.304	22	
	1.649			8.241	24	
	1.683			8.207	26	
	1.775			8.115	28	
	1.725			8.165	30	
	1.828			8.062	32	
	1.898			7.992	34	
	1.861			8.029	36	
	1.779			8.111	38	
1.908		1.925	9.873	7.965	40	CP
	1.870			8.003	42	
	1.941			7.932	44	
	2.002			7.871	46	
	1.899			7.974	48	
	2.001			7.872	50	
	2.049			7.824	52	
	2.070			7.803	54	
	2.170			7.703	56	
	2.084			7.789	58	
	1.971			7.902	60	
	1.872			8.001	62	
	1.868			8.005	64	
	1.989			7.884	66	
	1.985			7.888	68	
	1.900			7.973	70	
	1.902			7.971	72	
	2.038			7.835	74	
	2.061			7.812	76	
0.215		2.072	8.016	7.801	78	CP
	1.122			6.894	80	
	2.212			5.804	82	
	3.059			4.957	84	
	3.825			4.191	84.5	
1.84		2.233	7.623	5.783	85	
	2.712			4.911	86	
	3.348			4.275	87	
	3.938			3.685	88	
	4.184			3.439	89	
	3.667			3.956	90	

BS	I/S	FS	HI	RL	Chainage (m)	REMARKS
	3.016			4.607	91	
	2.902			4.721	92	
	2.989			4.634	93	
	3.070			4.553	94	
	3.082			4.541	95	
	3.172			4.451	96	
	3.342			4.281	97	
	3.469			4.154	98	
3.74		3.68	7.683	3.943	99	
	3.803			3.880	101	CP
	3.888			3.795	102	
	3.799			3.884	103	
	3.755			3.928	104	
	3.798			3.885	105	
	3.799			3.884	106	
	3.768			3.915	107	
	3.835			3.848	108	
	3.871			3.812	109	
	3.948			3.735	110	
	3.919			3.764	111	
	3.872			3.811	112	
	3.402			4.281	113	
	2.821			4.862	114	
	1.920			5.763	115	
	1.189			6.494	116	WE R/B
3.32		0.88	10.123	6.803	117	
	1.753			8.370	118	CP
	1.938			8.185	119	
	1.345			8.778	120	
	1.321			8.802	121	
	1.415			8.708	122	
	1.190			8.933	123	
	1.040			9.083	124	
		0.941		9.182	125	

Appendix 3: Recent discharge measurements

1. Ruvu at Kibungo, 1H5

No.	Date	Gauge Height (m)	Width (m)	Area (m2)	Velocity (m/s)	Discharge (m3/s)	Source	Method/measurement tool used
1	20/12/2012	0.48	30.3	16.341	0.42	7.691	This study	Large propeller current meter
2	20/12/2012	0.48	29	18.49	0.398	7.357	This study	Pigmy current meter
3	22/12/2012	0.44		15.918	0.404	6.434	This study	Large propeller current meter
4	15/01/2013	0.48	30	18.125	0.447	8.096	This study	Large propeller current meter
5	28/02/2013	0.34	29	5.896	0.508	2.995	This study	Pigmy current meter
6	13/04/2013	1.04	34	44.81	0.62	27.78	This study	Q-Liner Digital currentmeter
7	13/04/2013	1.1	34	49.81	0.66	32.87	This study	Q-Liner Digital currentmeter
8	14/04/2013	0.85	30	33.87	0.54	18.29	This study	Q-Liner Digital currentmeter
9	20/05/2013	0.65	30.6	22.32	0.684	15.27	This study	Large propeller current meter
10	21/05/2013	0.65	34	24.53	0.558	13.682	This study	
11	09-01-2007	0.8		32.156	0.666	21.416	JICA/Hydata	
12	27-03-2007	0.655		22.098	0.642	14.187	JICA/Hydata	
13	01-05-2007	0.696		17.813	1.372	24.440	JICA/Hydata	
14	01-12-2007	0.54		19.663	0.617	12.132	JICA/Hydata	
15	02-05-2008	1.78		32.387	1.436	46.508	JICA/Hydata	
16	03-05-2008	1.49		30.041	1.413	42.448	JICA/Hydata	
17	22-01-2009	0.32		18.961	0.255	4.835	JICA/Hydata	
18	28-01-2010	0.38		12.434	0.742	9.226	JICA/Hydata	
19	22-12-2010	0.4		18.860	0.314	5.926	JICA/Hydata	
20	15-07-2011	0.47		18.512	0.437	8.081	JICA/Hydata	
21	09-10-2011	0.81		28.540	0.660	18.824	JICA/Hydata	
22	10-11-2011	0.39		14.229	0.414	5.897	JICA/Hydata	
23	02-12-2011	0.417		15.912	0.395	6.287	JICA/Hydata	
24	17-01-2012	0.595		18.590	0.637	11.841	JICA/Hydata	
25	10-01-2010	0.31				4.09	Kassambili	
26	31-03-2010	0.55				11.078	Kassambili	
27	09-06-2010	0.3				3.479	Kassambili	
28	10-10-2010	0.297				3.63	Kassambili	
29	31-10-2010	0.45				9.038	Kassambili	
30	16-11-2010	0.43				8.61	Kassambili	
31	26-6-2011	0.46				16.659	Kassambili	
32	13-8-2011	0.45				6.219	Kassambili	
33	10-09-2011	0.78				18.225	Kassambili	
34	03-05-2012	0.46	30.5	13.828	0.495	6.845	WetseasonEFA	
35	03-05-2012	0.44	30.5	13.168	0.486	6.406	WetseasonEFA	
36	03-05-2012	0.46	30.5	13.728	0.522	7.163	WetseasonEFA	

2. Mgeta at Mgeta, 1HB2

Sno	Date	Gauge Height (m)	Width (m)	Area (m2)	Velocity (m/s)	Discharge (m3/s)	Source	Method/measurement tool used
1	04-02-2010	0.5		3.219	0.374	1.204	JICA/Hydata	
2	06-05-2008	0.71		5.687	1.109	6.307	JICA/Hydata	
3	12-01-2007	0.712		6.191	0.968	5.993	JICA/Hydata	
4	05-05-2008	0.74		5.848	1.183	6.918	JICA/Hydata	

5	13-08-2011	0.47				1.129		
6	04-02-2010	0.5				1.204		
7	18/12/2012	0.43	7.1	1.718	0.834	1.432	This study	Pigmy current meter
8	18/12/2012	0.43	7.1	1.792	0.812	1.454	This study	Acoustic Digital Currentmeter (ADC)
9	20/02/2013	0.438	7.4	1.962	0.767	1.505	This study	Pigmy current meter
10	12/1/2013	0.44	6.9	1.87	0.712	1.332	This study	Large propeller current meter
11	12/1/2013	0.44	6.9	1.989	0.72	1.433	This study	Pigmy current meter
12	19/02/2013	0.44	7.4	1.97	0.508	1.539	This study	Pigmy current meter
13	21/02/2013	0.44	7.5	1.97	1.587	1.539	This study	Pigmy current meter
14	19/02/2013	0.45	7.5	2.005	0.789	1.582	This study	Large propeller current meter
15	21/02/2013	0.51	7.5	2.684	0.883	2.369	This study	Large propeller current meter
16	21/02/2013	0.51	7.5	2.854	0.926	2.643	This study	Acoustic Digital Currentmeter (ADC)
17	28/04/2013	0.54	11.55	3.866	0.926	3.578	This study	Large propeller current meter
18	27/04/2013	0.55	11.9	3.889	0.936	3.639	This study	Large propeller current meter
19	26/04/2013	0.57	11.6	4.368	0.948	4.143	This study	Large propeller current meter
20	30/05/2013	0.51	11.3	3.553	0.913	3.245	This study	Large propeller current meter
21	1/6/2013	0.5	11.3	3.2	0.849	2.716	This study	Large propeller current meter

3. Mgeta at Duthumi

	Date	Gauge Height (m)	Width (m)	Area (m2)	Velocity (m/s)	Discharge (m3/s)	Useful pts	Method/measurement tool used
1	12-08-2011	0.28				2.884		
2	30-07-2011	0.38				4.227		
3	09-10-2011	0.5				4.293		
4	15-07-2011	0.5		13.75	0.202	2.76	JICA/HYDATA	DDCA (Qliner)
5	09-10-2011	0.5		10.149	0.437	4.435	JICA/HYDATA	DDCA (ADC)
6	10-11-2011	0.312		3.568		1.553	JICA/HYDATA	WRBWB (ADC)
7	02-12-2011	0.819		6.212		2.628	JICA/HYDATA	WRBWB (ADC)
8	17-01-2012	0.68		22.872	0.361	8.256	JICA/HYDATA	WRBWB (Qliner)
9	6/3/2012	0.55	20.30	9.915	0.618	6.131		
10	6/3/2012	0.50	20.30	9.01	0.636	5.739		
11	6/3/2012	0.43	28.00	11.14	0.505	5.628		
12	6/3/2012	0.70	19.00	12.495	0.503	6.291		
13	21/12/2012	0.8	15.2	14.816	0.516	7.675	This study	Large propeller current meter
14	22/12/2012	0.57	15.09	10.383	0.559	5.813	This study	Large propeller current meter
15	16/01/2013	0.72	15.2	13.251	0.433	5.741	This study	Large propeller current meter
16	27/02/2013	0.28	13.3	6.673	0.529	3.533	This study	Large propeller current meter
17	15/04/2013	3.78	28	97.83	0.69	67.5	This study	Q-Liner Digital currentmeter
18	15/04/2013	3.74	28	83.94	0.52	43.65	This study	Q-Liner Digital currentmeter
19	16/04/2013	4.25	30	102.4	0.7	71.68	This study	Q-Liner Digital currentmeter
20	22/05/2013	1.35	25	20.834	0.695	14.49	This study	Large propeller current meter
21	22/05/2013	1.355	30	21.986	0.727	15.976	This study	Large propeller current meter
22	25/05/2013	1.33	27	20.06	0.782	15.681	This study	

4. Ngerengere at Mgude

Sno.	Date	Gauge Height (m)	Width (m)	Area (m2)	Velocity (m/s)	Discharge (m3/s)	Source	Method/measurement tool used
1	11/1/2013	0.46	8.5	2.488	0.537	1.337	This study	
2	11/1/2013	0.46	8.5	2.368	0.556	1.317	This study	Large propeller current meter
3	26/02/2013	0.5	8.1	1.79	0.645	1.154	This study	Pigmy current meter
4	13-06-2009	0.76		3.173	0.502	1.593	JICA/HYDATA	
5	25/05/2013	1.17	10.6	6.256	0.5113	3.199	This study	
6	24/05/2013	1.21	15	5.085	0.531	2.7	This study	Qliner Digital Current meter
7	10/4/2013	1.95	20.5	20.15	0.39	7.86	This study	Large propeller current meter
8	10/4/2013	1.98	19	17.07	0.5	8.54	This study	Qliner Digital Current meter
9	11/4/2013	2.54	28	56.72	0.59	33.46	This study	Qliner Digital Current meter
10	19-04-2008	3.161		41.224	0.776	31.99	JICA/HYDATA	
11	18-04-2008	3.17		43.301	0.794	34.381	JICA/HYDATA	

5. Ngerengere at Konga

SN.	Date	Gauge Height (m)	Width (m)	Area (m2)	Velocity (m/s)	Discharge (m3/s)	Source	Method/measurement tool used
1	14/01/2013	0.12	3	0.351	0.529	0.186	This study	Pigmy Current meter
2	19/12/2012	0.19	2.92	0.578	0.386	0.223	This study	Pigmy Current meter
3	19/12/2012	0.19	2.95	0.514	0.399	0.205	This study	Pigmy Current meter
4	24/02/2013	0.22	2.9	0.545	0.483	0.263	This study	Large current meter
5	23/02/2013	0.23	2.7	0.708	0.556	0.394	This study	Large current meter
6	22/02/2013	0.24	3.3	1.037	0.631	0.654	This study	Large current meter
7	28/04/2013	0.55	3.7	1.614	0.559	0.903	This study	Large current meter
8	27/04/2013	0.58	4.1	1.807	0.51	0.922	This study	Large current meter
9	31/05/2013	0.6	3.62	1.357	0.437	0.593	This study	
10	26/04/2013	0.62	3.84	1.914	0.483	0.924	This study	
11	23-12-2008	0.64		0.389	0.419	0.163	This study	Large current meter
12	26-03-2008	0.645		0.468	0.434	0.203	JICA/HYDATA	
13	26-03-2009	0.66		0.435	0.517	0.225	JICA/HYDATA	
14	29-07-2009	0.67		0.38	0.476	0.181	JICA/HYDATA	Large current meter
15	24-01-2008	0.69		0.878	0.509	0.447	JICA/HYDATA	
16	18-12-2007	0.699		0.533	0.478	0.255	JICA/HYDATA	
17	22-04-2009	0.71		0.655	0.704	0.461	JICA/HYDATA	
18	24-06-2009	0.71		0.604	0.614	0.371	JICA/HYDATA	
19	08-10-2008	0.715		0.557	0.564	0.314	JICA/HYDATA	
20	09-06-2009	0.76		1.699	0.439	0.746	JICA/HYDATA	
21	19-06-2008	0.77		0.934	0.955	0.892	JICA/HYDATA	
22	2/2/2013	0.8	3.8	2.029	0.487	0.989	JICA/HYDATA	
23	23-02-2009	0.91		5.744	0.18	1.034	JICA/HYDATA	
24	12-01-2007	1		2.035	0.579	1.178	JICA/HYDATA	
25	12-06-2007	1		2.035	0.579	1.178	JICA/HYDATA	
26	13-05-2008	1.155		1.748	0.798	1.395	JICA/HYDATA	
27	07-11-2008	1.165		2.421	0.906	2.193	JICA/HYDATA	
28	07-05-2009	1.215		3.099	0.715	2.216	JICA/HYDATA	
29	05-05-2009	1.495		4.413	0.477	2.105	JICA/HYDATA	
30	22-04-2008	1.5		4.365	0.587	2.562	JICA/HYDATA	
31	16-11-2007	1.58		5.575	0.838	4.672		
32	15-04-2008	1.92		8.277	0.636	5.264		

6. Ruvu at Morogoro-Dar Bridge

Sno	Date	Gauge Height (m)	Width (m)	Area (m2)	Velocity (m/s)	Discharge (m3/s)	Source	Method/measurement tool used
1	01-02-2009	1.090		16.135	0.407	6.567	JICA/HYDATA	
2	11-06-2009	2.340		49.751	0.510	25.373	JICA/HYDATA	
3	12-05-2009	5.610		176.610	0.963	170.075	JICA/HYDATA	
4	13-05-2009	5.670		180.959	0.731	132.281	JICA/HYDATA	
5	14-05-2009	5.700		173.963	0.845	146.999	JICA/HYDATA	
6	16-04-2008	6.485		185.588	0.899	166.844	JICA/HYDATA	
7	17-04-2008	6.590		220.090	0.796	175.192	JICA/HYDATA	
8	24/12/2013	1.750	30.700	29.330	0.543	15.933	This study	Large propeller current meter
9	25/02/2013	1.790	32.000	34.705	0.469	16.292	This study	Large propeller current meter
10	10/1/2013	2.190	34.300	45.912	0.562	25.278	This study	Large propeller current meter
11	29/05/2013	2.874	34.000	92.100	0.416	38.271	This study	
12	4/4/2013	5.540	82.000	288.900	0.480	138.410	This study	Q-Liner Digital currentmeter
13	5/4/2013	5.650	82.000	275.500	0.560	154.280	This study	Q-Liner Digital currentmeter
14	6/4/2013	5.780	90.000	286.800	0.620	177.820	This study	Q-Liner Digital currentmeter
15	7/4/2013	5.950	92.000	278.300	0.680	189.260	This study	Q-Liner Digital currentmeter
16	7/4/2013	5.980	94.000	375.600	0.540	202.800	This study	Q-Liner Digital currentmeter

