THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF WATER AND IRRIGATION

2016/2017 ANNUAL BASIN HYDROLOGICAL REPORT

WAMI/RUVU BASIN WATER BOARD

P.O.BOX 826 MOROGORO

TANZANIA

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1. INTRODUCTION

Background

Wami/Ruvu Basin is one of the nine Rivers and Lakes Basins of Tanzania. The basin was established in 2002, and it operates under the Wami/Ruvu Water Board and the overall in charge is the Water Officer who is also the secretary of the Board. Wami/Ruvu Basin Water Board has the mandate to manage water resources in the basin.

Location of the Basin

Wami/Ruvu Basin is located to the Eastern side of Tanzania (**Figure 1**), which lies between Longitudes 350 30' 00" to 400 00' 00" E and Latitudes 050 00' 00" to 070 30' 00". The Basin covers an area of about 66,820 km^2 covering the six regions, Dar es Salaam, parts of Coast, Morogoro, Dodoma, Tanga and Manyara. It has two major Rivers of Wami and Ruvu covering an area of 43,946 and 18,078 km^2 respectively. The Coastal sub basin which consist Mpiji, Sinza, Mlalakuwa, Msimbazi, Mbezi, Mzinga and Kizinga rivers covers an area of 4,796 km^2, shows the locaton of Wami Ruvu Basin.

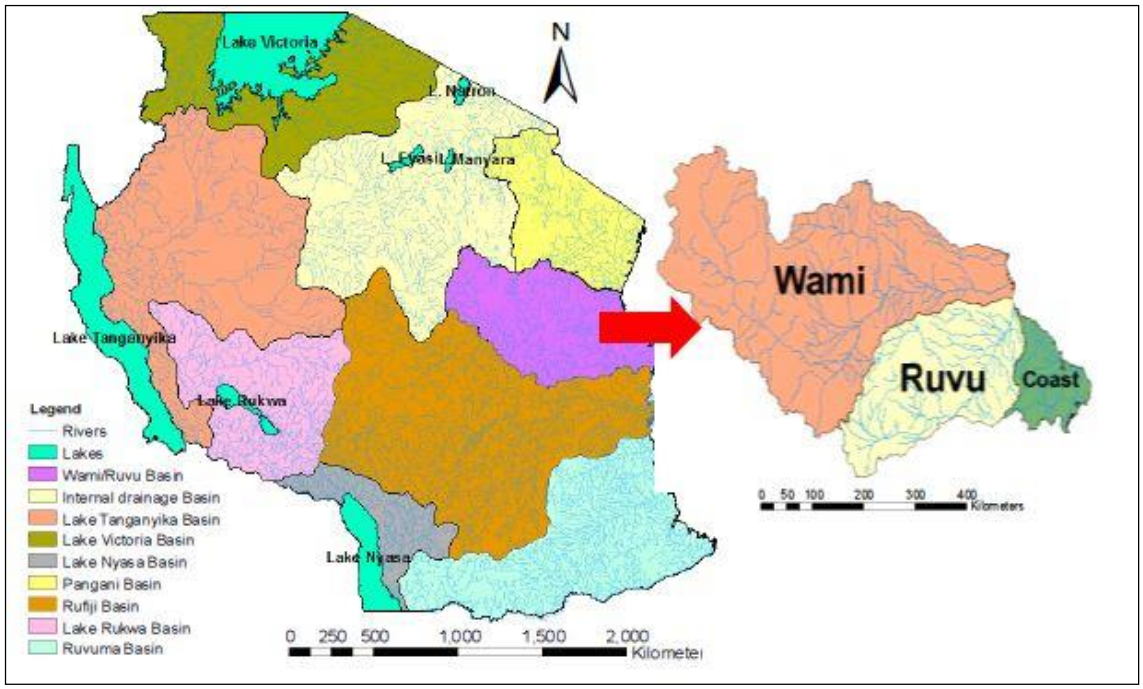

Figure 1 Nine River and Lake Basins in Tanzania and Location of Wami Ruvu Basin.

Physiography

1.2.1 Topography

The basin is covered by low lying and mountainous landscapes as follows;

Mountainous landscapes

- Uluguru mountains located south east, the source of Ruvu River (altitude 400 to 2500 m.a.s.l)
- Nguru Mountains located west of Kilosa (altitude 400 to 2000 m.a.s.l)
- Rubeho Mountains located west of Kilosa (altitude 500 to 1000 m.a.s.l)
- Ukaguru Mountains located South west of Wami River (altitude 400 to 1000 m.a.s.l)
- Nguu Mountains located western part of Wami River (altitude 400 to 2000 m.a.s.l)
- Low lying land
- Mkata plains (Altitude 400-800 m.a.m.s.l)
- Lower Wami (Altitude 200-400 m.a.m.s.l)
- Kisaki located south east of Uluguru mountain (altitude 140 – 200 m.a.m.s.l)

- Kimbiji and Mbezi located to the southern coastal area of Dar es Salaam (altitude 50 – 100 m.a.s.l)

1.2.2 Drainage Pattern

The Basin is sub divided into three Catchments (Ruvu, Wami and Coast) in which seven sub catchments (Kinyasungwe, Mkondoa, Wami, Upper Ruvu, Ngerengere, Lower Ruvu and Coast) are found. Many rivers in Wami catchment originate from Chenene, Nguru, Nguu and Rubeho Mountains and flows eastward towards the Indian Ocean. Most rivers in Wami basin are seasonal while few are perennial. Originally, some of Ruvu river tributaries were perennial originating from Uluguru Mountains and flow eastward towards the Indian Ocean. **Figure 2** shows the major rivers in the Wami/Ruvu Basin.