Appendix 3: Historical discharge measurements since 1950s

1. Ruvu River at Kibungo

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
1	05-03-1960	1.189	0.919	31.121	28.6
2	10-03-1960	0.61	0.37	10.208	3.777
3	01-08-1960	0.61	0.38	10.037	3.814
4	04-10-1960	1.814	1.173	46.471	54.51
5	12-05-1961	1.128	0.747	35.596	26.59
6	02-01-1962	1.006	0.654	28.231	18.463
7	05-03-1962	1.905	1.176	53.865	63.345
8	10-10-1962	0.762	0.42	17.193	7.221
9	01-03-1963	0.975	0.66	25.914	17.103
10	10-05-1963	0.594	0.349	10.871	3.794
11	06-08-1963	0.847	0.58	20.428	11.848
12	03-04-1964	0.829	0.557	20.336	11.327
13	03-05-1964	0.823	0.533	19.424	10.353
14	03-08-1964	0.957	0.632	24.437	15.444
15	12-08-1964	0.735	0.387	19.318	7.476
16	05-01-1965	1.073	0.699	33.907	23.701
17	05-02-1965	1.045	0.722	32.514	23.475
18	05-03-1965	1.027	0.689	32.591	22.455
19	05-05-1965	0.991	0.651	30.665	19.963
20	05-07-1965	1.052	0.744	31.97	23.786
21	05-10-1965	0.957	0.573	29.058	16.65
22	05-11-1965	1.122	0.812	33.617	27.297
23	05-04-1966	1.134	0.748	34.128	25.528
24	05-04-1966	1.134	0.764	34.139	26.082
25	05-04-1966	1.131	0.696	34.411	23.95
26	05-05-1966	1.289	0.88	39.722	34.955
27	05-05-1966	1.298	0.868	39.726	34.482
28	05-05-1966	1.28	0.261	132.184	34.5
29	05-06-1966	1.128	0.796	34.168	27.198
30	05-06-1966	1.128	0.79	34.858	27.538
31	05-06-1966	1.122	0.764	33.505	25.598
32	05-07-1966	1.097	0.736	32.848	24.176
33	05-07-1966	1.097	0.746	32.543	24.277
34	06-07-1966	1.097	0.756	32.874	24.853
35	05-09-1966	1.058	0.709	31.116	22.061
36	05-09-1966	1.061	0.686	31.917	21.895
37	06-09-1966	1.061	0.684	31.886	21.81
38	05-10-1966	1.036	0.658	32.302	21.255
39	05-10-1966	1.036	0.645	32.31	20.84
40	05-10-1966	1.036	0.648	32.293	20.926

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
41	04-01-1967	0.695	0.403	18.015	7.26
42	04-02-1967	0.64	0.374	15.781	5.902
43	04-03-1967	1.253	1.048	32.609	34.174
44	05-05-1967	1.442	0.988	49.913	49.314
45	05-05-1967	2.234	0.118	83.797	9.888
46	05-06-1967	1.615	1.055	56.426	59.529
47	04-07-1967	0.869	0.58	23.841	13.828
48	05-07-1967	1.783	0.987	69.68	68.774
49	04-08-1967	1.5	1.15	47.189	54.267
50	06-09-1967	1.189	0.842	37.816	31.841
51	05-10-1967	1.524	0.956	55.915	53.455
52	05-12-1967	1.28	0.907	45.169	40.968
53	12-05-1968	1.03	0.674	28.951	19.513
54	03-06-1968	0.951	0.708	24.85	17.594
55	12-05-1969	0.823	0.46	22.843	10.508
56	10-08-1969	0.777	0.44	19.523	8.59
57	04-11-1969	1.183	0.79	36.811	29.081
58	02-10-1971	0.835	0.539	20.2	10.888
59	08-10-1971	0.73	0.225	16.716	3.761
60	03-08-1974	0.62	0.306	13.82	4.229
61	10-09-1976	0.725	0.418	18.443	7.709
62	05-02-1977	1.13	0.737	42.887	31.608
63	05-05-1977	1.18	0.719	45.152	32.464
64	05-06-1977	1	0.649	36.029	23.383
65	06-06-1977	0.85	0.47	29.77	13.992
66	06-07-1977	0.84	0.457	30.002	13.711
67	05-09-1977	0.955	0.603	37.496	22.61
68	05-11-1977	0.89	0.514	34.204	17.581
69	09-10-1978	0.62	0.345	14.809	5.109
70	03-03-1979	1.015	0.633	34.821	22.042
71	03-05-1979	0.97	0.585	32.882	19.236
72	04-05-1979	1.495	0.98	53.542	52.471
73	03-08-1979	1	0.618	35.906	22.19
74	03-10-1979	1.365	0.953	44.721	42.619
75	04-10-1979	1.84	1.028	67.78	69.678
76	04-11-1979	1.82	1.042	65.421	68.169
77	03-12-1979	1.14	0.755	38.805	29.298
78	04-04-1981	0.88	0.53	27.774	14.72
79	04-08-1981	0.985	0.484	28.622	13.853
80	04-09-1981	1.375	1.023	43.224	44.218
81	03-11-1981	0.71	0.416	20.481	8.52
82	03-12-1981	0.7	0.379	19.499	7.39
83	03-12-1981	0.7	0.382	19.346	7.39
84	04-12-1981	2.4	1.229	89.862	110.441
85	09-01-2007	0.8	0.666	32.156	21.416

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
86	27-03-2007	0.655	0.642	22.098	14.187
87	01-05-2007	0.696	1.372	17.813	24.44
88	01-12-2007	0.54	0.617	19.663	12.132
89	02-05-2008	1.78	1.436	32.387	46.508
90	03-05-2008	1.49	1.413	30.041	42.448
91	22-01-2009	0.32	0.255	18.961	4.835
92	28-01-2010	0.38	0.742	12.434	9.226
93	22-12-2010	0.4	0.314	18.86	5.926
94	31-03-2011		0.593	24.075	14.271
95	26-06-2011	2.01	0.992	16.801	16.659
96	15-07-2011	0.47	0.437	18.512	8.081
97	30-07-2011		0.378	18.339	6.928
98	09-10-2011	0.81	0.66	28.54	18.824
99	10-11-2011	0.39	0.414435	14.229	5.897
100	02-12-2011	0.417	0.395111	15.912	6.287
101	17-01-2012	0.595	0.6365	18.5895	11.8405

2. Mgeta River at Mgeta

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
1	22-06-1954	0.53	0.23	7.391	1.7
2	04-09-1954	0.4	0.14	6.143	0.86
3	02-10-1954	0.37	0.13	5.769	0.75
4	23-01-1959	0.43	0.26	3.962	1.03
5	26-04-1959	0.61	0.35	7.057	2.47
6	03-01-1960	0.4	0.35	7.057	2.47
7	09-03-1960	0.64	0.7	5.014	3.51
8	13-05-1960	0.64	0.52	6.173	3.21
9	10-09-1960	0.38	0.31	2.935	0.91
10	02-11-1960	0.4	0.34	3.324	1.13
11	02-03-1961	0.55	0.64	3.875	2.48
12	05-06-1961	0.5	0.77	3.143	2.42
13	26-08-1961	0.4	0.32	3.625	1.16
14	31-01-1962	0.63	0.78	4.872	3.8
15	06-03-1962	0.55	0.59	4.119	2.43
16	26-04-1962	0.67	0.73	5.137	3.75
17	25-07-1962	0.46	0.42	2.952	1.24
18	22-08-1962	0.49	0.51	3.039	1.55
19	17-09-1962	0.44	0.38	3.026	1.15
20	13-12-1962	0.46	0.38	4.395	1.67
21	27-12-1962	0.7	0.59	7.898	4.66
22	30-05-1963	0.54	0.53	5.245	2.78
23	19-07-1963	0.41	0.31	4.645	1.44
24	14-08-1963	0.37	0.29	3.862	1.12
25	27-09-1963	0.32	0.23	3.739	0.86
26	27-09-1963	0.32	0.14	6.214	0.87
27	19-11-1963	0.82	0.66	9.303	6.14

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
28	21-11-1963	0.67	0.28	6.964	1.95
29	13-02-1964	0.47	0.4	3.975	1.59
30	22-05-1964	0.58	0.24	6.5	1.56
31	18-09-1964	0.33	0.21	4.238	0.89
32	18-09-1964	0.33	0.47	1.957	0.92
33	16-07-1965	0.41	0.3	4.067	1.22
34	13-01-1966	0.49	0.35	5.943	2.08
35	21-02-1966	0.73	0.76	6.789	5.16
36	29-10-1966	0.4	0.3	4.367	1.31
37	08-06-1967	0.69	0.49	8.469	4.15
38	21-03-1968	0.76	0.51	9.529	4.86
39	25-03-1968	0.67	0.46	8.326	3.83
40	26-03-1968	0.89	0.6	11.833	7.1
41	26-03-1968	0.85	0.63	10.698	6.74
42	31-03-1968	0.87	0.63	10.889	6.86
43	01-04-1968	0.81	0.58	9.948	5.77
44	02-04-1968	0.79	0.55	9.655	5.31
45	02-04-1968	0.81	0.6	9.95	5.97
46	03-04-1968	0.93	0.65	12.185	7.92
47	03-04-1968	0.91	0.65	11.615	7.55
48	03-04-1968	0.84	0.56	10.625	5.95
49	04-04-1968	0.8	0.53	10.208	5.41
50	05-04-1968	0.89	0.64	11.172	7.15
51	05-04-1968	0.85	0.59	10.492	6.19
52	06-04-1968	0.89	0.63	11.063	6.97
53	09-04-1968	0.95	0.7	11.671	8.17
54	10-04-1968	0.93	0.64	11.672	7.47
55	13-04-1968	1.08	0.99	11.051	10.94
56	13-04-1968	1.16	1	16.33	16.33
57	13-04-1968	1.17	1.03	17.709	18.24
58	13-04-1968	1.12	0.92	16.228	14.93
59	16-04-1968	0.97	0.75	13	9.75
60	16-04-1968	0.98	0.77	13.13	10.11
61	17-04-1968	1.01	0.8	13.188	10.55
62	17-04-1968	1.02	0.8	13.538	10.83
63	20-04-1968	1.03	0.8	13.25	10.6
64	20-04-1968	1.01	0.78	12.91	10.07
65	22-04-1968	1.04	0.65	17.6	11.44
66	23-04-1968	1.09	0.71	18.352	13.03
67	23-04-1968	1.11	0.71	16.845	11.96
68	02-05-1968	0.87	0.47	14.149	6.65
69	05-11-1968	0.33	0.19	4.737	0.9
70	07-12-1968	0.7	0.38	10.526	4
71	14-10-1969	0.3	0.21	3.905	0.82
72	04-03-1970	0.64	0.75	4.96	3.72
73	14-07-1970	0.41	0.71	1.817	1.29
74	05-02-1971	0.66	0.9	4.522	4.07
75	11-08-1971	0.55	0.16	3.938	0.63
76	16-10-1971	0.51	0.22	3.977	0.875
77	26-09-1972	0.445	0.42	2.883	1.211
78	14-08-1973	0.57	0.2	3.26	0.652
79	29-08-1974	0.585	0.32	3.116	0.997
80	16-11-1974	0.565	0.18	4.139	0.745

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
81	16-10-1975	0.6	0.53	1.37	0.726
82	15-11-1975	0.6	0.99	0.842	0.834
83	05-10-1976	0.46	0.55	3.395	1.867
84	07-10-1976	0.445	0.52	2.912	1.514
85	14-11-1977	1.25	0.73	5.89	4.3
86	04-01-1978	1.36	0.84	6.07	5.099
87	06-12-1978	1.43	0.66	9.303	6.14
88	01-03-1979	1.25	0.55	5.995	3.297
89	03-03-1979	1.25	0.51	5.896	3.007
90	05-03-1979	1.22	0.49	5.614	2.751
91	08-03-1979	1.23	0.62	5.906	3.662
92	08-03-1979	1.58	0.86	10.37	8.918
93	09-03-1979	1.28	0.66	6.286	4.149
94	12-03-1979	1.31	0.62	7.095	4.399
95	13-03-1979	1.39	0.7	7.39	5.173
96	13-03-1979	1.47	0.74	9.055	6.701
97	15-03-1979	1.46	0.76	8.478	6.443
98	16-03-1979	1.52	0.79	9.448	7.464
99	17-03-1979	1.46	0.74	8.684	6.426
100	19-03-1979	1.56	0.79	10.782	8.518
101	21-03-1979	1.64	0.93	10.831	10.073
102	09-04-1979	1.72	1.09	10.82	11.794
103	11-04-1979	1.82	1.07	12.006	12.846
104	12-04-1979	1.83	1.09	12.155	13.249
105	14-04-1979	1.74	1.07	9.695	10.374
106	22-04-1979	1.77	1.39	8.437	11.727
107	24-04-1979	1.91	1.47	9.988	14.683
108	24-04-1979	1.72	1	9.894	9.894
109	24-04-1979	1.93	1.54	9.852	15.172
110	26-04-1979	1.61	1.37	6.799	9.315
111	27-04-1979	1.61	0.88	10.494	9.235
112	09-05-1979	1.52	0.96	7.745	7.435
113	10-05-1979	1.5	0.93	7.384	6.867
114	11-05-1979	1.48	0.92	7.218	6.641
115	14-05-1979	1.44	0.89	6.404	5.7
116	16-05-1979	1.4	0.9	6.044	5.44
117	28-01-1980	0.54	0.5	4.16	2.08
118	21-08-1982	0.26	0.45	4.171	1.877
119	24-02-1983	0.5	0.55	3.129	1.721
120	07-03-1983	0.48	0.56	2.852	1.597
121	15-03-1983	0.53	0.64	4	2.56
122	16-03-1983	0.51	0.52	3.442	1.79
123	17-03-1983	0.74	0.86	6.779	5.83
124	17-03-1983	0.72	0.86	6.2	5.332
125	17-03-1983	0.69	0.8	5.628	4.502
126	30-03-1983	0.815	0.87	7.562	6.579
127	30-03-1983	0.81	0.86	7.393	6.358
128	18-04-1983	0.56	0.64	4.023	2.575
129	28-04-1983	0.66	0.77	5.195	4
130	28-04-1983	0.65	0.78	5.054	3.942
131	08-12-1989	0.457	0.55	5.115	2.813
132	12-01-2007	0.712	0.968	6.191	5.993
133	05-05-2008	0.74	1.183	5.848	6.918

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
134	06-05-2008	0.71	1.109	5.687	6.307
135	23-01-2009	0.52	0.632	1.848	1.168
136	06-05-2009	0.632	0.396	5.28	2.091
137	16-06-2009	0.55	0.776	2.47	1.917
138	17-12-2009	0.515	0.676	1.553	1.05
139	04-02-2010	0.5	0.374	3.219	1.204
140	**24-12-2010**	**0.57**	**0.608**	**1.968**	**1.196**
141	27-06-2011	0.515			1.552

3. Ngeregere River at Mgude

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
1	14-10-1968	0.54	0.363	1.242	0.451
2	14-10-1968	0.54	0.396	1.217	0.482
3	31-01-1969	0.61	0.582	2.256	1.313
4	01-02-1969	0.67	0.621	2.773	1.722
5	04-02-1969	1.22	0.679	8.583	5.828
6	09-04-1969	1.04	0.662	6.088	4.03
7	10-04-1969	1.04	0.687	6.336	4.353
8	11-04-1969	1.25	0.801	8.31	6.656
9	14-04-1969	1.58	0.822	11.369	9.345
10	15-04-1969	1.6	1.016	10.87	11.044
11	16-04-1969	1.58	1.112	10.823	12.035
12	17-04-1969	1.76	1.003	12.916	12.955
13	18-04-1969	1.83	1.03	13.471	13.875
14	19-04-1969	1.89	1.021	14.075	14.371
15	21-04-1969	2.13	1.054	17.598	18.548
16	22-04-1969	2.13	1.063	17.049	18.123
17	24-04-1969	2.15	1.069	16.953	18.123
18	24-04-1969	2.26	1.099	18.294	20.105
19	28-04-1969	1.98	1.151	15.007	17.273
20	29-04-1969	2.07	1.05	16.45	17.273
21	30-04-1969	2.53	1.03	22.763	23.446
22	05-05-1969	3.03	1.128	32.886	37.095
23	05-05-1969	3.08	1.073	50.934	54.652
24	08-05-1969	2.58	1.255	24.256	30.441
25	10-05-1969	2.3	1.19	19.981	23.777
26	12-05-1969	1.97	1.184	14.583	17.266
27	15-05-1969	1.65	0.796	11.562	9.203
28	16-05-1969	1.6	1.066	10.825	11.539
29	17-05-1969	1.52	0.991	10.358	10.265
30	21-05-1969	1.34	0.432	16.715	7.221
31	23-05-1969	1.25	0.775	8.659	6.711
32	28-05-1969	1.13	0.716	7.761	5.557
33	10-09-1969	0.54	0.825	2.015	1.662
34	12-09-1969	0.51	0.691	1.852	1.28
35	13-09-1969	0.56	0.758	2.266	1.718
36	16-09-1969	0.49	0.753	1.838	1.384
37	22-09-1969	0.41	0.622	1.654	1.029

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
38	24-09-1969	0.44	0.592	1.569	0.929
39	25-09-1969	0.45	0.568	1.616	0.918
40	27-09-1969	0.43	0.552	1.607	0.887
41	27-09-1969	0.43	0.553	1.606	0.888
42	01-10-1969	0.4	0.589	1.348	0.794
43	01-10-1969	0.4	0.531	1.273	0.676
44	23-12-1969	0.46	0.589	1.579	0.93
45	27-04-1970	2.5	1.094	25.507	27.905
46	28-04-1970	2.13	1.101	19.586	21.564
47	28-04-1970	2.01	1.06	17.329	18.369
48	29-04-1970	1.77	1.201	13.777	16.546
49	30-04-1970	1.66	1.055	11.8	12.449
50	07-05-1970	1.52	0.975	10.196	9.941
51	08-05-1970	1.49	0.98	10.233	10.028
52	11-05-1970	1.37	0.723	9.243	6.683
53	12-05-1970	1.28	0.697	9.06	6.315
54	13-05-1970	1.22	0.635	8.65	5.493
55	19-05-1970	0.98	0.656	5.877	3.855
56	22-05-1970	0.91	0.532	5.795	3.083
57	23-05-1970	1.11	0.613	7.576	4.644
58	24-05-1970	1.25	0.669	9.694	6.485
59	28-05-1970	1.04	0.63	6.787	4.276
60	01-06-1970	0.88	0.642	5.218	3.35
61	04-06-1970	0.76	0.842	3.686	3.104
62	11-10-1970	0.08	0.189	0.794	0.15
63	16-10-1970	0.34	0.513	1.378	0.707
64	17-10-1970	0.3	0.456	1.162	0.53
65	02-02-1971	0.96	0.618	6.028	3.725
66	11-02-1971	0.9	0.622	5.69	3.539
67	12-02-1971	0.79	0.548	5.4	2.959
68	21-07-1971	0.52	0.68	2.415	1.642
69	22-07-1971	0.53	0.662	2.566	1.699
70	24-07-1971	0.6	0.474	4.576	2.169
71	12-10-1971	0.08	0.188	0.771	0.145
72	09-02-1972	0.16	0.269	1.067	0.287
73	11-02-1972	0.18	0.292	1.164	0.34
74	14-02-1972	0.15	0.262	1.008	0.264
75	09-03-1972	1.06	0.541	7.447	4.029
76	11-03-1972	0.52	0.694	2.203	1.529
77	07-04-1972	0.44	0.541	2.089	1.13
78	08-04-1972	0.42	0.529	1.972	1.043
79	11-04-1972	1.08	0.56	7.196	4.03
80	18-04-1972	1.56	0.82	9.695	7.95
81	20-04-1972	2.05	0.82	9.695	7.95
82	22-04-1972	2.74	1.035	32.271	33.4
83	24-04-1972	2.31	1.099	20.883	22.95
84	25-04-1972	2.54	1.142	25.512	29.135
85	02-05-1972	1.86	0.957	13.334	12.761
86	03-05-1972	1.58	0.537	11.229	6.03
87	05-05-1972	1.36	0.903	8.549	7.72
88	06-05-1972	1.4	0.879	9.479	8.332

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
89	08-05-1972	1.79	0.873	11.936	10.42
90	15-05-1972	3.19	0.842	41.116	34.62
91	16-05-1972	2.85	0.976	39.303	38.36
92	19-05-1972	2.73	0.985	35.858	35.32
93	20-05-1972	2.98	1.076	41.747	44.92
94	22-05-1972	2.18	1.077	20.344	21.91
95	05-06-1972	1.52	0.963	11.121	10.71
96	06-06-1972	1.44	0.883	9.581	8.46
97	07-06-1972	1.38	0.897	8.673	7.78
98	08-06-1972	1.32	0.89	9.438	8.4
99	14-06-1972	1.08	0.662	7.896	5.227
100	16-06-1972	1.02	0.587	7.245	4.253
101	17-06-1972	0.96	0.572	7.472	4.274
102	19-06-1972	0.91	0.559	6.869	3.84
103	20-06-1972	0.88	0.511	6.591	3.368
104	21-06-1972	0.88	0.572	6.5	3.718
105	22-06-1972	0.84	0.587	6.411	3.763
106	23-06-1972	0.81	0.556	6.277	3.49
107	04-09-1972	0.27	0.386	1.808	0.698
108	08-09-1972	0.27	0.345	2.006	0.692
109	09-09-1972	0.26	0.358	1.793	0.642
110	12-09-1972	0.54	0.567	3.54	2.007
111	14-11-1972	1.22	0.624	8.851	5.523
112	15-11-1972	1.44	0.66	10.539	6.956
113	18-12-1972	0.82	0.568	5.648	3.208
114	19-12-1972	0.74	0.557	5.048	2.812
116	12-08-1974	0.34	0.466	1.738	0.81
117	15-08-1974	0.36	0.429	1.702	0.73
118	28-03-1975	0.77	0.283	2.625	0.743
119	29-03-1975	0.76	0.316	2.446	0.773
120	31-03-1975	0.7	0.252	2.218	0.559
121	01-04-1975	0.75	0.329	2.608	0.858
122	12-04-1975	1.44	0.54	10.309	5.567
123	13-04-1975	1.44	0.551	9.98	5.499
124	21-04-1975	1.56	0.531	13.422	7.127
125	22-04-1975	1.47	0.533	11.765	6.271
126	23-04-1975	1.48	0.506	10.478	5.302
127	24-04-1975	1.62	0.494	15.304	7.56
128	03-05-1975	1.56	0.641	13.257	8.498
129	05-05-1975	1.49	0.561	12.594	7.065
130	06-05-1975	1.52	0.574	11.063	6.35
131	07-05-1975	1.4	0.545	10.062	5.484
132	08-05-1975	1.39	0.536	9.062	4.857
133	09-05-1975	1.31	0.548	8.487	4.651
134	12-05-1975	1.23	0.512	7.371	3.774
135	13-05-1975	1.49	0.566	11.77	6.662
136	15-05-1975	0.66	0.269	2.286	0.615
137	19-05-1975	1.59	0.543	13.786	7.486
138	22-05-1975	1.44	0.542	10.838	5.874
140	14-08-1975	0.65	0.398	2.239	0.891
141	18-03-1976	0.59	0.322	0.991	0.319

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
139	23-05-1975	1.53	0.479	12.658	6.063
176	21-05-1976	1.6	0.629	13.488	8.484
142	19-03-1976	0.58	0.317	0.981	0.311
143	20-03-1976	0.52	0.333	0.661	0.22
144	22-03-1976	0.98	0.495	5.149	2.549
145	23-03-1976	0.92	0.452	4.735	2.14
146	24-03-1976	0.91	0.441	4.791	2.113
147	25-03-1976	0.97	0.364	6.214	2.262
148	29-03-1976	0.94	0.459	5.386	2.472
149	30-03-1976	0.95	0.518	4.998	2.589
150	01-04-1976	1.16	0.504	8.321	4.194
151	02-04-1976	1.08	0.589	6.229	3.669
152	03-04-1976	1	0.584	5.139	3.001
153	06-04-1976	0.87	0.47	4.151	1.951
154	07-04-1976	0.82	0.436	3.573	1.558
155	08-04-1976	0.78	0.409	3.357	1.373
156	09-04-1976	0.74	0.514	2.381	1.224
157	10-04-1976	0.72	0.511	2.258	1.154
158	12-04-1976	0.72	0.517	2.329	1.204
159	13-04-1976	0.89	0.392	5.145	2.017
160	14-04-1976	0.9	0.471	4.896	2.306
161	15-04-1976	0.86	0.479	3.998	1.915
162	17-04-1976	0.81	0.424	3.651	1.548
163	20-04-1976	1.2	0.452	9.529	4.307
164	21-04-1976	1.28	0.497	10.706	5.321
165	22-04-1976	1.31	0.575	9.814	5.643
166	23-04-1976	1.42	0.558	11.303	6.307
167	24-04-1976	1.43	0.587	11.334	6.653
168	07-05-1976	1.82	0.674	19.51	13.15
169	10-05-1976	1.72	0.696	14.375	10.005
170	11-05-1976	1.73	0.674	16.708	11.261
171	12-05-1976	1.67	0.651	13.515	8.798
172	13-05-1976	1.55	0.65	12.4	8.06
173	14-05-1976	1.46	0.704	10.467	7.369
174	15-05-1976	1.39	0.586	10.846	6.356
175	17-05-1976	1.32	0.59	9.573	5.648
177	22-05-1976	1.47	3.367	1.87	6.296
178	24-05-1976	1.32	0.57	8.686	4.951
179	25-05-1976	1.27	0.569	8.615	4.902
180	27-05-1976	1.18	0.625	7.058	4.411
181	01-06-1976	1.02	0.568	5.222	2.966
182	02-06-1976	1	0.547	5.124	2.803
183	03-06-1976	0.99	0.565	4.701	2.656
184	04-06-1976	0.98	0.543	4.7	2.552
185	19-06-1976	1.77	0.67	14.533	9.737
186	17-08-1976	0.66	0.402	1.493	0.6
187	13-03-1977	0.8	0.567	3.102	1.759
188	15-03-1977	0.78	0.364	2.94	1.07
189	16-03-1977	0.87	0.466	4.028	1.877
190	18-03-1977	0.77	0.516	2.63	1.357
191	19-03-1977	0.76	0.484	2.762	1.337

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
192	21-03-1977	0.68	0.553	1.62	0.896
193	22-03-1977	0.69	0.508	1.74	0.884
194	23-03-1977	1.3	0.376	11.835	4.45
195	24-03-1977	0.76	0.523	2.707	1.416
196	25-03-1977	0.68	0.539	1.77	0.954
197	26-03-1977	0.67	0.536	1.791	0.96
198	29-03-1977	1.05	0.435	7.637	3.322
199	30-03-1977	1.15	0.407	8.835	3.596
200	31-03-1977	1.19	0.453	8.755	3.966
201	01-04-1977	1.16	0.473	7.753	3.667
202	02-04-1977	1.15	0.513	7.156	3.671
203	04-04-1977	1.02	0.527	5.702	3.005
204	06-04-1977	0.98	0.522	4.697	2.452
205	07-04-1977	0.96	0.551	4.702	2.591
206	12-04-1977	1.2	0.575	7.224	4.154
207	13-04-1977	1.25	0.509	8.68	4.418
208	15-04-1977	1.36	0.452	10.409	4.705
209	17-04-1977	1.24	0.544	7.943	4.321
210	19-04-1977	1.05	0.553	5.707	3.156
211	20-04-1977	1.01	0.558	5.916	3.301
212	22-04-1977	1.03	0.487	5.632	2.743
213	01-05-1977	1.2	0.55	7.704	4.237
214	07-05-1977	1.41	0.53	10.081	5.343
215	09-05-1977	1.28	0.542	8.852	4.798
216	10-05-1977	1.28	0.516	8.804	4.543
217	16-05-1977	1.06	0.53	5.83	3.09
218	19-05-1977	0.98	0.55	4.989	2.744
219	21-05-1977	0.92	0.572	4.168	2.384
220	23-05-1977	1.02	0.538	5.855	3.15
221	04-06-1977	1.31	0.621	7.404	4.598
222	03-10-1977	1.1	1.543	3.563	5.498
223	06-10-1977	0.96	1.708	2.584	4.414
224	14-02-1978	0.99	0.522	3.42	1.785
225	14-02-1978	0.98	0.529	2.694	1.425
226	16-02-1978	0.94	0.406	2.734	1.11
227	19-02-1978	0.88	0.506	1.802	0.912
228	21-02-1978	0.86	0.54	1.846	0.997
229	23-02-1978	0.97	0.496	2.827	1.402
230	28-02-1978	1.34	0.517	5.882	3.041
231	01-03-1978	1.23	0.523	4.258	2.227
232	02-03-1978	1.16	0.512	3.154	1.615
233	03-03-1978	1.1	0.487	2.984	1.453
234	04-03-1978	1.06	0.503	3.074	1.546
235	06-03-1978	0.98	0.478	2.444	1.168
236	07-03-1978	0.95	0.484	2.376	1.15
237	09-03-1978	0.98	0.445	3.106	1.382
238	12-03-1978	0.93	0.448	2.299	1.03
239	14-03-1978	1.02	0.421	2.589	1.09
240	15-03-1978	1	0.435	2.811	1.223
241	16-03-1978	0.97	0.454	2.242	1.018
242	17-03-1978	0.97	0.371	3.48	1.291

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
243	18-03-1978	2.17	0.456	26.134	11.917
244	03-04-1978	1.46	0.466	7.107	3.312
245	04-04-1978	1.58	0.448	9.063	4.06
246	12-04-1978	2.35	0.736	30.458	22.417
247	13-04-1978	2.23	0.693	35.851	24.845
248	16-04-1978	1.3	0.511	15.89	8.12
249	17-04-1978	1.78	0.589	11.983	7.058
250	19-04-1978	2	0.671	14.833	9.953
251	20-04-1978	2.12	0.608	27.536	16.742
252	21-04-1978	2.1	0.513	23.082	11.841
253	22-04-1978	2.1	0.555	21.429	11.893
254	23-04-1978	2.45	0.608	27.536	16.742
255	01-05-1978	2.52	0.655	25.519	16.715
256	11-05-1978	1.72	0.44	21.257	9.353
257	12-05-1978	1.84	0.486	28.27	13.739
258	02-06-1978	1.38	0.466	9.562	4.456
259	03-06-1978	1.39	0.468	10.011	4.685
260	05-06-1978	1.34	0.517	8.919	4.611
261	06-06-1978	1.36	0.5	7.954	3.977
262	07-06-1978	1.33	0.499	8.585	4.284
263	08-06-1978	1.3	0.452	7.619	3.444
264	02-08-1978	0.75	0.488	1.658	0.809
265	02-08-1978	0.75	0.49	1.824	0.894
266	03-08-1978	0.76	0.465	1.828	0.85
267	03-08-1978	0.76	0.484	1.884	0.912
268	05-08-1978	0.74	0.47	1.785	0.839
269	07-08-1978	0.72	0.477	1.633	0.779
270	08-08-1978	0.74	0.52	1.74	0.905
271	10-08-1978	0.72	0.463	1.635	0.757
272	12-08-1978	0.7	0.483	1.489	0.719
273	15-01-1979	1.78	0.499	23.986	11.969
274	17-01-1979	1.62	0.454	20.729	9.411
275	21-01-1979	1.5	0.147	18.272	2.686
276	22-01-1979	1.42	0.422	11.396	4.809
277	23-01-1979	1.91	0.382	13.319	5.088
278	24-01-1979	1.78	0.633	30.641	19.396
279	12-02-1979	1.53	0.493	11.777	5.806
280	14-02-1979	1.49	0.468	11.321	5.298
281	15-02-1979	1.51	0.552	12.462	6.879
282	16-02-1979	1.46	0.511	10.924	5.582
283	17-02-1979	1.56	0.552	14.036	7.748
284	23-02-1979	2.32	0.717	30.841	22.113
285	23-02-1979	2.3	0.668	30.545	20.404
286	24-02-1979	2.02	0.663	25.528	16.925
287	24-02-1979	2.04	0.583	25.907	15.104
288	28-02-1979	1.95	0.647	25.649	16.595
289	03-03-1979	1.52	0.095	12.505	1.188
290	04-03-1979	1.48	0.482	11.151	5.375
291	05-03-1979	1.4	0.477	10.333	4.929
292	06-03-1979	1.36	0.496	9.665	4.794
293	07-03-1979	1.32	0.474	9.165	4.344