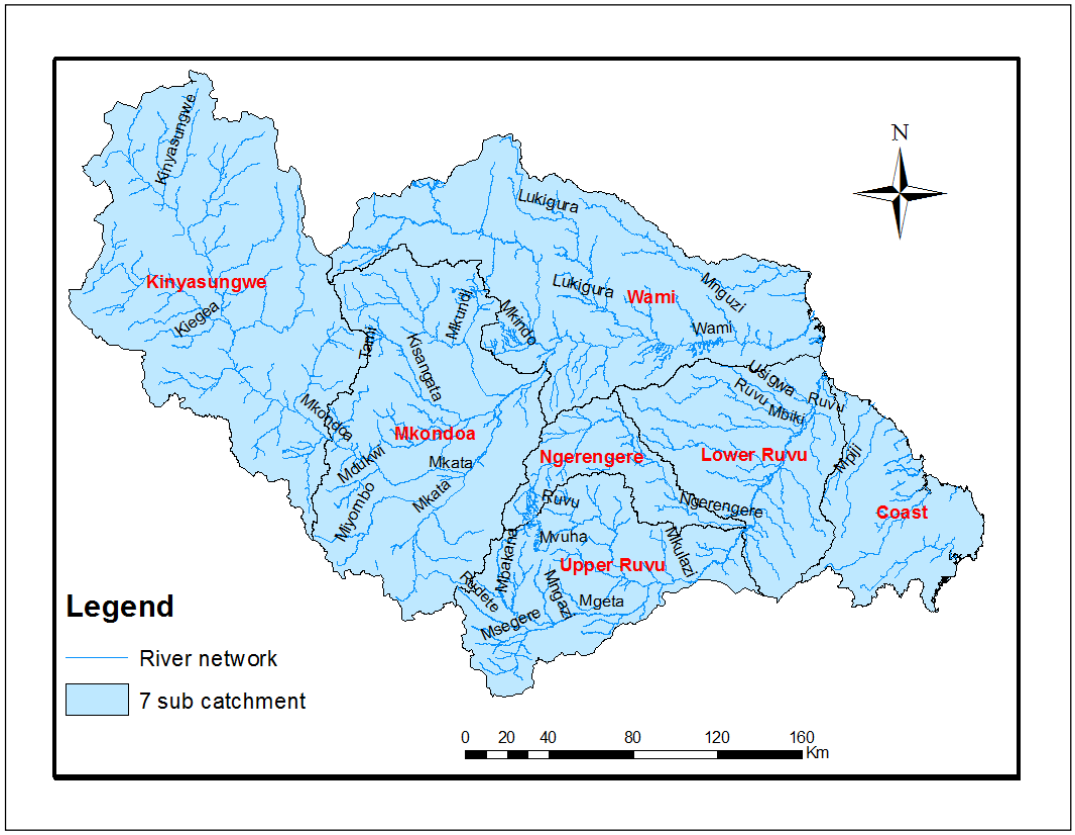

Figure 2 Major rivers in Wami/Ruvu Basin

1.2.3 Soils

Generally, the catchment is characterized by 12 main types of soils namely: Cambisols, Ferralsols, Acrisols, Fluvisols, Luvisols, Lixisols, Arenosols, Leptosols, Nitisols, Vertisols, Planosols and Haplic Phaeozems. The dominant soils are Cambisols which covers parts of Bagamoyo, Kisarawe, Mkuranga, Morogoro Rural, Dodoma Urban, Bahi and Chamwino. The map below shows the distribution (**Figure 3**).

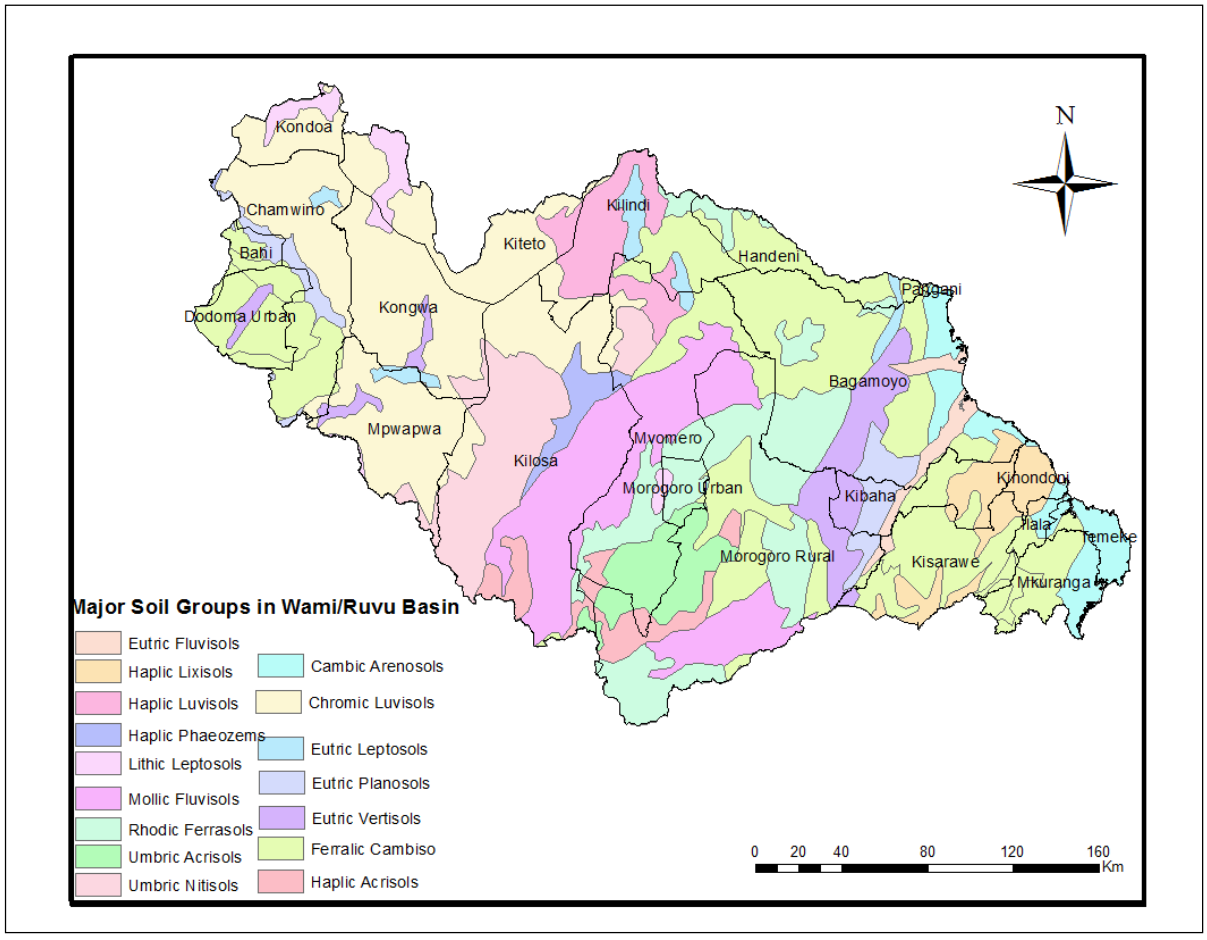

Figure 3 Major soil groups in Wami/Ruvu Basin

1.2.4 Geology

The geology of the catchment is mainly dominated by:-

Precambian: Mostly occur in the Chenene Hills (Dodoma), Kiborian Hills (Mpwapwa) and rolling hills of Ikowa, Mlima wa Nyoka in Dodoma Kongwa and Uluguru Mountains and in the western part of the Ngerengere sub-basin. These rocks are mainly granitoid, gneisses, granulites and crystalline limestone meta-sediments and meta-igneous rocks with synorogenic granite, schist and gneiss and gneisses, granulites and crystalline limestone.

Usagaran:- Occupy Rubeho Mountains in Kilosa area and Ukaguru Mountains, Wota Mountains and area around Lumuma. In the north they occupy Nguru Mountains. They consist of biotitic muscovite gneiss and schist, metadorerite and metagabro, Migmatitic biotite gneiss and hornblende.

Jurassic rocks occur in the eastern margin of the Uluguru Mountains and elevated rolling hills between the Ruvu and Wami rivers. They consist of course sandstone, mudstone, and oolitic limestone deposited under the marine environment (Kapilima, 1988)

The Karoo rocks occupy south-eastern area of the Uluguru Mountains. The rocks consist mainly of sandstone, and shale deposited in the shallow fresh to brackish water. Their ages may vary from Permian to Triassic (Kent at al,1971).

Cretaceous rocks lie on the elevated rolling hills. They consist of clay, shale, calcareous` sandstone, sandy limestone and mudstone.

Tertiary and Quaternary (youngest strata in the basin): occur in the catchment area of the Ngerengere River near Morogoro Municipality, and in the elevated rolling hills and floodplains along the Ruvu River, Kibaha, Bagamoyo and extend up to Dar es Salaam. Pleistocene to recent sediments exists in the area developing as alluvial deposits all detrital deposits resulting from the operations of modern rivers, colluvial deposits alluvium in part but also containing angular fragments of original rocks such as talus and cliff debris, and coastal deposits. Mbugas depression fills and beach deposits.

Neogene Rocks: These are found in floodplains of Mkata, Mpwapwa, Kongwa, Dodoma and along Wami, Mkondoa, Kinyasungwe Rivers and along Saadan and Bagamoyo to Indian Ocean.

The deposit consists of calcareous crust, red-brown soils, alluvium, fluvial and sandy clay, and clayey sand with minor lenses of pure sand/clay, gravel and silt. In coastal areas inter bedded sandy clays and clayey sands with minor lenses of pure sand or clay are found. **Figure 4** shows the distribution of different geology within the basin.

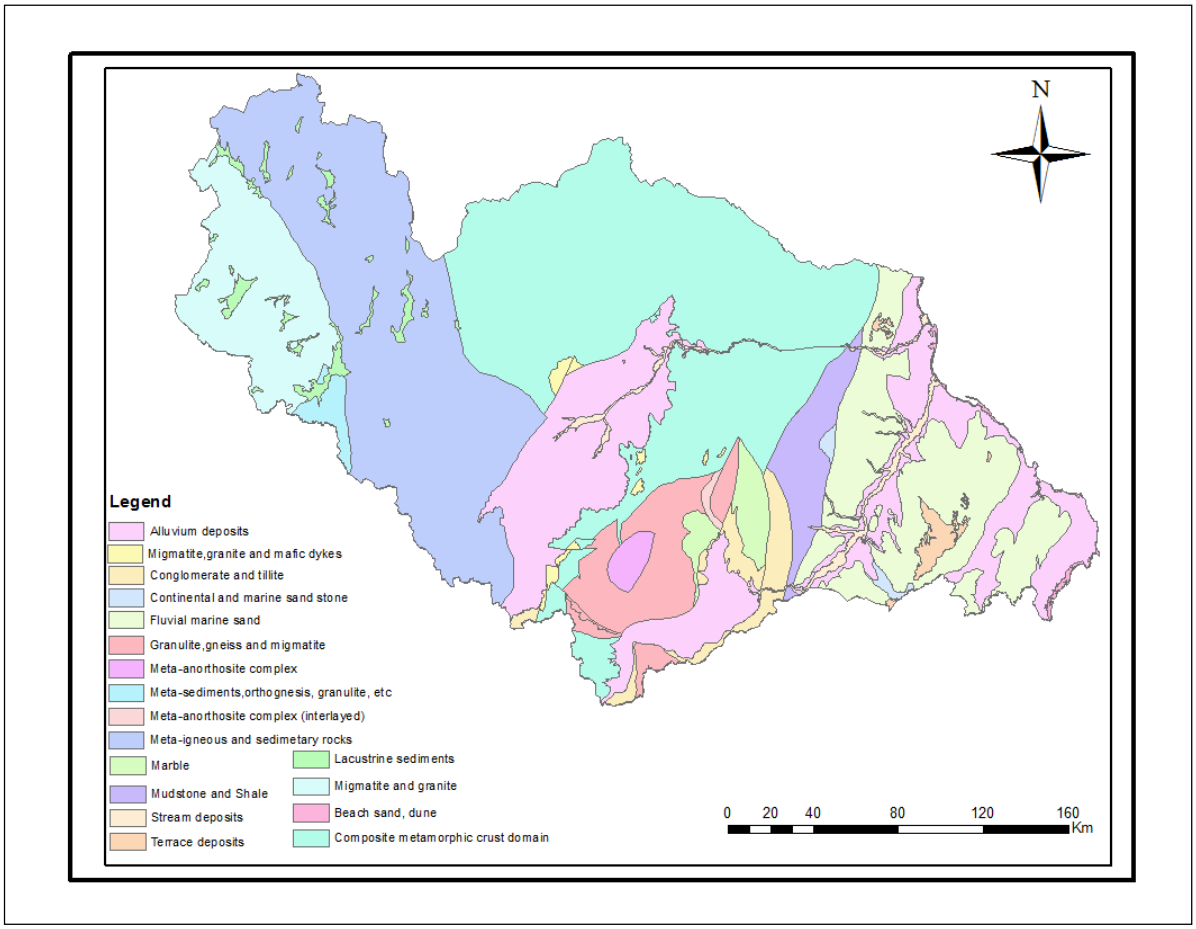

Figure 4 Geological types in Wami/Ruvu Basin

Objectives of this report

The main objective of this report is to give an overview of water status for 2016/2017 hydrological year (November 2016 to October 2017). Specifically the report aims to address the following areas:

a) Characteristics of the Wami/Ruvu Basin

b) Existing hydro met network of the Basin and their status

c) Hydrological analysis and interpretation of the Wami/Ruvu Basin for the year 2016/2017

Scope and Outline of this report

Chapter one presents the general basin characteristics and objectives of this report. The rest of the report is organized into the following Chapters:

- Chapter 2 presents the existing hydro met network of the Basin
- Chapter 3 describes the hydrological analyses and interpretations and comparisons with other years accompanied by graphs, charts tables and maps. (Rainfall histograms, maps, river discharge time series plots, reservoir water levels) of Wami/Ruvu Basin for the year 2016/2017 starting from November 2016 to October 2017.
- Chapter 4 identifies the challenges and success based on hydrology

2. HYDRMET NETWORK OF THE BASIN

2.1 Overview

Most of the hydrometric network stations were established in the early 1950s and records exist since that time. In the past there were 40 hydrometric stations, 9 weather stations and 33 rainfall stations. However, there is a serious shortage of usable hydrometric records from 1990s to 2005, as most of the stations were vandalised or were non-operational during that period. Since 2006, most of the network has been rehabilitated and improved. Others were rehabilitated during the IWRM&D study in the Basin by JICA study team in collaboration with the Basin Water Board.

2.2 Temporal and spatial coverage of climatic data

Wami/Ruvu Basin is currently collecting rainfall and other climatic data from a total of 57 stations where by 34 stations are only manual rain gauges, 17 stations are automatic rain gauges and 6 are Met stations

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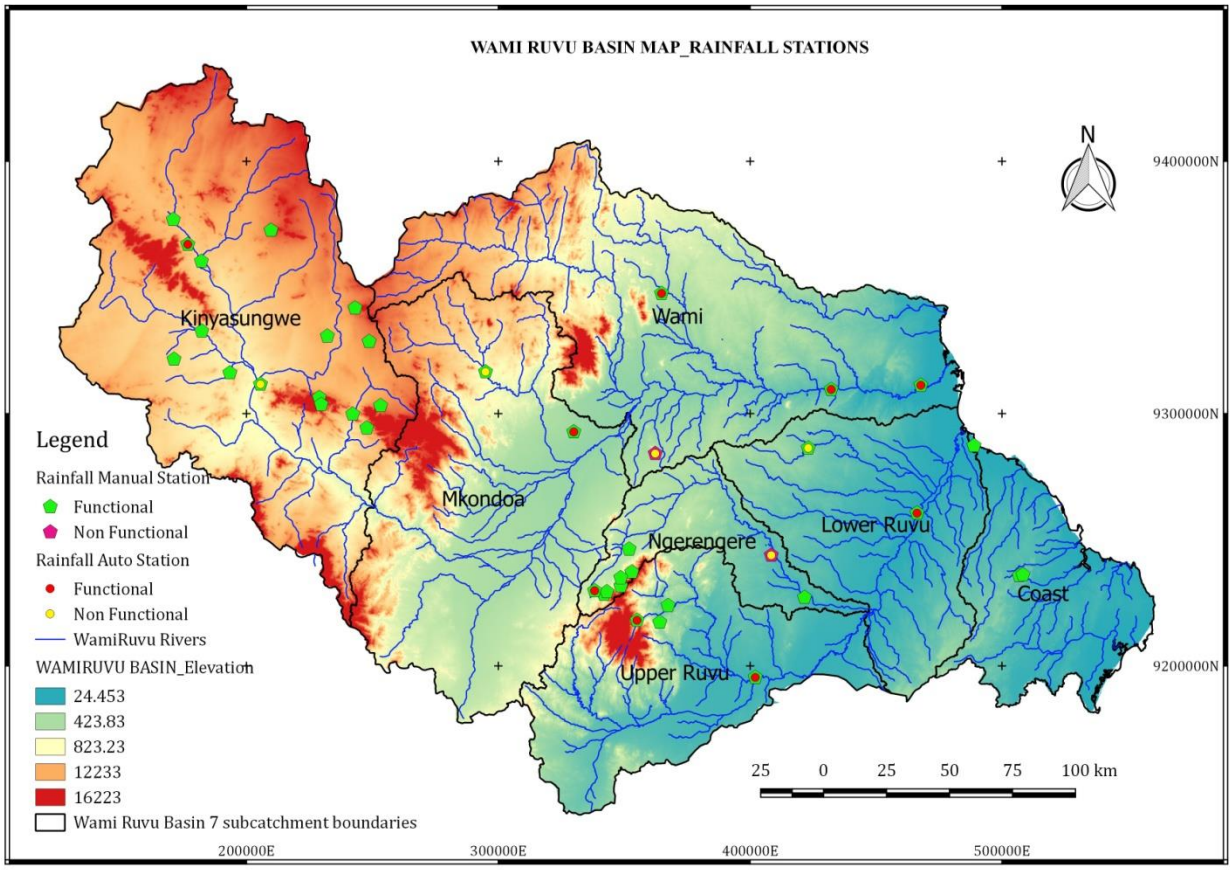