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
294	09-03-1979	1.3	0.517	8.404	4.345
295	10-03-1979	1.3	0.449	9.189	4.126
296	11-03-1979	1.24	0.519	8.295	4.305
297	12-03-1979	1.28	0.527	8.898	4.689
298	13-03-1979	1.34	0.51	9.373	4.78
299	14-03-1979	1.42	0.557	10.522	5.861
300	16-03-1979	2.04	0.826	21.093	17.423
301	17-03-1979	2.28	0.914	23.992	21.929
302	20-03-1979	2.38	0.793	30.566	24.239
303	21-03-1979	3.54	0.885	65.719	58.161
304	22-03-1979	3.24	0.946	64.225	60.757
305	23-03-1979	2.41	0.678	35.497	24.067
306	24-03-1979	2.09	0.617	28.833	17.79
307	25-03-1979	2.97	0.955	54.381	51.934
308	25-03-1979	2.99	1.008	55.406	55.849
309	26-03-1979	2.83	1.071	45.236	48.448
310	26-03-1979	2.82	1.02	45.807	46.723
311	30-03-1979	2.44	0.897	39.796	35.697
312	30-03-1979	2.43	0.937	39.099	36.636
313	03-04-1979	1.87	0.639	21.628	13.82
314	03-04-1979	1.85	0.698	21.223	14.814
315	04-04-1979	1.94	0.659	23.388	15.413
316	04-04-1979	1.96	0.667	23.706	15.812
317	06-04-1979	2.24	0.777	30.933	24.035
318	07-04-1979	2.28	0.84	27.958	23.485
319	09-04-1979	2.35	0.928	32.894	30.526
320	09-04-1979	2.37	0.874	32.926	28.777
321	10-04-1979	2.4	0.69	35.178	24.273
322	11-04-1979	2.38	0.869	33.284	28.924
323	16-04-1979	2.84	1.021	50.767	51.833
324	14-05-1979	1.92	0.601	26.747	16.075
325	21-04-1980	2.5	0.894	41.213	36.844
326	30-09-1980	0.4	0.274	0.989	0.271
327	06-12-1980	0.98	0.439	5.911	2.595
328	08-12-1980	1.22	0.526	10.633	5.593
329	09-12-1980	1.24	0.542	11.076	6.003
330	10-12-1980	1.16	0.489	10.313	5.043
331	11-12-1980	1.02	0.505	7.873	3.976
332	12-12-1980	0.99	0.508	5.835	2.964
333	13-12-1980	0.82	0.478	4.933	2.358
334	17-12-1980	0.9	0.538	5.359	2.883
335	03-10-1981	0.38	0.29	0.721	0.209
336	10-03-1982	0.34	0.442	0.466	0.206
337	11-03-1982	0.32	0.252	0.302	0.076
338	12-03-1982	0.3	0.407	0.241	0.098
339	13-03-1982	0.28	0.383	0.188	0.072
340	13-03-1982	0.28	0.343	0.204	0.07
341	14-03-1982	0.3	0.406	0.207	0.084
342	15-03-1982	0.28	0.313	0.16	0.05
343	16-03-1982	0.3	0.403	0.201	0.081
344	18-03-1982	0.26	0.232	0.185	0.043

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
345	22-03-1982	0.37	0.531	0.397	0.211
346	23-03-1982	0.39	0.433	0.554	0.24
347	24-03-1982	0.38	0.431	0.522	0.225
348	25-03-1982	0.36	0.42	0.462	0.194
349	26-03-1982	0.34	0.36	0.397	0.143
350	27-03-1982	0.36	0.37	0.53	0.196
351	31-03-1982	0.48	0.487	1.06	0.516
352	02-04-1982	0.37	0.312	0.641	0.2
353	03-04-1982	0.41	0.37	0.741	0.274
354	05-04-1982	0.48	0.447	1.427	0.638
355	06-04-1982	0.98	0.414	8.942	3.702
356	07-04-1982	0.9	0.565	5.958	3.366
357	08-04-1982	0.94	0.576	6.122	3.526
358	10-04-1982	1	0.539	7.297	3.933
359	12-04-1982	0.93	0.562	6.11	3.434
360	13-04-1982	0.88	0.553	6.016	3.327
361	14-04-1982	0.83	0.535	4.791	2.563
362	15-04-1982	0.75	0.49	4.245	2.08
363	16-04-1982	0.7	0.452	3.874	1.751
364	17-04-1982	0.7	0.469	3.832	1.797
365	18-04-1982	0.74	0.337	6.065	2.044
366	20-04-1982	0.76	0.481	4.497	2.163
367	22-04-1982	0.93	0.556	6.108	3.396
368	23-04-1982	0.88	0.575	5.563	3.199
369	24-04-1982	0.96	0.508	6.949	3.53
370	26-04-1982	0.89	0.503	6.322	3.18
371	29-04-1982	0.91	0.47	6.436	3.025
372	02-05-1982	0.84	0.481	5.694	2.739
373	08-05-1982	1.4	0.468	15.944	7.462
374	17-05-1982	1.34	0.58	12.493	7.246
375	18-05-1982	1.26	0.598	10.201	6.1
376	19-05-1982	1.16	0.607	8.733	5.301
377	20-05-1982	1.09	0.611	7.957	4.862
378	21-05-1982	1.02	0.592	7.316	4.331
379	22-05-1982	0.97	0.59	6.646	3.921
380	24-05-1982	1.16	0.585	9.174	5.367
381	25-05-1982	1.18	0.436	9.615	4.192
382	26-05-1982	1.08	0.588	8.085	4.754
383	27-05-1982	1.02	0.621	6.692	4.156
384	29-05-1982	0.98	0.58	6.693	3.882
385	21-11-1983	0.34	0.234	0.936	0.219
386	26-11-1983	0.38	0.546	4.524	2.47
387	11-08-1984	0.63	0.595	2.103	1.251
388	13-08-1984	0.62	0.395	2.962	1.17
389	10-04-1985	0.96	0.089	5.09	0.453
390	11-04-1985	0.71	0.458	4.926	2.256
391	12-04-1985	0.64	0.452	4.54	2.052
392	13-04-1985	0.7	0.455	5.233	2.381
393	15-04-1985	0.99	0.482	5.12	2.468
394	17-04-1985	1.3	0.757	13.458	10.188
395	17-04-1985	1.32	1.008	10.853	10.94

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
398	22-04-1985	1.53	0.863	14.156	12.217
399	23-04-1985	1.89	0.736	12.906	9.499
400	23-04-1985	1.62	0.853	11.352	9.683
401	23-04-1985	1.46	0.82	13.174	10.803
402	24-04-1985	1.36	0.661	12.451	8.23
403	24-04-1985	1.36	0.793	12.006	9.521
404	24-04-1985	1.45	0.827	13.388	11.072
405	26-04-1985	1.26	0.792	12.701	10.059
406	29-04-1985	1.14	0.683	12.728	8.693
407	25-05-1985	1.37	0.703	10.989	7.725
408	25-05-1985	1.35	0.661	11.383	7.524
409	25-11-1985	0.58	0.36	1.353	0.487
410	30-11-1985	0.62	0.278	3.335	0.927
411	01-12-1985	0.58	0.191	3.576	0.683
412	02-12-1985	0.56	0.286	2.252	0.644
413	03-12-1985	0.7	0.344	4.488	1.544
414	04-12-1985	0.79	0.489	4.738	2.317
415	07-12-1985	0.78	0.264	3.966	1.047
416	09-12-1985	0.6	0.376	2.957	1.112
417	10-03-1986	0.58	0.355	0.944	0.335
418	13-03-1986	0.68	0.281	1.907	0.536
419	15-03-1986	0.84	0.469	3.61	1.693
420	18-03-1986	0.9	0.561	5.998	3.365
421	19-03-1986	0.9	0.555	3.27	1.815
422	20-03-1986	0.94	0.483	4.772	2.305
423	28-03-1986	0.8	0.389	2.9	1.128
424	31-03-1986	1.12	0.505	8.046	4.063
425	03-04-1986	1.47	0.714	11.667	8.33
426	04-04-1986	1.68	0.836	13.361	11.17
427	05-04-1986	1.62	0.853	11.464	9.779
428	28-04-1986	1.48	0.937	10.171	9.53
429	29-04-1986	1.52	0.742	13.205	9.798
430	29-04-1986	1.52	0.791	11.293	8.933
431	09-11-1987	0.58	0.808	0.333	0.269
432	10-11-1987	0.54	0.338	0.538	0.182
433	12-11-1987	0.5	0.222	0.5	0.111
434	13-11-1987	0.52	0.307	0.57	0.175
435	16-11-1987	0.6	0.372	0.551	0.205
436	17-11-1987	0.4	0.303	0.667	0.202
437	27-11-1987	0.46	0.293	0.099	0.029
438	28-11-1987	0.47	0.102	0.304	0.031
439	30-11-1987	0.35	0.203	0.453	0.092
440	01-12-1987	0.34	0.217	0.396	0.086
441	16-11-1988	1.4	0.444	2.655	1.179
442	28-11-1988	1.64	0.62	6.01	3.726
443	29-11-1988	1.6	0.573	5.845	3.349
444	30-11-1988	1.58	0.548	4.195	2.299
445	01-12-1988	1.54	0.586	3.341	1.958
446	02-03-1989	1.26	0.561	1.597	0.896
447	03-03-1989	1.24	0.533	1.552	0.827
448	04-03-1989	1.22	0.524	1.494	0.783

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
449	06-03-1989	1.21	0.501	1.451	0.727
450	07-03-1989	1.2	0.494	1.421	0.702
451	08-03-1989	1.2	0.475	1.442	0.685
452	22-03-1989	1.52	0.542	3.426	1.857
453	28-03-1989	1.4	0.436	3.163	1.379
454	01-04-1989	1.54	0.564	3.089	1.742
455	07-04-1989	1.6	0.599	5.97	3.576
456	27-04-1989	1.64	0.945	12.322	11.644
457	04-05-1989	1.47	0.516	3.273	1.689
458	08-05-1989	1.63	0.619	6.181	3.826
459	19-05-1989	1.58	0.602	4.364	2.627
460	19-05-1990	1.98	0.891	9.23	8.224
461	20-05-1990	1.9	0.967	8.421	8.143
462	22-05-1990	1.82	0.924	7.429	6.864
463	24-05-1990	1.76	0.857	6.564	5.625
464	26-05-1990	1.68	0.693	6.358	4.406
465	27-05-1990	1.64	0.693	7.01	4.858
466	28-05-1990	1.62	0.781	5.822	4.547
467	29-05-1990	1.6	0.674	5.519	3.72
468	30-05-1990	1.85	0.716	14.432	10.333
469	30-05-1991	1.8	0.658	13.398	8.816
470	31-05-1991	1.84	0.731	13.345	9.755
471	31-05-1991	1.84	0.578	14.73	8.514
472	17-06-1991	1.38	0.537	5.02	2.696
473	17-06-1991	1.37	0.469	4.896	2.296
474	18-06-1991	1.34	0.519	4.753	2.467
475	18-06-1991	1.34	0.472	4.809	2.27
476	19-06-1991	1.36	0.479	4.401	2.108
477	19-06-1991	1.36	0.484	4.725	2.287
478	30-01-1992	0.28	0.37	1.078	0.399
479	30-01-1992	0.28	0.446	0.998	0.445
480	29-05-1992	1.7	0.681	11.467	7.809
481	30-05-1992	1.68	0.658	9.384	6.175
482	31-05-1992	1.66	0.703	8.361	5.878
483	01-06-1992	1.64	0.622	6.965	4.332
484	02-06-1992	1.68	0.651	9.353	6.089
485	03-06-1992	1.66	0.696	8.236	5.732
486	04-06-1992	1.67	0.626	9.219	5.771

4. Ngerengere River at Konga

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
1	08-11-1962	0.18	0.09	2.444	0.22
2	01-06-1963	0.29	0.16	3.75	0.6
3	15-08-1963	0.24	0.1	3.1	0.31
4	28-08-1963	0.25	0.11	3.091	0.34
5	28-09-1963	0.25	0.12	2.75	0.33
6	18-05-1964	0.27	0.15	5.267	0.79
7	12-01-1966	0.12	0.09	4.333	0.39

8	28-10-1966	0.14	0.24	2.167	0.52
9	14-03-1967	0.05	0.06	2.667	0.16
10	03-04-1967	0.11	0.09	4	0.36
11	09-04-1967	0.32	0.2	8.05	1.61
12	12-04-1967	0.24	0.18	6.444	1.16
13	14-04-1967	0.38	0.4	5.05	2.02
14	15-04-1967	0.25	0.17	6.824	1.16
15	21-04-1967	0.18	0.15	5.6	0.84
16	01-05-1967	0.34	0.13	13.385	1.74
17	02-05-1967	0.26	0.22	5.909	1.3
18	03-05-1967	0.26	0.21	5.667	1.19
19	04-05-1967	0.25	0.22	5.545	1.22
20	05-05-1967	0.54	0.29	9.966	2.89
21	05-05-1967	0.45	0.26	9.5	2.47
22	06-05-1967	0.76	0.27	16.778	4.53
23	07-05-1967	0.62	0.25	14.24	3.56
24	07-05-1967	0.87	0.4	15.2	6.08
25	08-05-1967	0.52	0.22	12.455	2.74
26	08-05-1967	0.46	0.25	10.32	2.58
27	08-05-1967	0.45	0.23	10.913	2.51
28	09-05-1967	0.72	0.27	16.667	4.5
29	09-05-1967	0.52	0.23	12.478	2.87
30	10-05-1967	0.51	0.24	11.292	2.71
31	25-03-1968	0.21	0.26	3.385	0.88
32	26-03-1968	0.32	0.4	4.775	1.91
33	26-03-1968	0.29	0.37	4.135	1.53
34	27-03-1968	0.21	0.34	2.971	1.01
35	28-03-1968	0.38	0.42	5.429	2.28
36	29-03-1968	0.23	0.35	3.286	1.15
37	30-03-1968	0.56	0.46	7.957	3.66
38	03-04-1968	0.64	0.51	8.275	4.22
39	03-04-1968	0.46	0.45	6.067	2.73
40	09-04-1968	0.48	0.46	6.543	3.01
41	10-04-1968	0.55	0.5	6.76	3.38
42	12-04-1968	0.59	0.52	7.308	3.8
43	14-04-1968	0.72	0.51	9.627	4.91
44	14-04-1968	0.65	0.53	8.453	4.48
45	19-04-1968	0.73	0.49	10.204	5
46	22-04-1968	0.61	0.4	8.775	3.51
47	26-04-1968	0.62	0.44	8.659	3.81
48	27-04-1968	0.54	0.41	8.098	3.32
49	28-04-1968	0.49	0.38	7.605	2.89
50	03-05-1968	0.34	0.33	5.364	1.77
51	06-05-1968	0.3	0.31	5.065	1.57
52	07-05-1968	0.41	0.48	5.625	2.7
53	08-05-1968	0.53	0.43	6.93	2.98
54	07-12-1968	0.46	0.21	14.286	3
55	15-10-1969	0.06	0.06	4.5	0.27
56	08-04-1971	0.23	0.17	5.588	0.95
57	09-04-1971	0.3	0.2	7.65	1.53
58	13-04-1971	0.32	0.21	7.667	1.61
59	14-04-1971	0.29	0.2	7.25	1.45
60	19-04-1971	0.39	0.25	9.92	2.48

61	22-04-1971	0.6	0.32	13.375	4.28
62	23-04-1971	0.53	0.3	13.4	4.02
63	24-04-1971	0.43	0.28	9.214	2.58
64	29-04-1971	0.34	0.22	8.455	1.86
65	03-05-1971	0.23	0.15	6.733	1.01
66	18-05-1971	0.24	0.18	5.722	1.03
67	21-05-1971	0.69	0.53	9.849	5.22
68	03-06-1971	0.19	0.22	3.091	0.68
69	19-08-1972	0.11	0.36	0.658	0.237
70	12-09-1975	0.115	0.2	1.835	0.367
71	16-10-1975	0.085	0.32	0.406	0.13
72	09-07-1976	0.125	0.21	1.695	0.356
73	31-07-1976	0.09	0.22	1.323	0.291
74	24-09-1976	0.155	0.69	0.826	0.57
75	08-10-1976	0.085	0.16	1.806	0.289
76	27-10-1976	0.072	0.12	1.683	0.202
77	14-07-1978	0.1	0.18	1.422	0.256
78	25-01-1980	0.07	0.4	0.465	0.186
80	25-09-1990	0.02	0.25	0.572	0.143
81	12-01-2007	1	0.579	2.035	1.178
82	05-06-2007	1.24	0.461	2.931	1.351
83	12-06-2007	1	0.579	2.035	1.178
84	16-11-2007	1.58	0.838	5.575	4.672
85	18-12-2007	0.699	0.478	0.533	0.255
86	24-01-2008	0.69	0.509	0.878	0.447
87	21-02-2008	0.61	0.423	0.414	0.175
88	26-03-2008	0.645	0.434	0.468	0.203
89	15-04-2008	1.92	0.636	8.277	5.264
90	22-04-2008	1.5	0.587	4.365	2.562
91	13-05-2008	1.155	0.798	1.748	1.395
92	19-06-2008	0.77	0.955	0.934	0.892
94	22-08-2008	0.695	0.415	0.47	0.195
95	08-10-2008	0.715	0.564	0.557	0.314
96	07-11-2008	1.165	0.906	2.421	2.193
97	23-12-2008	0.64	0.419	0.389	0.163
98	19-01-2009	0.605	0.274	0.303	0.083
100	23-02-2009	0.91	0.18	5.744	1.034
101	26-03-2009	0.66	0.517	0.435	0.225
102	22-04-2009	0.71	0.704	0.655	0.461
103	05-05-2009	1.495	0.477	4.413	2.105
104	07-05-2009	1.215	0.715	3.099	2.216
105	09-06-2009	0.76	0.439	1.699	0.746
106	24-06-2009	0.71	0.614	0.604	0.371
107	02-07-2009	0.75	0.486	0.553	0.269
108	23-07-2009	0.74	0.377	0.523	0.197
109	29-07-2009	0.67	0.476	0.38	0.181
110	04-02-2010	0.6	0.374	0.099	0.037
111	23-12-2010	0.6	0.164	0.549	0.09

5. Ruvu River at Morogoro-Dar Es Salaam Bridge

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
1	30-12-1958	2.32	0.618	63.186	39.049
2	07-04-1959	1.78	0.646	41.248	26.646
3	10-04-1959	1.71	0.638	35.019	22.342
4	27-05-1959	2.44	0.62	59.923	37.152
5	07-07-1959	1.62	0.609	32.688	19.907
6	26-07-1959	1.19	0.457	22.926	10.477
7	29-10-1959	1.05	0.454	18.026	8.184
8	21-12-1959	1.33	0.543	26.179	14.215
9	02-03-1960	1.4	0.544	32.116	17.471
10	12-03-1960	2.71	0.719	63.605	45.732
11	26-04-1960	6.58	0.113	262.115	29.619
12	06-05-1960	6.13	0.798	247.01	197.114
13	11-05-1960	5.61	0.659	217.64	143.425
14	16-08-1960	1.46	0.318	48.264	15.348
15	10-12-1960	0.75	0.185	20.816	3.851
16	24-02-1961	4.23	0.539	159.605	86.027
17	05-05-1961	5.52	0.682	201.166	137.195
18	13-11-1961	6.55	0.995	273.606	272.238
19	21-11-1961	6.48	0.749	343.507	257.287
20	29-11-1961	6.57	0.099	331.798	32.848
21	04-12-1961	6.12	0.703	296.663	208.554
22	18-12-1961	6.18	0.765	293.162	224.269
23	01-03-1962	3.72	0.464	175.272	81.326
24	14-03-1962	6.18	0.921	282.369	260.062
25	30-03-1962	5.47	0.646	254.37	164.323
26	02-06-1962	2.93	0.416	121.026	50.347
27	28-06-1962	2.29	0.328	92.375	30.299
28	30-07-1962	1.71	0.282	66.876	18.859
29	08-08-1962	1.66	0.291	65.88	19.171
30	09-11-1962	1.62	0.372	57.852	21.521
31	01-04-1963	5.98	0.769	251.796	193.631
32	30-05-1963	3.21	0.389	148.499	57.766
33	13-07-1963	2.2	0.323	93.892	30.327
34	21-07-1963	1.99	0.304	84.484	25.683
35	18-09-1963	1.24	0.202	51.446	10.392
36	30-11-1963	6.91	0.015	426.667	6.4
37	15-12-1963	4.63	0.502	234.432	117.685
38	02-01-1964	6	0.756	323.134	244.289
39	09-02-1964	2.72	0.426	120.115	51.169
40	28-04-1964	6.43	1.054	395.495	416.852
41	04-06-1964	2.95	0.385	134.377	51.735
42	16-12-1964	1.01	0.295	26.203	7.73

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
43	08-01-1965	1.65	0.463	52.168	24.154
44	08-01-1965	1.65	0.448	52.525	23.531
45	09-01-1965	1.6	0.442	50.676	22.399
46	05-03-1965	1.46	0.456	42.412	19.34
47	20-04-1965	5.76	0.782	260.464	203.683
48	13-10-1965	1.59	0.499	49.03	24.466
49	24-12-1965	3.02	0.596	103.018	61.399
50	17-02-1966	3.24	0.614	106.064	65.123
51	23-02-1966	3.11	0.906	99.883	90.494
52	26-02-1966	2.71	0.712	80.118	57.044
53	29-03-1966	4.58	0.075	172.467	12.935
54	30-03-1966	4.8	0.076	186.013	14.137
55	07-04-1966	5.62	0.809	218.03	176.386
56	08-04-1966	5.84	0.817	241.438	197.255
57	09-04-1966	5.92	0.77	246.43	189.751
58	10-04-1966	5.95	0.851	246.051	209.389
59	11-04-1966	6.05	0.826	258.251	213.315
60	12-04-1966	6.22	0.886	276.786	245.232
61	13-04-1966	6.28	0.869	285.395	248.008
62	14-04-1966	6.39	0.787	392.729	309.078
63	15-04-1966	6.45	0.837	419.262	350.922
64	16-04-1966	6.45	0.814	415.708	338.386
65	17-04-1966	6.4	0.794	410.583	326.003
66	18-04-1966	6.37	0.748	415.587	310.859
67	19-04-1966	6.37	0.749	417.004	312.336
68	20-04-1966	6.37	0.738	417.885	308.399
69	22-04-1966	6.36	0.726	425.455	308.88
70	23-04-1966	6.27	0.682	400.579	273.195
71	24-04-1966	6.17	0.659	379.844	250.317
72	25-04-1966	5.81	0.621	321.407	199.594
73	26-04-1966	5.49	0.581	273.609	158.967
74	27-04-1966	5.05	0.576	245.314	141.301
75	30-04-1966	5.15	0.63	248.59	156.612
76	01-05-1966	5.21	0.633	253.336	160.362
77	02-05-1966	5.22	0.646	250.158	161.602
78	03-05-1966	5.11	0.626	241.879	151.416
79	04-05-1966	4.79	0.594	222.291	132.041
80	05-05-1966	4.37	0.544	203.156	110.517
81	06-05-1966	4.21	0.586	189.666	111.144
82	07-05-1966	4.24	0.534	188.29	100.547
83	08-05-1966	4.35	0.614	189.041	116.071
84	09-05-1966	4.42	0.606	207.003	125.444
85	10-05-1966	4.47	0.618	194.709	120.33
86	11-05-1966	4.4	0.667	188.51	125.736
87	12-05-1966	4.32	0.613	185.561	113.749

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
88	13-05-1966	4.15	0.611	171.245	104.631
89	14-05-1966	3.93	0.575	161.12	92.644
90	15-05-1966	3.89	0.597	158.442	94.59
91	18-10-1966	1.13	0.375	21.389	8.021
92	30-10-1966	2.02	0.535	62.021	33.181
93	18-11-1966	1.4	0.438	35.95	15.746
94	04-05-1967	6.23	0.745	364.573	271.607
95	05-05-1967	6.21	0.702	371.637	260.889
96	06-05-1967	6.18	0.685	353.39	242.072
97	07-05-1967	6.2	0.659	363.517	239.558
98	09-05-1967	6.14	0.653	358.74	234.257
99	10-05-1967	6.16	0.72	350.976	252.703
100	11-05-1967	6.17	0.73	355.342	259.4
101	12-05-1967	6.15	0.685	357.772	245.074
102	13-05-1967	6.19	0.733	373.918	274.082
103	14-05-1967	6.22	0.69	386.629	266.774
104	15-05-1967	6.26	0.731	397.044	290.239
105	16-05-1967	6.28	0.739	390.778	288.785
106	17-05-1967	6.27	0.721	398.732	287.486
107	18-05-1967	6.27	0.72	409.399	294.767
108	19-05-1967	6.24	0.719	400.955	288.287
109	20-05-1967	6.15	0.676	378.339	255.757
110	21-05-1967	5.98	0.622	358.947	223.265
111	22-05-1967	5.62	0.566	311.62	176.377
112	23-05-1967	5.04	0.499	274.265	136.858
113	24-05-1967	4.72	0.508	246.12	125.029
114	25-05-1967	4.69	0.496	248.619	123.315
115	26-05-1967	4.69	0.485	246.616	119.609
116	27-05-1967	4.51	0.538	214.797	115.561
117	28-05-1967	4.33	0.556	205.392	114.198
118	29-05-1967	4.27	0.52	202.838	105.476
119	30-05-1967	4.32	0.511	202.413	103.433
120	31-05-1967	4.36	0.509	202.919	103.286
121	01-06-1967	4.63	0.636	202.904	129.047
122	02-06-1967	4.88	0.628	230.057	144.476
123	30-08-1967	2.13	0.554	61.982	34.338
124	31-08-1967	2.07	0.555	58.51	32.473
125	31-08-1967	2.07	0.594	57.305	34.039
126	01-09-1967	2.07	0.573	56.515	32.383
127	01-09-1967	2.06	0.544	56.467	30.718
128	02-09-1967	2.04	0.543	56.565	30.715
129	03-09-1967	2.01	0.578	54.066	31.25
130	04-09-1967	2.27	0.597	65.157	38.899
131	04-09-1967	2.38	0.617	72.16	44.523
132	05-09-1967	2.44	0.6	74.862	44.917

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
133	05-09-1967	2.44	0.598	75.758	45.303
134	06-09-1967	2.37	2.464	17.603	43.373
135	02-12-1967	5.49	0.653	278.727	182.009
136	03-12-1967	5.75	0.667	287.69	191.889
137	04-12-1967	5.9	0.632	302.883	191.422
138	09-12-1967	5.07	0.658	223.652	147.163
139	21-12-1967	6.36	0.938	325.342	305.171
140	29-12-1967	6.46	0.982	354.826	348.439
141	30-12-1967	6.45	0.877	364.82	319.947
142	29-03-1968	6.22	4.135	301.871	1248.235
143	30-03-1968	6.43	1.188	252.849	300.385
144	02-04-1968	6.43	0.918	342.393	314.317
145	03-04-1968	6.41	1.063	325.124	345.607
146	05-04-1968	6.4	0.85	356.459	302.99
147	06-04-1968	6.39	0.828	349.207	289.143
148	08-04-1968	6.41	0.99	347.596	344.12
149	09-04-1968	6.42	0.915	343.804	314.581
150	10-04-1968	6.52	0.957	338.501	323.945
151	11-04-1968	6.65	1.214	329.446	399.947
152	12-04-1968	7	1.411	425.455	600.317
153	14-04-1968	6.96	1.38	462.509	638.262
154	16-04-1968	6.89	1.31	419.544	549.602
155	16-04-1968	6.89	1.285	416.462	535.154
156	18-04-1968	6.3	1.355	399.508	541.333
157	19-04-1968	6.93	1.374	455.481	625.831
158	20-04-1968	6.91	2.101	213.891	449.384
159	21-04-1968	6.9	1.293	448.514	579.929
160	22-04-1968	7.08	1.291	512.818	662.048
161	22-04-1968	7.08	1.412	464.661	656.101
162	23-04-1968	6.91	1.588	378.105	600.43
163	24-04-1968	6.84	1.377	355.76	489.881
164	25-04-1968	6.84	1.297	427.656	554.67
165	27-04-1968	6.83	1.307	427.353	558.55
166	28-04-1968	6.87	1.389	459.104	637.695
167	29-04-1968	6.79	1.38	416.135	574.266
168	02-05-1968	6.64	1.328	351.828	467.228
169	03-05-1968	6.61	1.192	416.675	496.677
170	05-05-1968	6.54	1.032	416.768	430.105
171	05-05-1968	6.53	1.06	212.723	225.486
172	06-05-1968	6.51	1.11	323.118	358.661
173	07-05-1968	6.47	0.973	409.765	398.701
174	09-05-1968	6.52	0.948	338.339	320.745
175	10-05-1968	6.28	0.898	379.44	340.737
176	11-05-1968	6.19	0.78	290.51	226.598
177	12-05-1968	6.12	0.691	349.146	241.26

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
178	13-05-1968	6.07	0.711	378.633	269.208
179	14-05-1968	6.04	0.332	690.777	229.338
180	17-05-1968	5.16	0.488	321.35	156.819
181	18-05-1968	4.89	0.537	284.75	152.911
182	18-05-1968	4.96	0.488	340.904	166.361
183	19-05-1968	4.85	0.537	260.81	140.055
184	20-05-1968	4.6	0.52	275.229	143.119
185	21-05-1968	4.53	0.443	278.693	123.461
186	22-05-1968	4.5	0.448	279.138	125.054
187	22-05-1968	4.51	0.556	235.04	130.682
188	23-05-1968	4.56	0.472	284.218	134.151
189	24-05-1968	4.69	0.507	283.448	143.708
190	24-05-1968	4.64	0.834	281.811	235.03
191	25-05-1968	4.74	0.523	283.547	148.295
192	27-05-1968	4.35	0.409	138.469	56.634
193	06-06-1968	5.8	0.614	312.593	191.932
194	07-06-1968	5.92	0.624	383.003	238.994
195	08-06-1968	5.95	0.588	403.139	237.046
196	09-06-1968	5.91	0.691	325.767	225.105
197	10-06-1968	5.78	0.663	339.119	224.836
198	11-06-1968	5.53	0.659	310.325	204.504
199	12-06-1968	5.21	1.302	245.326	319.414
200	13-06-1968	5.11	0.63	263.71	166.137
201	15-06-1968	4.73	0.541	260.767	141.075
202	16-06-1968	4.45	0.485	259.231	125.727
203	17-06-1968	4.22	0.477	242.801	115.816
204	18-06-1968	4.02	0.478	237.672	113.607
205	20-06-1968	3.83	0.432	224.699	97.07
206	21-06-1968	3.7	0.435	214.818	93.446
207	22-06-1968	3.61	0.43	207.437	89.198
208	23-06-1968	3.49	0.38	203.434	77.305
209	24-06-1968	3.43	0.44	176.336	77.588
210	25-06-1968	3.35	0.428	172.217	73.709
211	18-02-1969	1.79	0.468	54.859	25.674
212	19-02-1969	1.73	0.441	57.642	25.42
213	20-02-1969	1.66	0.399	52.586	20.982
214	21-02-1969	1.6	0.409	50.335	20.587
215	22-02-1969	1.56	0.405	49.758	20.152
216	23-02-1969	1.52	0.414	44.258	18.323
217	24-02-1969	1.49	0.395	46.833	18.499
218	25-02-1969	1.49	0.387	45.804	17.726
219	28-04-1969	5.52	0.354	498.506	176.471
220	28-04-1969	5.44	0.434	455.157	197.538
221	02-05-1969	6.15	0.414	622.012	257.513
222	07-05-1969	6.36	0.923	360.48	332.723