Figure 5). From existing meteorological stations data are collected on daily basis and available data are on rainfall, temperature, radiation, wind speed and relative humidity.

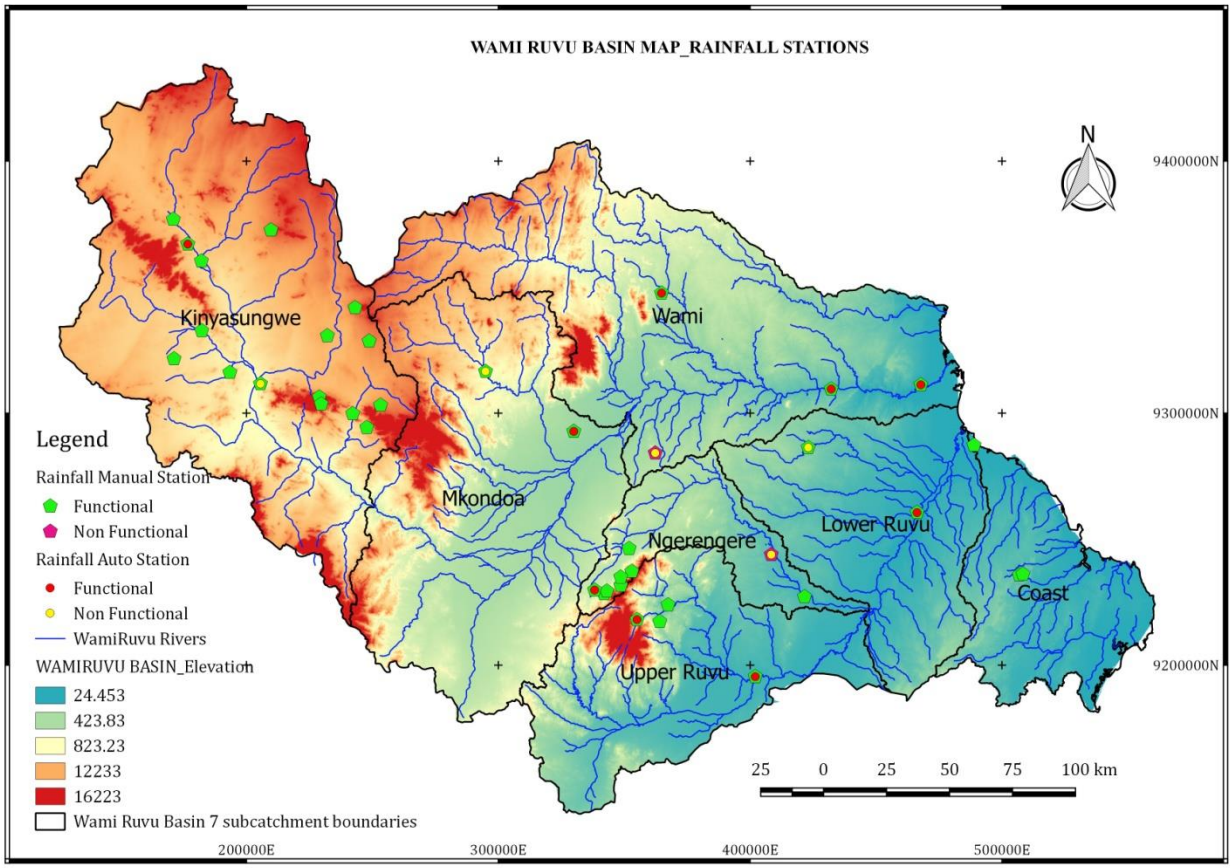

Figure 5 Map showing distributions of rainfall and weather stations

2.3 River Discharge and Sediment Data

2.3.1 Temporal and Spatial Coverage of Measuring Stations

The stations are distributed evenly to the Basin in which major rivers are gauged and total number of gauge stations is 43 were 21 stations are functional. The mountainous regions have higher network of rivers than the flat lands. Efforts are being made to evenly locate the gauging stations wherever it is necessary
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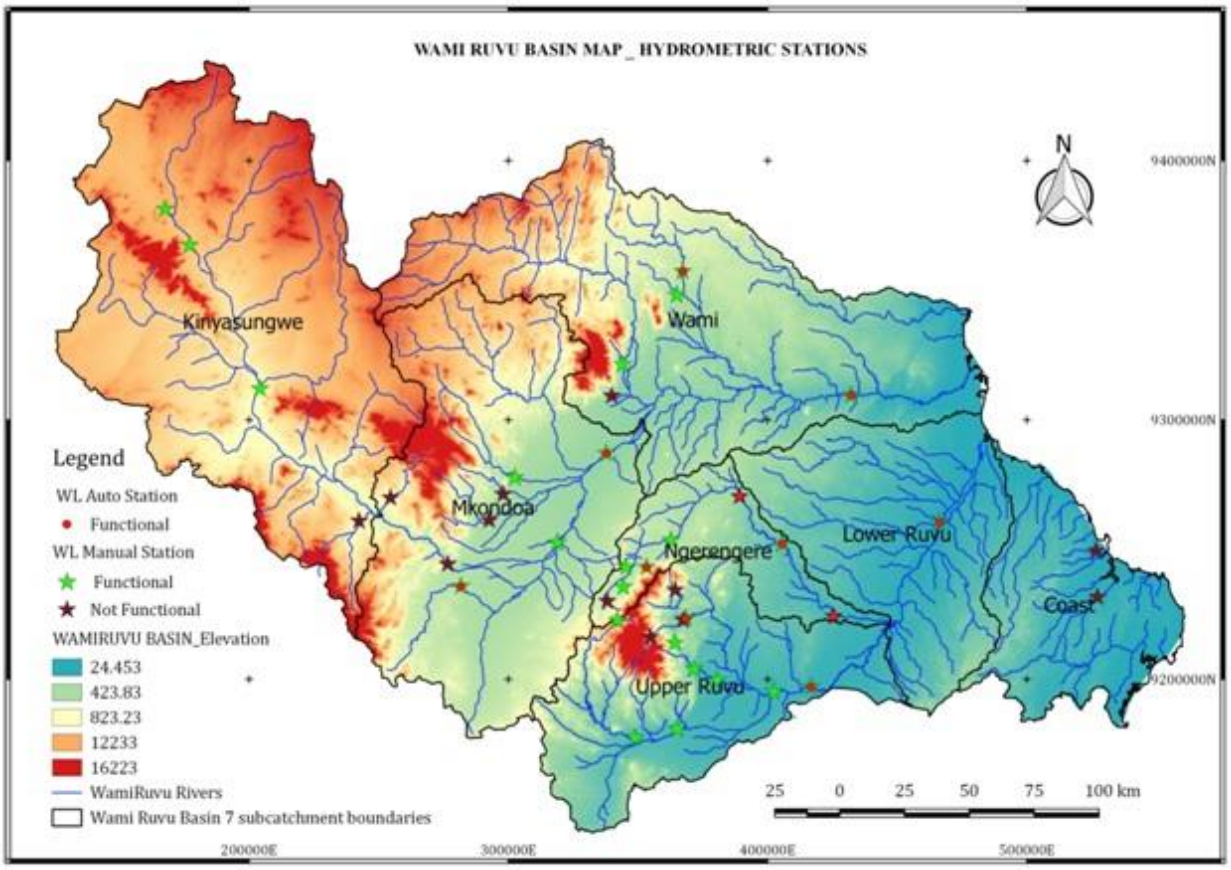