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
223	12-05-1969	6.44	0.452	785.292	354.952
224	12-05-1969	6.44	0.044	792.864	34.886
225	13-05-1969	6.44	0.456	783.991	357.5
226	14-05-1969	6.45	0.455	800.341	364.155
227	27-12-1969	1.93	0.604	55.421	33.474
228	29-12-1969	1.69	0.563	43.21	24.327
229	29-03-1970	4.36	0.722	154.213	111.342
230	30-03-1970	4.59	0.757	169.452	128.275
231	31-03-1970	4.83	0.828	190.831	158.008
232	02-04-1970	4.75	0.845	176.938	149.513
233	03-04-1970	4.81	0.865	184.895	159.934
234	04-04-1970	5	0.889	193.982	172.45
235	05-04-1970	5.43	0.885	205.258	181.653
236	06-04-1970	5.18	0.854	206.574	176.414
237	08-04-1970	4.54	0.852	167.276	142.519
238	09-04-1970	4.19	0.836	148.359	124.028
239	10-04-1970	4.07	0.826	146.863	121.309
240	12-04-1970	3.7	0.776	127.718	99.109
241	13-04-1970	3.65	2.566	33.393	85.687
242	24-04-1970	5.28	0.888	215.565	191.422
243	25-04-1970	5.36	0.886	218.289	193.404
244	07-05-1970	3.34	0.787	104.093	81.921
245	08-05-1970	3.4	0.827	106.831	88.349
246	10-05-1970	3.43	0.822	106.964	87.924
247	12-05-1970	3.23	0.824	97.597	80.42
248	13-05-1970	3.09	0.768	92.914	71.358
249	14-05-1970	3	0.766	90.569	69.376
250	15-05-1970	2.9	0.799	79.741	63.713
251	16-05-1970	2.82	0.799	75.31	60.173
252	17-05-1970	2.76	0.805	71.513	57.568
253	19-05-1970	2.65	0.836	65.033	54.368
254	21-05-1970	2.56	0.698	63.45	44.288
255	23-05-1970	2.52	0.655	63.032	41.286
256	24-05-1970	2.6	0.674	66.969	45.137
257	25-05-1970	2.58	0.703	62.917	44.231
258	26-05-1970	2.54	0.631	67.314	42.475
259	27-05-1970	2.69	0.66	74.439	49.13
260	29-05-1970	2.48	0.576	70.792	40.776
261	31-05-1970	2.38	0.605	60.846	36.812
262	02-06-1970	2.29	0.643	52.846	33.98
263	03-06-1970	2.26	0.646	51.724	33.414
264	04-06-1970	2.23	0.639	47.416	30.299
265	28-10-1970	1.3	0.277	31.906	8.838
266	29-10-1970	1.26	0.302	31.235	9.433
267	01-02-1971	2.42	0.682	71.328	48.646

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
268	20-02-1971	1.71	0.582	38.328	22.307
269	22-02-1971	1.71	0.582	38.447	22.376
270	24-04-1971	5.79	0.904	232.299	209.998
271	25-04-1971	5.99	0.851	246.167	209.488
272	30-04-1971	6.33	0.793	302.095	239.561
273	05-05-1971	6.16	0.845	288.865	244.091
274	15-05-1971	3.76	0.717	132.785	95.207
275	19-05-1971	3.26	0.702	101.085	70.962
276	20-05-1971	3.19	0.788	90.657	71.438
277	21-05-1971	3.47	0.812	103.615	84.135
278	22-05-1971	3.56	0.785	109.329	85.823
279	24-05-1971	3.51	0.753	111.673	84.09
280	25-05-1971	3.75	0.749	126.764	94.946
281	29-05-1971	3.24	0.673	114.655	77.163
282	01-06-1971	2.91	0.767	78.106	59.907
283	02-06-1971	2.82	0.778	73.377	57.087
284	03-06-1971	2.74	0.753	68.83	51.829
285	04-06-1971	2.64	0.762	66.395	50.593
286	06-06-1971	2.59	0.685	65.326	44.748
287	07-06-1971	2.47	0.7	58.143	40.7
288	17-07-1971	1.86	0.582	40.577	23.616
289	19-07-1971	1.83	0.55	40.865	22.476
290	04-08-1971	1.8	0.557	42.553	23.702
291	08-10-1971	1.15	0.319	21.68	6.916
292	09-10-1971	1.14	0.309	22.078	6.822
293	03-02-1972	1.63	0.533	28.882	15.394
294	13-02-1972	1.62	0.463	30.281	14.02
295	17-02-1972	1.64	0.527	30.009	15.815
296	19-02-1972	1.58	0.492	27.868	13.711
297	03-03-1972	1.63	0.535	28.852	15.436
298	13-03-1972	2.37	0.66	58.97	38.92
299	06-04-1972	3.82	0.731	126.389	92.39
300	13-04-1972	3.72	0.483	190.161	91.848
301	17-04-1972	4.48	0.93	135.72	126.22
302	24-04-1972	2.48	0.459	153.394	70.408
303	24-04-1972	2.48	0.386	107.334	41.431
304	27-04-1972	6.76	0.843	376.096	317.049
305	02-05-1972	6.78	0.685	394.53	270.253
306	11-05-1972	5.86	0.661	313.398	207.156
307	12-05-1972	5.65	0.631	293.002	184.884
308	14-05-1972	6.13	0.694	337.643	234.324
309	25-05-1972	6.46	0.729	401.868	292.962
310	26-05-1972	6.45	0.714	391.116	279.257
311	27-05-1972	6.47	0.75	389.251	291.938
312	02-06-1972	6.25	0.668	363.069	242.53

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
313	09-06-1972	3.96	0.526	192.559	101.286
314	18-09-1972	1.44	0.473	37.304	17.645
315	21-09-1972	1.45	0.504	39.688	20.003
316	22-09-1972	1.49	0.447	40.152	17.948
317	25-09-1972	1.58	0.476	49.914	23.759
318	29-09-1972	1.37	0.454	33.359	15.145
319	17-11-1972	2.96	0.67	104.11	69.754
320	18-11-1972	2.781	0.655	98.362	64.427
321	19-11-1972	2.781	0.652	92.431	60.265
322	08-12-1972	2.438	0.662	80.15	53.059
323	09-12-1972	2.344	0.636	75.648	48.112
324	11-12-1972	2.841	0.678	99.947	67.764
325	26-12-1972	2.505	0.694	77.291	53.64
326	27-12-1972	2.432	0.66	76.003	50.162
327	28-12-1972	2.326	0.653	71.083	46.417
328	30-01-1973	4.078	0.774	144.309	111.695
329	01-02-1973	3.44	0.831	106.043	88.122
330	02-02-1973	3.29	0.984	82.055	80.742
331	03-02-1973	3.11	0.751	89.281	67.05
332	04-02-1973	3.04	0.761	87.512	66.597
333	05-02-1973	2.8	0.786	81.095	63.741
334	06-02-1973	2.79	0.747	80.621	60.224
335	07-02-1973	2.68	0.816	71.463	58.314
336	08-02-1973	2.62	0.754	71.353	53.8
337	09-02-1973	2.53	0.679	70.081	47.585
338	10-02-1973	2.48	0.696	66.51	46.291
339	12-02-1973	2.4	0.622	65.215	40.564
340	14-02-1973	2.29	0.643	57.698	37.1
341	16-02-1973	3.493	0.778	118.332	92.062
342	19-02-1973	3.267	0.81	96.196	77.919
343	22-02-1973	3.06	0.782	94.875	74.192
344	23-02-1973	3.12	0.794	102.024	81.007
345	05-03-1973	5.096	0.811	206.054	167.11
346	07-03-1973	3.52	0.813	113.522	92.293
347	08-03-1973	3.115	0.798	94.051	75.053
348	09-03-1973	2.954	0.82	84.002	68.882
349	28-03-1973	3.6	0.778	129.229	100.54
350	29-03-1973	3.65	0.758	131.044	99.331
351	05-04-1973	3.14	0.713	104.424	74.454
352	06-04-1973	3.53	0.773	124.07	95.906
353	07-04-1973	3.79	0.702	153.574	107.809
354	19-04-1973	6.68	0.88	299.261	263.35
355	21-04-1973	6.16	0.809	312.225	252.59
356	24-04-1973	6.05	0.583	370.117	215.778
357	28-04-1973	5.21	0.732	223.402	163.53

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
358	06-05-1973	7.1	0.892	436.929	389.741
359	07-05-1973	7.03	0.914	446.138	407.77
360	08-05-1973	7.12	0.887	448.407	397.737
361	09-05-1973	7.25	0.931	468.12	435.82
362	10-05-1973	7.21	0.953	454.622	433.255
363	11-05-1973	7.16	0.917	466.017	427.338
364	12-05-1973	7.09	0.887	431.003	382.3
365	11-08-1973	1.69	0.469	43.642	20.468
366	12-08-1973	1.58	0.438	43.502	19.054
367	18-08-1973	1.77	0.476	48.5	23.086
368	26-08-1973	1.86	0.443	48.777	21.608
369	27-08-1973	1.77	0.492	42.561	20.94
370	29-08-1973	1.65	0.447	39.128	17.49
371	31-08-1973	1.68	0.534	37	19.758
372	01-09-1973	1.62	0.471	40.828	19.23
373	21-11-1973	1.67	0.513	44.52	22.839
374	24-11-1973	2.68	0.632	95.5	60.356
375	26-11-1973	2.93	0.6	113.187	67.912
376	27-11-1973	2.59	0.587	88.957	52.218
377	03-12-1973	1.48	0.436	38.39	16.738
378	04-12-1973	1.565	0.482	43.272	20.857
379	11-12-1973	2.65	0.584	92.772	54.179
380	14-12-1973	1.92	0.559	56.953	31.837
381	18-12-1973	1.81	0.478	55.753	26.65
382	10-01-1974	1.33	0.344	37.483	12.894
383	02-02-1974	2.34	0.593	81.121	48.105
384	04-02-1974	2.28	0.601	69.947	42.038
385	14-02-1974	1.36	0.497	23.974	11.915
386	29-03-1974	2.293	0.532	74.955	39.876
387	21-04-1974	4.54	0.738	182.913	134.99
388	22-04-1974	4.42	0.717	185.941	133.32
389	23-04-1974	4.015	0.735	154.952	113.89
390	24-04-1974	3.75	0.711	133.066	94.61
391	27-04-1974	3.73	0.752	134.348	101.03
392	29-04-1974	4.61	0.804	188.619	151.65
393	30-04-1974	5.41	0.773	235.912	182.36
394	01-05-1974	5.64	0.73	268.438	195.96
395	04-05-1974	6.605	0.812	369.803	300.28
396	07-05-1974	6.72	0.734	397.875	292.04
397	10-05-1974	7.125	0.782	492.468	385.11
398	11-05-1974	7	0.884	443.326	391.9
399	12-05-1974	6.18	0.76	439.658	334.14
400	29-05-1974	3.63	0.538	173.792	93.5
401	14-06-1974	2.77	0.313	100.16	31.35
402	15-06-1974	2.7	0.305	98.931	30.174

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
403	17-06-1974	2.63	0.565	96.775	54.678
404	18-06-1974	2.58	0.568	87.026	49.431
405	20-08-1974	1.48	0.474	35.295	16.73
406	21-08-1974	1.46	0.466	34.871	16.25
407	23-08-1974	1.42	0.481	31.476	15.14
408	24-08-1974	1.4	0.451	31.353	14.14
409	11-10-1974	1.93	0.599	54.925	32.9
410	14-10-1974	1.51	0.515	39.089	20.131
411	15-03-1975	1.9	0.806	36.514	29.43
412	25-03-1975	3.36	0.698	110.185	76.909
413	02-04-1975	2.13	0.656	74.396	48.804
414	02-04-1975	2.13	0.656	74.396	48.804
415	03-04-1975	2.65	0.766	62.59	47.944
416	04-04-1975	2.94	0.816	80.293	65.519
417	09-04-1975	4.36	1.179	116.641	137.52
418	10-04-1975	4.475	0.805	159.104	128.079
419	11-04-1975	4.41	0.839	162.813	136.6
420	12-04-1975	4.71	0.808	139.532	112.742
421	14-04-1975	5.26	0.703	252.723	177.664
422	15-04-1975	4.97	0.8	175.9	140.72
423	17-04-1975	4.95	0.833	172.761	143.91
424	19-04-1975	5.25	0.929	183.027	170.032
425	21-04-1975	5.08	0.938	143.977	135.05
426	22-04-1975	5.1	0.905	176.508	159.74
427	23-04-1975	5.31	0.904	189.978	171.74
428	24-04-1975	5.47	0.862	201.677	173.846
429	27-04-1975	6.05	0.91	259.501	236.146
430	30-04-1975	5.4	0.871	216.303	188.4
431	03-05-1975	5.33	0.765	220.562	168.73
432	05-05-1975	4.97	0.803	198.418	159.33
433	06-05-1975	4.98	0.828	197.536	163.56
434	08-05-1975	4.42	0.769	161.691	124.34
435	10-05-1975	3.62	0.665	120.168	79.912
436	20-05-1975	4.68	0.636	216.204	137.506
437	22-05-1975	5.255	1.015	173.645	176.25
438	23-05-1975	5.33	0.896	205.922	184.506
439	24-05-1975	5.24	0.854	204.496	174.64
440	27-05-1975	5.02	0.851	185.805	158.12
441	07-06-1975	3.295	0.73	106.618	77.831
442	09-06-1975	3.02	0.741	90.818	67.296
443	18-08-1975	1.43	0.284	51.218	14.546
444	18-03-1976	2.49	0.703	71.882	50.533
445	19-03-1976	2.8	0.681	74.449	50.7
446	20-03-1976	3.36	0.713	120.045	85.592
447	22-03-1976	3.64	0.799	115.829	92.547

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
448	31-03-1976	4.48	0.797	168.9	134.613
449	01-04-1976	4.64	0.819	171.188	140.203
450	05-04-1976	3.97	0.799	130.776	104.49
451	07-04-1976	3.93	0.797	133.915	106.73
452	08-04-1976	3.85	0.771	127.567	98.354
453	10-04-1976	3.33	0.76	101.48	77.125
454	14-04-1976	3.08	0.888	82.332	73.111
455	22-04-1976	4.04	0.768	139.193	106.9
456	23-04-1976	4.29	0.773	155.618	120.293
457	26-04-1976	5.03	0.857	176.399	151.174
458	27-04-1976	5.14	0.8	192.645	154.116
459	29-04-1976	5.33	0.851	197.899	168.412
460	30-04-1976	5.35	0.813	199.287	162.02
461	03-05-1976	4.92	0.87	187.141	162.813
462	05-05-1976	5.26	0.805	196.186	157.93
463	06-05-1976	5.45	0.881	201.487	177.51
464	07-05-1976	5.64	0.9	221.888	199.699
465	08-05-1976	5.92	0.878	236.761	207.876
466	09-05-1976	6.05	0.897	262.637	235.585
467	10-05-1976	6.09	0.915	272.689	249.51
468	12-05-1976	5.86	0.835	250.795	209.414
469	13-05-1976	5.59	0.759	238.366	180.92
470	15-05-1976	4.41	0.745	170.698	127.17
471	17-05-1976	3.87	0.716	140.489	100.59
472	18-05-1976	3.81	0.718	132.632	95.23
473	19-05-1976	3.85	0.754	143.21	107.98
474	21-05-1976	4.16	0.736	159.573	117.446
475	22-05-1976	4.1	0.747	153.253	114.48
476	24-05-1976	3.68	0.713	122.259	87.171
477	26-05-1976	3.29	0.693	107.489	74.49
478	29-05-1976	2.93	0.643	92.784	59.66
479	31-05-1976	2.82	0.668	81.841	54.67
480	01-06-1976	2.72	0.613	82.445	50.539
481	02-06-1976	2.66	0.671	78.733	52.83
482	07-06-1976	2.42	0.588	74.398	43.746
483	09-06-1976	2.37	0.721	60.57	43.671
484	11-06-1976	2.29	0.518	74.237	38.455
485	16-06-1976	2.7	0.641	82.574	52.93
486	11-08-1976	1.43	0.448	31.589	14.152
487	24-08-1976	1.326	0.441	26.488	11.681
488	24-03-1977	3.115	0.696	99.04	68.932
489	25-03-1977	1.93	0.565	54.984	31.066
490	26-03-1977	2.315	0.61	69.07	42.133
491	30-03-1977	3.6	0.666	126.356	84.153
492	31-03-1977	3.56	0.626	121.173	75.854

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
493	01-04-1977	3.06	0.66	95.464	63.006
494	02-04-1977	2.72	0.682	76.098	51.899
495	03-04-1977	2.63	0.648	79.4	51.451
496	05-04-1977	2.48	0.636	70.781	45.017
497	07-04-1977	2.73	0.655	82.687	54.16
498	14-04-1977	2.82	0.563	85.08	47.9
499	22-04-1977	2.38	0.622	68.473	42.59
500	23-04-1977	2.61	0.638	76.746	48.964
501	26-04-1977	3.765	0.681	125.85	85.704
502	28-04-1977	4.21	0.722	148.364	107.119
503	30-04-1977	4.93	0.708	195.016	138.071
504	02-05-1977	5.415	0.74	226.332	167.486
505	06-05-1977	5.405	0.75	216	162
506	07-05-1977	4.825	0.689	182.231	125.557
507	09-05-1977	3.69	0.725	110.566	80.16
508	16-05-1977	2.595	0.553	74.79	41.359
509	26-05-1977	2.54	0.606	77.611	47.032
510	27-05-1977	2.675	0.563	84.075	47.334
511	28-05-1977	3.325	0.648	105.519	68.376
512	20-03-1978	2.72	0.635	88.346	56.1
513	21-03-1978	3.19	0.677	101.507	68.72
514	22-03-1978	2.85	0.623	88.299	55.01
515	30-03-1978	6.06	0.726	237.92	172.73
516	03-04-1978	6.17	0.709	277.504	196.75
517	04-04-1978	6.085	0.734	293.719	215.59
518	06-04-1978	5.785	0.701	252.753	177.18
519	10-04-1978	5.53	0.672	220.833	148.4
520	11-04-1978	5.72	0.628	254.029	159.53
521	12-04-1978	5.78	0.708	258.39	182.94
522	17-04-1978	4.59	0.616	194.075	119.55
523	19-04-1978	4.75	0.651	202.949	132.12
524	20-04-1978	5.15	0.662	222.598	147.36
525	23-04-1978	5.99	0.546	368.297	201.09
526	24-04-1978	6.11	0.694	281.153	195.12
527	28-04-1978	6.255	1.021	259.589	265.04
528	29-04-1978	6.225	0.801	311.124	249.21
529	09-05-1978	4.03	0.543	179.355	97.39
530	10-05-1978	3.76	0.539	165.343	89.12
531	11-05-1978	3.58	0.523	155.679	81.42
532	13-05-1978	3.83	0.568	163.574	92.91
533	15-05-1978	3.61	0.58	147.5	85.55
534	16-05-1978	3.42	0.544	138.879	75.55
535	17-05-1978	3.3	0.558	130.932	73.06
536	18-05-1978	3.205	0.534	128.652	68.7
537	19-05-1978	3.115	0.523	123.518	64.6

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
538	20-05-1978	3.02	0.525	120.019	63.01
539	22-05-1978	2.9	0.513	114.581	58.78
540	23-05-1978	2.84	0.544	111.801	60.82
541	24-05-1978	3.15	0.612	121.699	74.48
542	25-05-1978	3.18	0.615	124.358	76.48
543	26-05-1978	2.99	0.584	116.61	68.1
544	30-05-1978	2.81	0.536	105.28	56.43
545	31-05-1978	2.715	0.599	95.292	57.08
546	06-06-1978	2.49	0.622	71.929	44.74
547	07-06-1978	2.48	0.645	70.822	45.68
548	10-06-1978	2.34	0.601	65.541	39.39
549	13-06-1978	2.22	0.601	61.431	36.92
550	15-06-1978	2.18	0.621	61.884	38.43
551	05-12-1978	4.74	0.591	154.966	91.585
552	06-12-1978	5.02	0.69	152.099	104.948
553	07-12-1978	5.38	0.738	178.027	131.384
554	08-12-1978	5.53	0.653	231.466	151.147
555	09-12-1978	5.6	0.788	231.939	182.768
556	10-12-1978	5.68	0.748	226.222	169.214
557	11-12-1978	5.81	0.774	255.293	197.597
558	13-12-1978	5.62	0.734	249.405	183.063
559	14-12-1978	5.37	0.723	229.562	165.973
560	15-12-1978	5.3	0.652	229.649	149.731
561	16-12-1978	5.42	0.737	230.064	169.557
562	17-12-1978	5.45	0.687	240.255	165.055
563	18-12-1978	5.93	0.776	275.369	213.686
564	19-12-1978	6.19	0.75	307.02	230.265
565	20-12-1978	6.37	0.77	335.174	258.084
566	29-12-1978	6.12	0.677	369.886	250.413
567	30-12-1978	6.04	0.637	365.95	233.11
568	01-01-1979	5.32	0.591	272.222	160.883
569	02-01-1979	4.95	0.6	244.308	146.585
570	03-01-1979	4.9	0.921	132.099	121.663
571	15-02-1979	4.29	0.806	149.64	120.61
572	16-02-1979	4.7	0.801	173.38	138.877
573	17-02-1979	5.015	0.781	207.006	161.672
574	18-02-1979	5.04	0.791	197.671	156.358
575	20-02-1979	5.1	0.791	203.049	160.612
576	21-02-1979	5.55	0.855	226.175	193.38
577	22-02-1979	5.7	0.822	226.046	185.81
578	23-02-1979	5.69	0.766	231.971	177.69
579	24-02-1979	5.78	0.802	251.683	201.85
580	26-02-1979	6.15	0.771	307.553	237.123
581	27-02-1979	6.3	0.79	328.329	259.38
582	28-02-1979	6.4	0.801	334.808	268.181

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
583	01-03-1979	6.405	0.784	343.236	269.097
584	08-03-1979	3.73	0.52	180.638	93.932
585	09-03-1979	3.52	0.494	165.387	81.701
586	10-03-1979	3.64	0.522	167.487	87.428
587	13-03-1979	3.81	0.56	181.109	101.421
588	14-03-1979	3.89	0.565	176.991	100
589	18-03-1979	4.9	0.685	225.915	154.752
590	20-03-1979	5.57	0.709	269.763	191.262
591	21-03-1979	5.74	0.701	291.763	204.526
592	23-03-1979	5.98	0.686	323.891	222.189
593	25-03-1979	6	0.575	341.437	196.326
594	26-03-1979	6.02	0.583	344.962	201.113
595	27-03-1979	6.06	0.628	348.763	219.023
596	28-03-1979	6.17	0.652	347.817	226.777
597	29-03-1979	6.32	1.08	247.222	267
598	30-03-1979	6.46	0.594	378.367	224.75
599	02-04-1979	6.65	0.663	403.192	267.316
600	09-04-1979	6.48	0.692	376.13	260.282
601	08-05-1979	6.77	1.049	418.341	438.84
602	09-05-1979	6.675	0.908	436.637	396.466
603	10-05-1979	6.775	0.974	442.811	431.298
604	11-05-1979	6.78	0.988	408.62	403.717
605	12-05-1979	6.5	0.593	383.592	227.47
606	15-05-1979	6.41	0.835	375.104	313.212
607	16-05-1979	6.33	0.879	271.019	238.226
608	17-05-1979	6.205	0.782	353.63	276.539
609	06-10-1979	1.27	0.448	36.882	16.523
610	08-10-1979	1.24	0.355	41.885	14.869
611	10-10-1979	1.22	0.409	45.533	18.623
612	11-10-1979	1.28	0.439	42.285	18.563
613	26-05-1980	3.49	0.649	109.778	71.246
614	27-05-1980	3.36	0.705	97.756	68.918
615	27-05-1980	3.31	0.719	94.238	67.757
616	03-12-1980	1.635	0.531	49.55	26.311
617	04-12-1980	2.18	0.582	68.43	39.826
618	05-12-1980	2.52	0.694	71.916	49.91
619	05-02-1981	2.8	0.628	92.76	58.253
620	06-02-1981	2.435	0.624	77.994	48.668
621	07-02-1981	2.24	0.699	61.096	42.706
622	09-02-1981	2.04	0.725	53.411	38.723
623	10-02-1981	1.94	0.609	57.054	34.746
624	11-02-1981	1.88	0.598	53.562	32.03
625	12-02-1981	1.82	0.551	52.474	28.913
626	13-02-1981	1.78	0.559	49.369	27.597
627	14-02-1981	1.78	0.586	48.208	28.25

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
628	16-02-1981	2.5	0.622	84.1	52.31
629	17-02-1981	2.44	0.673	74.661	50.247
630	18-02-1981	2.44	0.617	79.825	49.252
631	19-02-1981	2.54	0.652	78.917	51.454
632	20-02-1981	2.32	0.648	71.162	46.113
633	21-02-1981	2.2	0.641	63.027	40.4
634	23-02-1981	2.68	0.712	80.732	57.481
635	24-02-1981	2.4	0.669	69.297	46.36
636	03-03-1981	1.75	0.565	47.485	26.829
637	10-03-1981	1.52	0.536	43.547	23.341
638	11-03-1981	1.48	0.504	36.244	18.267
639	16-03-1981	1.405	0.524	34.21	17.926
640	20-03-1981	1.48	0.465	43.314	20.141
641	21-03-1981	1.46	0.443	34.745	15.392
642	23-03-1981	2.23	0.598	63.744	38.119
643	24-03-1981	2.43	0.671	73.323	49.2
644	25-03-1981	2.61	0.625	82.602	51.626
645	26-03-1981	2.28	0.589	70.569	41.565
646	04-04-1981	3.89	0.806	113.252	91.281
647	06-04-1981	2.92	0.781	83.169	64.955
648	13-04-1981	3.1	0.686	82.054	56.289
649	14-04-1981	4.2	0.749	153.324	114.84
650	17-04-1981	3.98	0.808	129.401	104.556
651	20-04-1981	4.67	0.863	190.171	164.118
652	21-04-1981	4.75	0.625	202.485	126.553
653	22-04-1981	4.73	0.76	199.721	151.788
654	25-04-1981	4.6	0.871	188.037	163.78
655	05-05-1981	5.75	0.872	278.407	242.771
656	06-05-1981	5.68	0.861	265.496	228.592
657	07-05-1981	5.71	0.883	284.085	250.847
658	08-05-1981	5.81	0.852	284.487	242.383
659	09-05-1981	5.91	1.211	226.733	274.574
660	12-05-1981	6.18	0.959	332.425	318.796
661	13-05-1981	6.36	0.943	343.001	323.45
662	14-05-1981	6.65	0.887	389.317	345.324
663	18-05-1981	6.39	0.87	416.711	362.539
664	21-05-1981	7	0.924	437.592	404.335
665	22-07-1981	2.36	0.669	66.952	44.791
666	11-03-1982	1.44	0.267	36.663	9.789
667	12-03-1982	1.49	0.248	35.468	8.796
668	17-03-1982	1.22	0.205	33.039	6.773
669	18-03-1982	1.45	0.23	41.53	9.552
670	19-03-1982	1.81	0.252	53.921	13.588
671	20-03-1982	1.9	0.277	57.029	15.797
672	21-03-1982	1.92	0.275	58.618	16.12

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
673	22-03-1982	1.88	0.282	56.667	15.98
674	23-03-1982	1.78	0.282	48.177	13.586
675	24-03-1982	1.89	0.283	47.057	13.317
676	25-03-1982	1.84	0.275	51.273	14.1
677	26-03-1982	1.68	0.277	40.419	11.196
678	30-03-1982	1.4	0.241	36.021	8.681
679	01-04-1982	1.34	0.237	36.076	8.55
680	02-04-1982	1.41	0.257	34.918	8.974
681	03-04-1982	1.57	0.26	40.546	10.542
682	04-04-1982	1.72	0.279	51.276	14.306
683	05-04-1982	1.93	0.276	55.435	15.3
684	07-04-1982	3.11	0.323	111.83	36.121
685	07-04-1982	3.38	0.388	109.66	42.548
686	07-04-1982	3.33	0.333	134.661	44.842
687	08-04-1982	3.63	0.351	136.872	48.042
688	09-04-1982	3.75	0.356	146.416	52.124
689	14-04-1982	3.05	0.358	103.67	37.114
690	15-04-1982	3.04	0.22	93.664	20.606
691	16-04-1982	3.15	0.375	103.821	38.933
692	19-04-1982	3.13	0.37	105.822	39.154
693	20-04-1982	3.12	0.36	99.886	35.959
694	21-04-1982	3.32	0.371	109.825	40.745
695	22-04-1982	3.9	0.374	147.88	55.307
696	22-04-1982	3.81	0.378	132.86	50.221
697	23-04-1982	4.07	0.373	155.399	57.964
698	24-04-1982	4.37	0.379	174.327	66.07
699	25-04-1982	4.23	0.393	155.519	61.119
700	28-04-1982	3.05	0.368	96.848	35.64
701	30-04-1982	2.69	0.356	71.784	25.555
702	01-05-1982	2.6	0.345	71.632	24.713
703	02-05-1982	2.84	0.369	83.71	30.889
704	05-05-1982	3.11	0.38	98.887	37.577
705	06-05-1982	3.88	0.369	136.184	50.252
706	06-05-1982	3.78	0.377	133.817	50.449
707	07-05-1982	4.03	0.389	140.383	54.609
708	08-05-1982	4.22	0.367	158.91	58.32
709	10-05-1982	4.46	0.415	154.294	64.032
710	11-05-1982	4.66	0.392	182.673	71.608
711	12-05-1982	4.78	0.392	184.569	72.351
712	13-05-1982	4.93	0.412	182.051	75.005
713	14-05-1982	5.14	0.341	205.806	70.18
714	15-05-1982	5.34	0.362	213.997	77.467
715	16-05-1982	5.49	0.424	214.634	91.005
716	19-05-1982	4.47	0.398	161.93	64.448
717	20-05-1982	3.85	0.41	131.649	53.976

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
718	21-05-1982	3.45	0.357	112.417	40.133
719	22-05-1982	3.19	0.35	101.266	35.443
720	24-05-1982	3.17	0.349	102.453	35.756
721	25-05-1982	3.03	0.314	93.615	29.395
722	26-05-1982	2.87	0.345	82.38	28.421
723	10-06-1982	1.33	0.353	44.584	15.738
724	03-09-1982	1.405	0.397	45.295	17.982
725	07-09-1982	1.385	0.387	47.163	18.252
726	11-09-1982	1.31	0.353	42.411	14.971
727	13-09-1982	1.29	0.352	40.804	14.363
728	17-09-1982	1.38	0.385	44.143	16.995
729	02-05-1983	4.64	0.811	175.568	142.386
730	03-05-1983	4.9	0.807	197.914	159.717
731	04-05-1983	5.15	0.868	211.063	183.203
732	05-05-1983	5.33	0.841	219.954	184.981
733	06-05-1983	5.4	0.863	230.977	199.333
734	07-05-1983	5.48	0.858	228.49	196.044
735	09-05-1983	5.55	0.881	231.264	203.744
736	10-05-1983	5.62	0.851	229.096	194.961
737	11-05-1983	5.7	0.887	236.207	209.516
738	12-05-1983	5.86	0.911	241.212	219.744
739	13-05-1983	5.88	0.879	250.053	219.797
740	14-05-1983	5.72	0.885	233.401	206.56
741	19-05-1983	5.76	0.881	251.472	221.547
742	20-05-1983	5.8	0.885	251.637	222.699
743	23-05-1983	5.76	0.846	236.725	200.269
744	25-05-1983	5.65	0.824	247.443	203.893
745	26-05-1983	5.5	0.794	241.136	191.462
746	30-05-1983	5.16	0.771	216.612	167.008
747	01-06-1983	5.42	0.834	228.159	190.285
748	02-06-1983	5.64	0.841	226.875	190.802
749	05-06-1983	5.72	0.84	264.021	221.778
750	08-06-1983	5.05	0.734	217.549	159.681
751	09-06-1983	4.6	0.734	184.627	135.516
752	10-06-1983	4.25	0.693	165.719	114.843
753	11-06-1983	3.88	0.672	140.207	94.219
754	15-02-1984	2.04	0.48	64.956	31.179
755	16-02-1984	1.89	0.486	57.012	27.708
756	17-02-1984	2.96	0.67	94.212	63.122
757	17-02-1984	1.86	0.482	58.581	28.236
758	18-02-1984	1.98	0.571	64.497	36.828
759	20-02-1984	2.91	0.703	109.073	76.678
760	21-02-1984	2.96	0.662	118.322	78.329
761	22-02-1984	3.02	0.73	112.279	81.964
762	23-02-1984	2.96	0.695	97.45	67.728