Figure 6). Annex 5.3 showing status of gauging Station and monthly average discharge data some of station in Wami/Ruvu

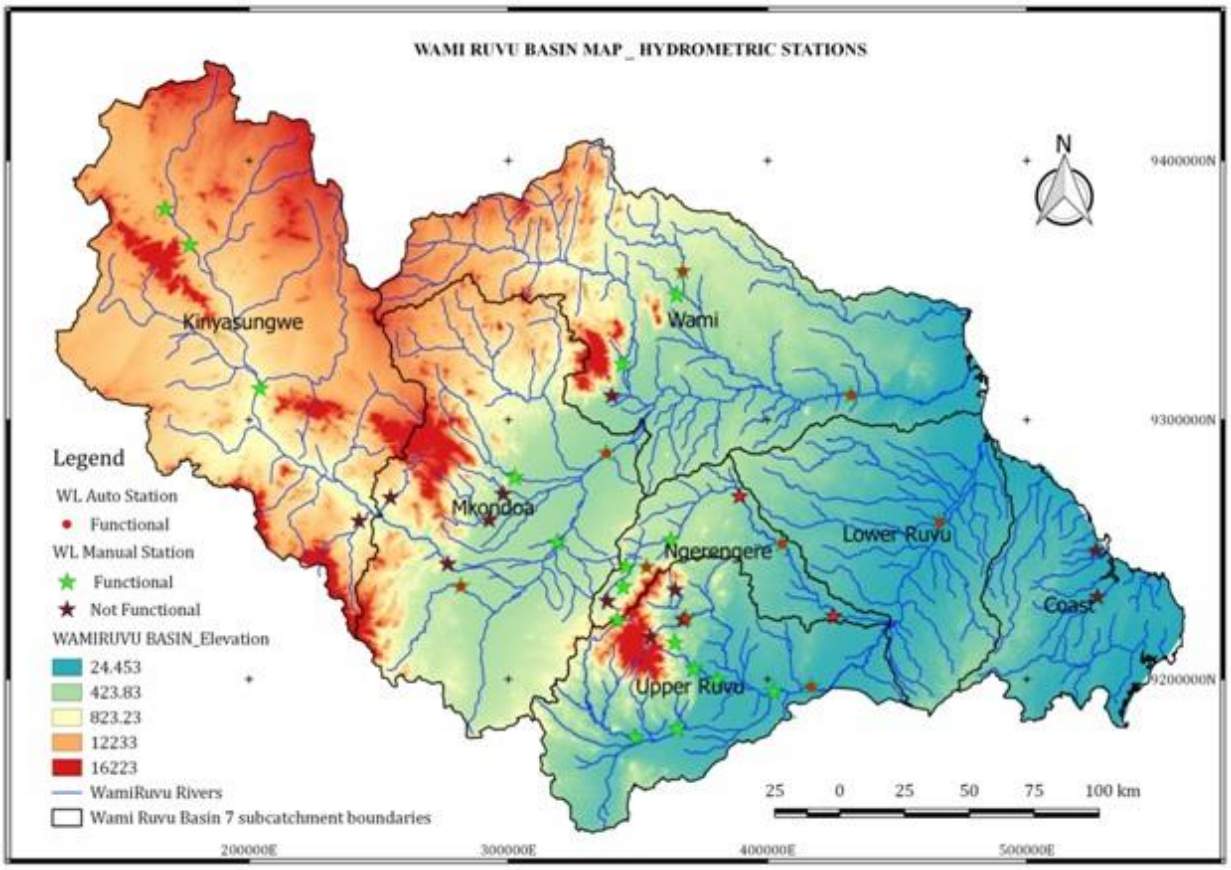


Figure 6 Map showing distribution of river gauging stations in Wami/Ruvu catchment

2.4 Water quality data

Total number of 76 water quality monitoring stations was established in the Wami/Ruvu Basin as indicated in **Table 1** and

Figure **7**.

Table 1 existing water quality Monitoring stations

S/No	TYPE OF MONITORING	TOTAL SAMPLING POINTS
1	GROUNDWATER	**14**
2	SURFACE WATER	**30**
3	WASTE WATER	**32**
TOTAL		**76**

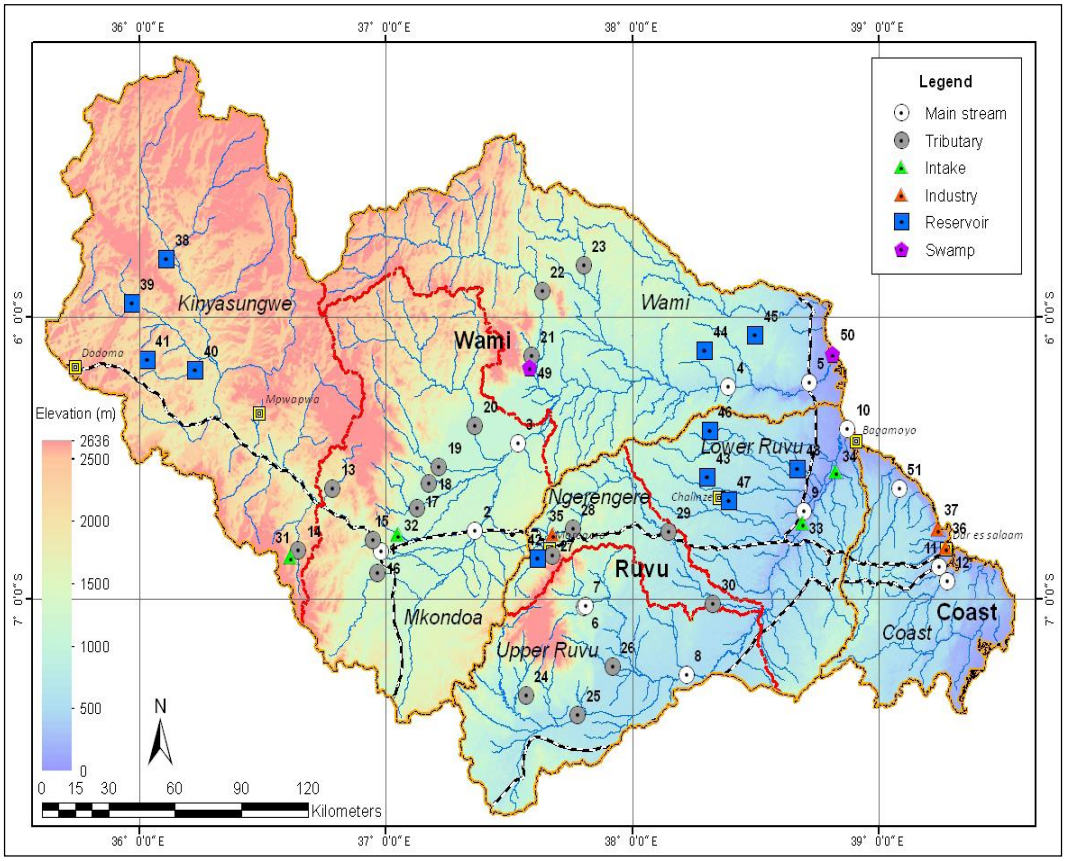


Figure 7 Water quality monitoring stations in the Wami/Ruvu Basin

The basin water office water quality sampling program collects information on the following parameters. The table below shows the list of parameters and their priority.

	Category	Parameters to be Analyzed

1	High Priority	Temperature, pH, Turbidity (NTU), Electric conductivity/EC (us/cm),TDS (mg/l), Suspended solids/SS (mg/l), BOD (mg/l), Dissolved oxygen/DO (mg/l),Total coliform (count/100ml), Fecal coliform (count/100ml)
2	Low Priority	COD (mg/l), Nitrate (mg/l), Ammonium (mg/l), Chloride (Cl-) (mg/l).

Sample processing routinely occurs in the field for pH, temperature, and electrical conductivity (total dissolved solids). Dissolved oxygen, phosphates, nitrates, sulphates, and ammonia are all analyzed at the water quality office in Morogoro. BOD and COD are analyzed at the head water quality laboratory in Dodoma.

For the case of surface water two types of sample sites are routinely sampled from during the water quality surveys; industry and river. Industry sites are typically effluent discharge canals that have just entered the main river. River sites are typically surface water sites with no apparent industry nearby. While for the case of groundwater quality Electrical conductivity is very important. The areas of high electric conductivity (EC) are observed in several areas. The high value is probably caused by long residence time, and dissolved composition of geology (**Figure 8**). However the Mkata plain shows low levels in EC which is speculated to be due to the direct recharge from Kinyasungwe River.

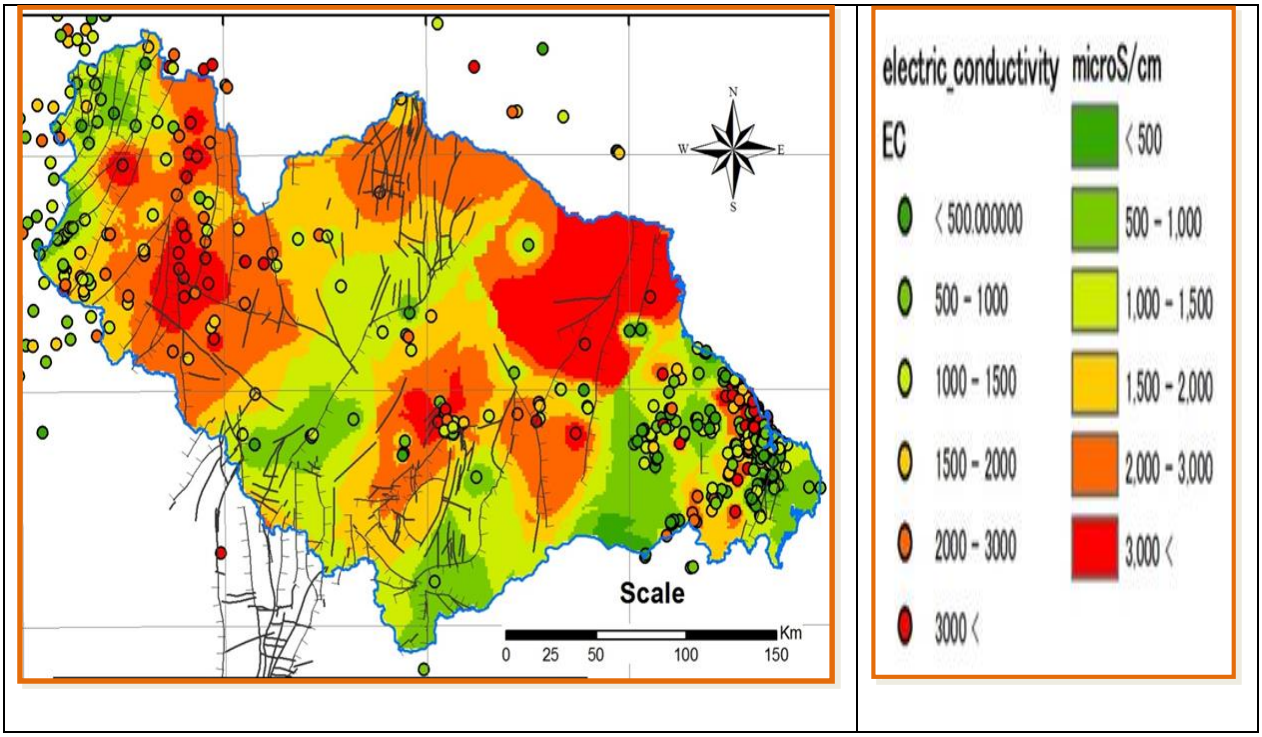


Figure 8 Groundwater quality distribution map for Wami/Ruvu Basin

2.5 Reservoirs/Lakes Information

There are about 9 constructed dams in the basin and about 150 reservoirs which collect water from rivers, groundwater and other are rain fed only. Daily monitoring of water levels is done only at the Mindu Dam which is supplying water to Morogoro Municipality. Water levels in the dam decreased due to decreased rainfall amount falling around Uluguru Mountains in Morogoro Municipality area.

Groundwater Data

2.6.1 Temporal and Spatial Coverage of Groundwater Monitoring Stations

Groundwater monitoring in the basin is currently monitored manually and automatically, although the station are not sufficiently and lack long-term data. Only one sub catchment, Makutupora has been being monitored for so long since 1960's. Basically the catchment has twelve monitoring boreholes in which only five monitoring wells are operating. Water level data have been collected by gauge readers from existing five monitoring wells in the Makutupora well field namely BH No. 86/78, BH No. 122/75, BH No. 234/75, BH No. 89/75 and BH No. 103/78.

Apart from 5 monitoring borehole in Makutupora, The basin has constructed ad installed a total of 21 monitoring boreholes during IWRMA & D project 2010/2011 which covers each at least each aquifer type (**Figure 9**).