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
763	24-02-1984	2.72	0.654	86.731	56.722
764	25-02-1984	2.47	0.584	80.152	46.809
765	27-02-1984	2.13	0.54	66.089	35.688
766	28-02-1984	1.92	0.55	62.805	34.543
767	01-03-1984	1.73	0.465	52.856	24.578
768	02-03-1984	1.68	0.423	50.809	21.492
769	03-03-1984	1.63	0.419	53.945	22.603
770	05-03-1984	1.6	1	22.495	22.495
771	10-03-1984	1.46	0.361	42.396	15.305
772	12-03-1984	1.42	0.351	42.593	14.95
773	13-03-1984	1.4	0.33	40.739	13.444
774	14-03-1984	1.44	0.395	41.248	16.293
775	15-03-1984	1.74	0.47	52.289	24.576
776	16-03-1984	2.62	0.633	87.15	55.166
777	20-03-1984	2.54	0.618	81.482	50.356
778	21-03-1984	2.55	0.643	82.432	53.004
779	22-03-1984	2.585	0.63	83.921	52.87
780	24-03-1984	2.35	0.58	76.636	44.449
781	28-03-1984	2	0.45	61.338	27.602
782	02-04-1984	2.48	0.59	92.671	54.676
783	04-04-1984	2.79	0.581	109.497	63.618
784	13-04-1984	3.1	0.73	99.44	72.591
785	16-04-1984	3.28	0.728	115.474	84.065
786	18-04-1984	3.73	0.765	126.241	96.574
787	19-04-1984	3.7	0.744	134.462	100.04
788	21-04-1984	3.16	0.761	105.854	80.555
789	24-04-1984	3.59	0.762	129.013	98.308
790	25-04-1984	4.1	0.785	149.164	117.094
791	28-04-1984	5.28	0.857	215.218	184.442
792	28-09-1984	1.1	0.419	29.2	12.235
793	04-10-1984	1.04	0.216	40.435	8.734
794	09-10-1984	1.02	0.212	39.297	8.331
795	11-10-1984	1.87	0.497	71.181	35.377
796	12-10-1984	1.98	0.493	74.519	36.738
797	13-10-1984	1.89	0.452	78.305	35.394
798	15-10-1984	1.54	0.378	54.741	20.692
799	19-10-1984	1.22	0.264	48.5	12.804
800	20-10-1984	1.2	0.269	47.996	12.911
801	22-10-1984	1.14	0.253	47.672	12.061
802	16-05-1985	6.3	0.739	399.138	294.963
803	17-05-1985	6.26	0.835	372.29	310.862
804	18-05-1985	6.16	0.81	347.699	281.636
805	19-05-1985	5.94	0.8	309.493	247.594
806	20-05-1985	5.34	0.659	297.781	196.238
807	21-05-1985	4.52	0.558	244.382	136.365

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
808	22-05-1985	4.22	0.455	211.308	96.145
809	23-05-1985	3.86	0.506	208.318	105.409
810	24-05-1985	3.48	0.484	183.079	88.61
811	25-05-1985	3.38	0.475	166.425	79.052
812	26-05-1985	3.3	0.454	167.601	76.091
813	27-05-1985	3.16	0.462	156.89	72.483
814	28-05-1985	3.06	0.443	151.108	66.941
815	29-05-1985	3	0.448	147.388	66.03
816	30-05-1985	2.88	0.432	141.856	61.282
817	31-05-1985	2.82	0.414	138.529	57.351
818	04-06-1985	2.55	0.375	119.411	44.779
819	05-06-1985	2.52	0.364	116.387	42.365
820	06-06-1985	2.48	0.381	117.793	44.879
821	07-06-1985	2.44	0.364	114.857	41.808
822	21-11-1985	1.9	1.895	15.991	30.302
823	22-11-1985	1.72	0.454	29.401	13.348
824	23-11-1985	1.62	0.478	52.849	25.262
825	24-11-1985	1.53	0.428	47.748	20.436
826	26-11-1985	1.22	0.59	90.085	53.15
827	27-11-1985	2.73	0.614	108.264	66.474
828	28-11-1985	2.4	0.632	76.429	48.303
829	29-11-1985	2.2	0.63	69.983	44.089
830	04-12-1985	2.24	0.584	102.87	60.076
831	05-12-1985	2.12	0.475	70.636	33.552
832	06-12-1985	2.02	0.488	71.027	34.661
833	12-12-1985	2.04	0.493	72.144	35.567
834	19-12-1985	2.24	0.518	63.664	32.978
835	20-02-1986	2.06	1.413	54.552	77.082
836	24-02-1986	2.04	0.495	59.418	29.412
837	25-02-1986	1.92	0.609	38.736	23.59
838	26-02-1986	1.8	0.546	45.5	24.843
839	27-02-1986	1.74	0.558	42.758	23.859
840	28-02-1986	1.68	0.461	52.51	24.207
841	03-03-1986	1.56	0.463	47.099	21.807
842	05-03-1986	1.47	0.484	42.758	20.695
843	07-03-1986	1.52	0.462	43.71	20.194
844	10-03-1986	1.48	0.426	38.85	16.55
845	01-04-1986	3.9	0.664	137.187	91.092
846	02-04-1986	4.1	0.71	138.815	98.559
847	03-04-1986	4.04	0.7	137.099	95.969
848	04-04-1986	3.94	0.686	139.554	95.734
849	06-04-1986	3.76	0.695	121.456	84.412
850	07-04-1986	4	0.678	140.77	95.442
851	09-04-1986	5.02	0.7	196.106	137.274
852	11-04-1986	6.26	0.808	288.959	233.479

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
853	12-04-1986	6.68	0.795	325.597	258.85
854	13-04-1986	6.65	0.802	329.397	264.176
855	14-04-1986	6.56	0.679	310.741	210.993
856	15-04-1986	6.64	0.776	353.152	274.046
857	17-04-1986	6.96	0.744	411.569	306.207
858	21-04-1986	6.44	0.664	337.334	223.99
859	22-04-1986	6.32	0.642	332.872	213.704
860	23-04-1986	6.16	0.613	330.688	202.712
861	29-04-1986	4.28	0.444	185.495	82.36
862	02-05-1986	3.82	0.468	156.66	73.317
863	05-05-1986	3.88	0.541	159.898	86.505
864	03-06-1987	3.26	0.692	97.127	67.212
865	04-06-1987	3.12	0.669	96.457	64.53
866	05-06-1987	2.98	0.601	91.705	55.115
867	06-06-1987	2.9	0.633	90.213	57.105
868	08-06-1987	2.741	0.561	74.371	41.722
869	09-06-1987	2.66	0.553	73.595	40.698
870	10-06-1987	2.6	0.551	66.419	36.597
871	11-06-1987	2.54	0.53	65.251	34.583
872	12-06-1987	2.48	0.502	64.743	32.501
873	14-06-1987	2.38	0.484	61.233	29.637
874	16-06-1987	2.3	0.486	56.496	27.457
875	18-06-1987	2.22	0.477	55.164	26.313
876	20-06-1987	2.16	0.435	54.354	23.644
877	22-06-1987	2.1	0.417	51.854	21.623
878	15-02-1988	1.72	0.514	55.401	28.476
879	16-02-1988	1.62	0.533	42.657	22.736
880	18-02-1988	1.7	0.488	49.072	23.947
881	19-02-1988	1.64	0.451	42.186	19.026
882	23-02-1988	1.4	0.44	35.405	15.578
883	25-02-1988	1.34	0.413	34.847	14.392
884	02-03-1988	2.33	0.597	68.362	40.812
885	03-03-1988	2.1	0.57	57.295	32.658
886	05-04-1988	1.76	0.507	47.897	24.284
887	01-05-1988	3.5	0.762	79.497	60.577
888	01-05-1988	3.52	0.779	89.454	69.685
889	02-05-1988	3.46	0.796	78.926	62.825
890	02-05-1988	3.495	0.773	77.668	60.037
891	03-05-1988	3.36	0.7	76.14	53.298
892	04-05-1988	3.14	0.7	64.543	45.18
893	04-05-1988	3.22	0.822	67.164	55.209
894	05-05-1988	3.02	0.783	50.229	39.329
895	05-05-1988	2.975	0.676	59.444	40.184
896	06-05-1988	2.815	0.683	54.274	37.069
897	19-05-1988	4.4	0.897	99.116	88.907

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
898	01-03-1989	1.9	0.479	38.86	18.614
899	02-03-1989	1.86	0.46	38.646	17.777
900	03-03-1989	1.82	0.434	43.901	19.053
901	06-03-1989	1.74	0.515	20.992	10.811
902	08-03-1989	1.7	0.499	20.22	10.09
903	24-03-1989	1.94	0.499	42.485	21.2
904	02-04-1989	2.6	0.521	78.702	41.004
905	03-04-1989	2.5	0.567	74.436	42.205
906	04-04-1989	2.48	0.579	75.534	43.734
907	05-04-1989	2.81	0.614	87.313	53.61
908	06-04-1989	2.98	0.551	89.78	49.469
909	07-04-1989	2.97	0.549	91.395	50.176
910	12-04-1989	3.2	1.483	41.075	60.914
911	13-04-1989	3.34	0.62	102.81	63.742
912	14-04-1989	3.82	0.66	135.492	89.425
913	15-04-1989	4.08	0.723	124.382	89.928
914	18-04-1989	4.32	0.745	152.672	113.741
915	19-04-1989	4.46	0.716	156.105	111.771
916	20-04-1989	4.59	0.668	164.344	109.782
917	23-04-1989	5.46	0.761	192.742	146.677
918	24-04-1989	5.64	0.705	189.082	133.303
919	25-04-1989	5.76	0.731	205.521	150.236
920	26-04-1989	5.84	0.489	206.135	100.8
921	05-05-1989	6	0.656	265.102	173.907
922	09-05-1989	5.64	0.736	213.757	157.325
923	10-05-1989	5.52	0.667	182.421	121.675
924	12-05-1989	5.2	0.668	191.87	128.169
925	13-03-1990	6.45	0.808	375.532	303.43
926	13-03-1990	6.46	0.797	380.981	303.642
927	14-03-1990	6.34	0.801	370.311	296.619
928	14-03-1990	6.3	0.644	384.071	247.342
929	16-03-1990	5.98	0.688	331.222	227.881
930	17-03-1990	6.14	0.711	334.706	237.976
931	19-03-1990	6.4	0.788	383.829	302.457
932	29-03-1991	1.43	0.28	17.211	4.819
933	30-03-1991	1.44	0.371	16.07	5.962
934	31-03-1991	1.48	0.427	15.384	6.569
935	14-05-1991	3.72	1.27	102.506	130.182
936	15-05-1991	3.86	0.811	103.428	83.88
937	16-05-1991	4	1.01	112.376	113.5
938	19-05-1991	3.64	0.806	96.52	77.795
939	20-05-1991	3.58	78.833	0.89	70.161
940	22-05-1991	3.6	0.779	90.249	70.304
941	24-05-1991	3.78	0.781	108.348	84.62
942	26-05-1991	3.96	0.816	110.571	90.226

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
943	29-05-1991	3.73	0.796	103.754	82.588
944	18-06-1991	2.19	0.779	50.049	38.988
945	20-06-1991	2.12	0.511	42.002	21.463
946	31-10-1991	1.18	0.303	17.125	5.189
947	01-11-1991	1.22	0.304	22.674	6.893
948	02-11-1991	1.16	0.31	18.8	5.828
949	03-11-1991	1.16	0.328	19.939	6.54
950	04-11-1991	1.14	0.304	19.27	5.858
951	06-11-1991	1.13	2.059	2.8	5.765
952	19-11-1991	1.44	0.43	32.67	14.048
953	20-11-1991	1.35	0.456	27.075	12.346
954	05-02-1992	1.36	0.383	12.292	4.708
955	06-02-1992	1.36	0.388	13.034	5.057
956	07-02-1992	1.36	0.389	12.661	4.925
957	08-02-1992	1.34	0.383	11.809	4.523
958	09-02-1992	1.34	0.396	10.24	4.055
959	10-02-1992	1.44	0.407	14.423	5.87
960	10-05-1992	1.44	0.465	14.482	6.734
961	12-05-1992	5.97	0.667	381.877	254.712
962	13-05-1992	5.98	0.635	356.953	226.665
963	14-05-1992	5.98	0.709	363.633	257.816
964	16-05-1992	6.01	0.668	368.942	246.453
965	18-05-1992	5.84	0.621	288.831	179.364
966	19-05-1992	5.54	0.605	301.241	182.251
967	20-05-1992	5.24	0.554	274.413	152.025
968	08-05-1993	6.85	0.97	430.472	417.558
969	09-05-1993	6.74	0.831	420.752	349.645
970	10-05-1993	6.64	0.791	406.142	321.258
971	12-05-1993	6.72	0.778	432.023	336.114
972	13-05-1993	6.65	0.799	415.335	331.853
973	14-05-1993	6.57	0.797	373.073	297.339
974	17-06-1994	2.3	0.485	49.672	24.091
975	18-06-1994	2.27	0.4	44.865	17.946
976	19-06-1994	2.3	0.419	50.272	21.064
977	20-06-1994	2.25	0.453	46.464	21.048
978	21-06-1994	2.2	0.427	45.747	19.534
979	22-06-1994	2.06	0.402	43.955	17.67
980	11-04-2003	2.96	0.27	104.696	28.268
981	11-04-2003	2.88	0.295	97.193	28.672
982	12-04-2003	2.88	0.92	30.895	28.423
983	13-04-2003	2.76	0.296	87.132	25.791
984	14-04-2003	2.55	0.327	83.031	27.151
985	15-04-2003	2.39	0.313	76.843	24.052
986	16-04-2003	2.31	0.3	74.23	22.269
987	17-04-2003	2.45	0.309	79.259	24.491

SNo.	Date	Stage (metres)	Velocity (m/s)	Area (m2)	Measured (cumecs)
988	18-04-2003	2.4	0.382	73.081	27.917
989	11-06-2003	1.75	0.537	36.97	19.853
990	19-06-2003	1.48	0.153	45.065	6.895
991	20-06-2003	1.45	0.225	42.96	9.666
992	21-06-2003	1.45	0.176	46.352	8.158
993	01-07-2003	1.45	0.209	44.378	9.275
994	02-07-2003	1.42	0.197	42.33	8.339
995	03-07-2003	1.41	0.2	40.81	8.162
996	17-07-2003	1.37	0.183	35.929	6.575
997	18-07-2003	1.29	0.177	31.475	5.571
998	19-07-2003	1.28	0.185	35.265	6.524
999	04-08-2003	1.15	0.188	18.601	3.497
1000	05-08-2003	1.15	0.166	19.066	3.165
1001	06-08-2003	1.13	0.174	18.931	3.294
1002	07-08-2003	1.12	0.177	18.599	3.292
1003	08-08-2003	1.11	0.181	18.575	3.362
1004	09-08-2003	1.09	0.173	18.509	3.202
1005	10-08-2003	1.13	0.186	18.882	3.512
1006	11-08-2003	1.13	0.184	19.141	3.522
1007	13-08-2003	1.1	0.177	18.051	3.195
1008	17-03-2004	3.33	0.596	64.391	38.377
1009	08-04-2004	4.625	0.743	148.851	110.596
1010	09-04-2004	4.37	0.741	141.501	104.852
1011	10-04-2004	4.05	0.718	121.812	87.461
1012	11-04-2004	4.1	0.767	121.695	93.34
1013	12-04-2004	3.995	0.756	126.901	95.937
1014	13-04-2004	4.26	0.72	144.389	103.96
1015	14-04-2004	4.625	0.872	148.165	129.2
1016	15-04-2004	5.155	0.732	178.264	130.489
1017	16-04-2004	4.845	0.732	162.709	119.103
1018	17-04-2004	5.645	0.592	254.988	150.953
1019	20-04-2004	5.895	0.669	277.664	185.757
1020	21-04-2004	6.14	0.69	284.677	196.427
1021	23-04-2004	6.21	0.652	298.845	194.847
1022	27-04-2004	5.67	0.585	260.851	152.598
1023	28-04-2004	5.56	0.585	258.267	151.086
1024	29-04-2004	5.51	0.623	268.125	167.042
1025	30-04-2004	5.46	0.612	256.292	156.851
1026	16-04-2008	6.485	0.899	185.588	166.844
1027	17-04-2008	6.59	0.796	220.09	175.192
1028	01-02-2009	1.09	0.407	16.135	6.567
1029	12-05-2009	5.61	0.963	176.61	170.075
1030	13-05-2009	5.67	0.731	180.959	132.281
1031	14-05-2009	5.7	0.845	173.963	146.999
1032	11-06-2009	2.34	0.51	49.751	25.373