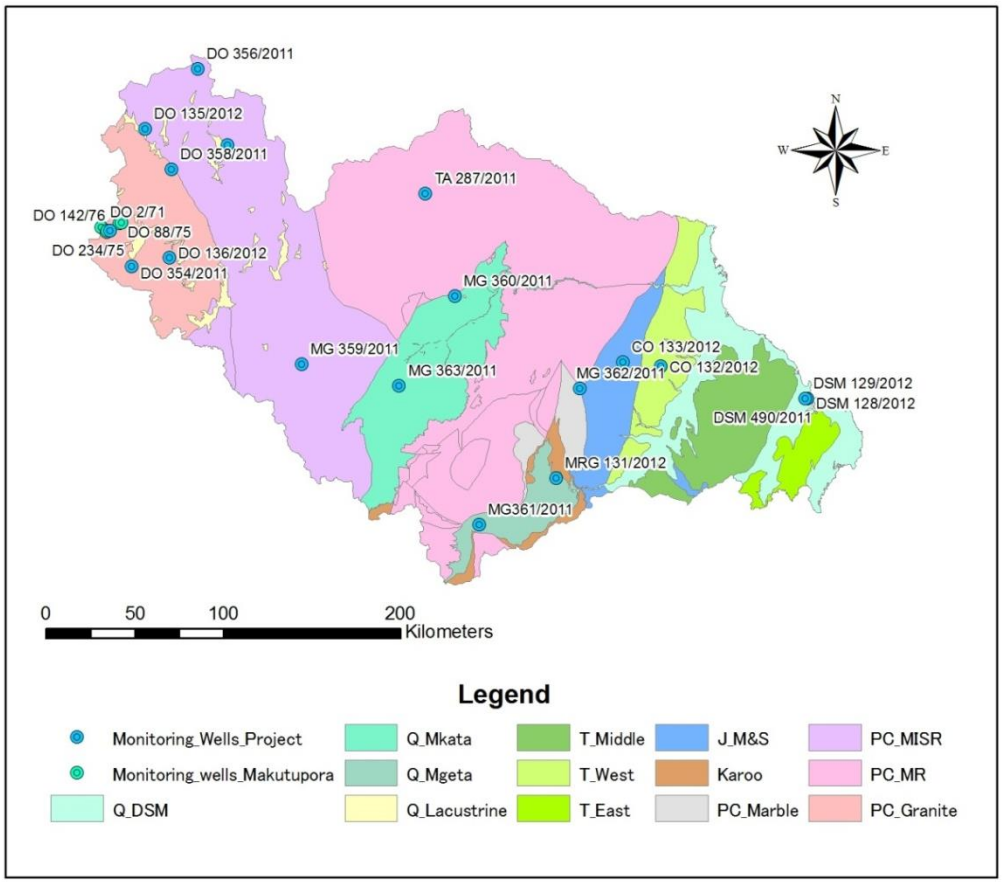


Figure 9 Groundwater monitoring stations in the Wami/Ruvu Basin

3 HYDROLOGICAL ANALYSIS AND INTERPRETATION

Rainfall

Wami/Ruvu Basin has both unimodal and bimodal types of rainfall patterns. The unimodal type is found in the central part of Tanzania in the main Wami Catchment (Kinyasugwe sub catchment) while bimodal type is received in the part of Wami (Mkondoa and Wami sub catchments) Ruvu and Coastal Rivers catchments. In the unimodal type only one rainfall is experienced during the months of January, February and March while in the bimodal type, there are two rainy seasons, short rains (*Vuli rains*) in October to December and heavy rains (*Masika rains*) which is received from March to May.

Wami River Catchment

Wami River catchment has both unimodal and bimodal rainfall patterns. Unimodal pattern is usually observed in Kinyasungwe subcatchment (Figure **10**) and bimodal pattern is observed in Mkondoa and Wami subcatchments. The eight (8) presentative stations were selected (4 presenting Wami and Mkondoa subcatchment namely; Wami Prison, Murad Sadiq, Kutukutu and Mziha Primary school and the remain 4 presenting Kinyasungwe sub catchment namely; Dodoma Maji, Dabalo Dam, Zanka and Ikombo), selection basis on the stations that has Long term data as well as shows the amount rainfall received in the elevated parts such as Ukaguru, Nguru, Nguu and Chenene Mountains where the Wami river source and its tributaries originated.

Wami and Mkondoa sub catchment experiences an initial period of increased rainfall during the *Vuli* (short rains occurring from mid-October to December), then a slight lull during January and February, followed by the *Masika* (long rains occurring from March to May). The Catchment receives a total rainfall average of 740mm per annual where the *Vuli* rainfall peaks at 32.3mm/ month in December, whilst March, April and May are the wettest *Masika* months, with average monthly rainfalls of 183.0 mm/month, 145.2 mm/month and 130.2 mm/month respectively. Thereafter a sustained four month dry season prevails with 19.1, 1.7, 8.9 and 7.2 mm/month falling in June, July, August and September respectively.

The rainfall records of the different stations show that the recorded rainfall is average compared to the long term average, also there is an increase in rainfall from Vuli towards Masika season/periods while in the months of June to September Catchment receives extremely low rainfall compared to the other Catchment. Therefore it is recommended that the all project lie under Catchment to harvest rainfall water by adopted and constructing the storage structural like dams for storage of water so as to overcome the deficit of water during the dry period.

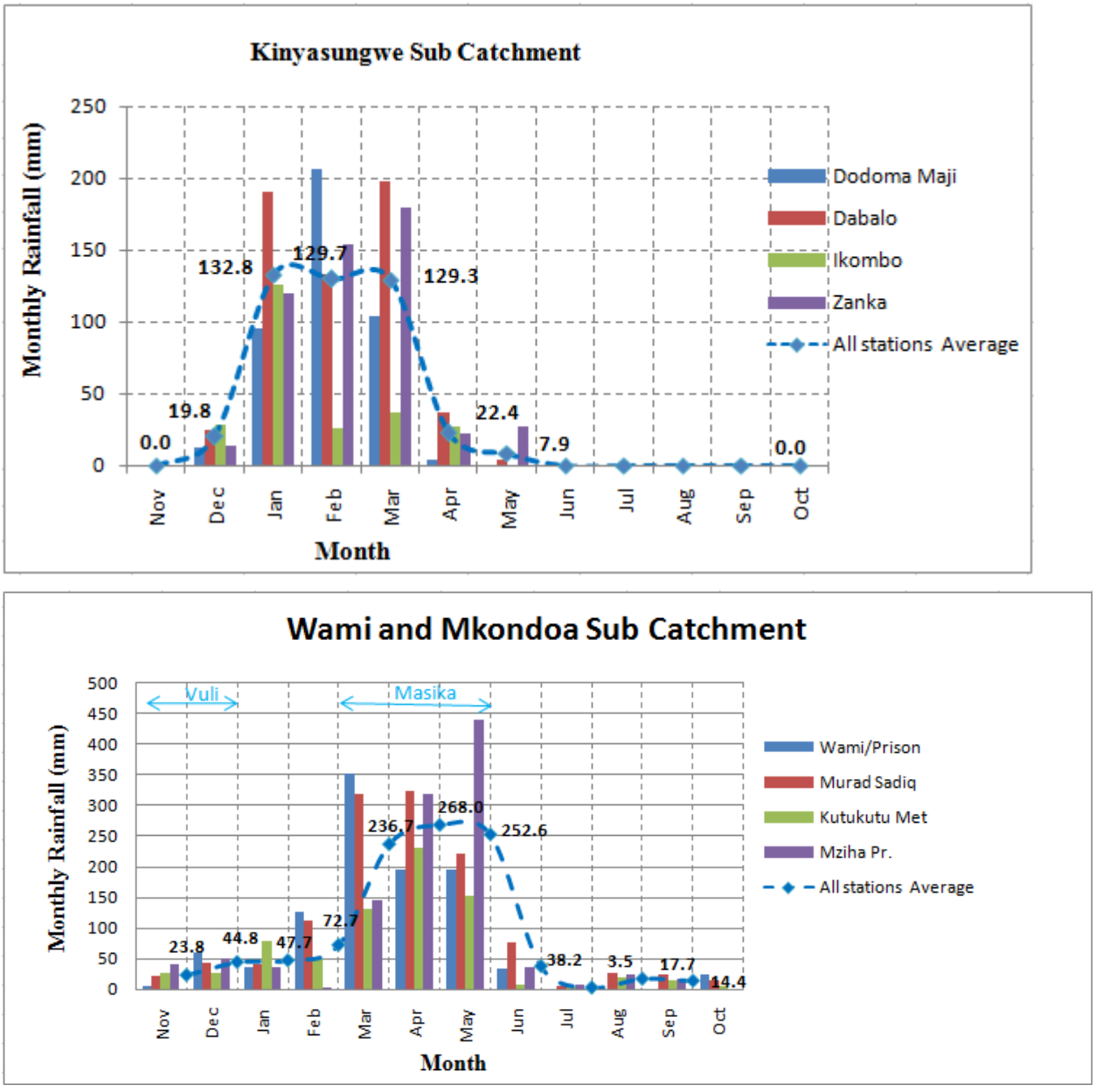


Figure 10 Rainfall distribution in Kinyasugwe sub-catchment Mkondoa and Wami sub-catchments covering the period of November 2016 to October 2017.

Table 2 Monthly Average of all representative stations and monthly Rainfall in Wami Catchment

Station Name	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Dodoma Maji	0	12.6	94.7	206	103.2	3.7	0	0	0	0	0	0
Dabalo	0	25	190	133	197.9	36.2	4.1	0	0	0	0	0
Ikombo	0	28.5	126.3	26.2	36.4	27.5	0	0	0	0	0	0
Zanka	0	13.1	120	153.6	179.8	22.1	27.4	0	0	0	0	0
Wami/Prison	6	60.2	36.4	126.3	352.5	197.3	196.9	34	0	1.7	2.5	26
Murad Sadiq	22.3	43	40	112.2	318.1	324	221.2	76.1	3.9	26.3	24.6	14.3
Kutukutu Met	25.6	25.6	78	50.1	131.3	230.5	151.2	7.3	2.1	18.2	14.5	3.9
Mziha Pr.	41.2	50.5	36.3	2.3	144.8	320	441.1	35.3	7.8	24.6	15.8	25.5
Average	**11.9**	**32.3**	**90.2**	**101.2**	**183.0**	**145.2**	**130.2**	**19.1**	**1.7**	**8.9**	**7.2**	**8.7**

Table 3 Comparison of Annual Rainfall and MAP for representative stations in Wami Catchment

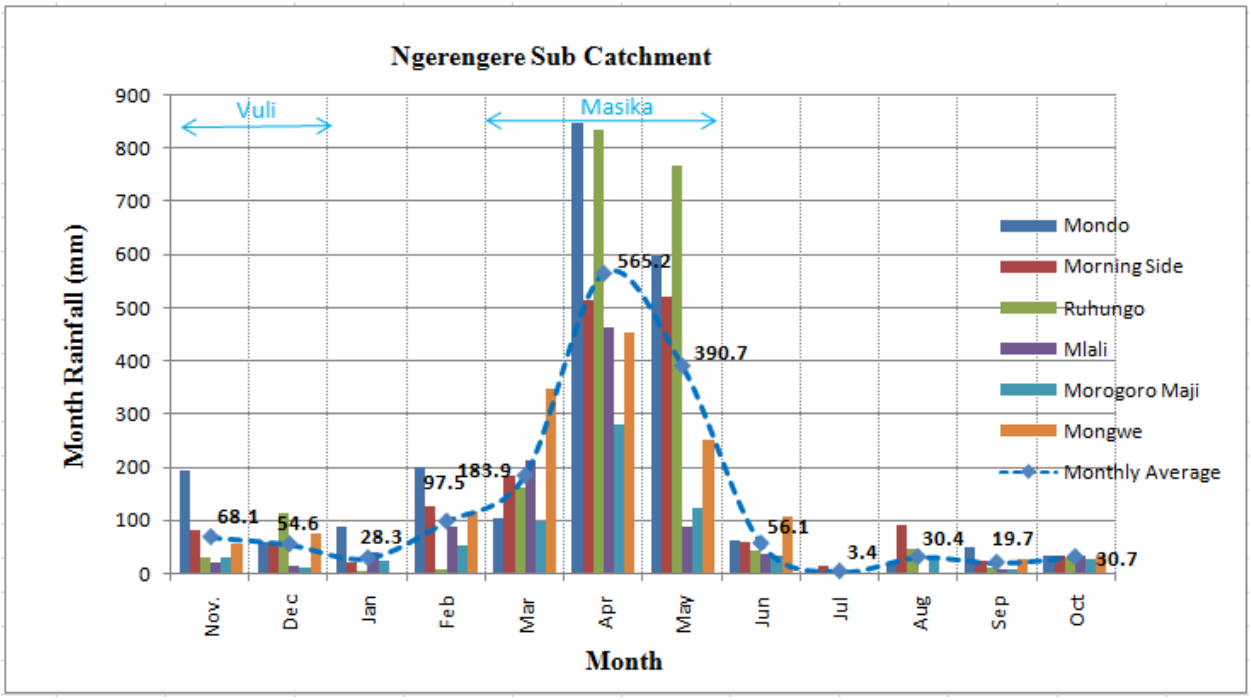
Station No.	Station Name	Mean Annual Precipitation (MAP) 1960-2010 [mm]	Nov 2016-Oct 2017		
			Annual Rainfall in 2016/2017 [mm]	%	Description
9635012	Dodoma Maji	565.4	420.2	74.3	Average
9536004	Dabalo Dam	599.6	586.2	97.8	Average
9637056	Wami/Prison	1044.3	1039.8	99.6	Average

Ruvu River Catchment

Ruvu River catchment experiences a typical bimodal rainfall pattern were the Catchment comprised of Ngerengere and Upper Ruvu Sub catchments. Ruvu Catchment experiences an initial period of increased rainfall during the *Vuli* (short rains occurring from mid-October to December), then followed by the *Masika* (long rains occurring from March to May) as shown in the **figure 11**. In 2016/2017 the *Vuli* rainfall peaks at 144.9mm/ month and 68.1mm/ month in November for Upper Ruvu and Ngerengere sub catchment respectively, whilst March, April and May are the wettest *Masika* months, where Ngerengere has higher peak average of 565.2mm/ month compared to Upper Ruvu with Averange of 414.1 mm/month. However Upper Ruvu receives high rainfall compared to other sub catchments in the Basin, in hydrological year 2016/2017 it has receive about 1600mm per annual followed by Ngerengere sub catchment which receive 1529mm per annual. This is due to the presence of mountains and forests (Eastern Arc Mountains) within the sub catchment.

In comparison to Mean Annual Precipitation, Rainfall in Ruvu River catchment varied between sub catchments. In Upper Ruvu sub catchments all the stations recorded rainfall above the average, this speculates that the sub catchments have received rainfall above normal (**Table 6, Figure 11**). In Ngerengere sub catchment most of the station recorded rainfall within average range except for Ruhungo, Mongwe and Mlali stations which were above average (**Table 6, Figure 11**)

Therefore rainfall records of the different stations show that there is an increase in rainfall from Vuli towards Masika season/periods compared to months of June to September where the Catchment receives low rainfall. It is recommended that the all project lie under Catchment to harvest rainfall water by adopted and constructed the storage structural like dams for storage of water so as to overcome the deficit of water during the dry period



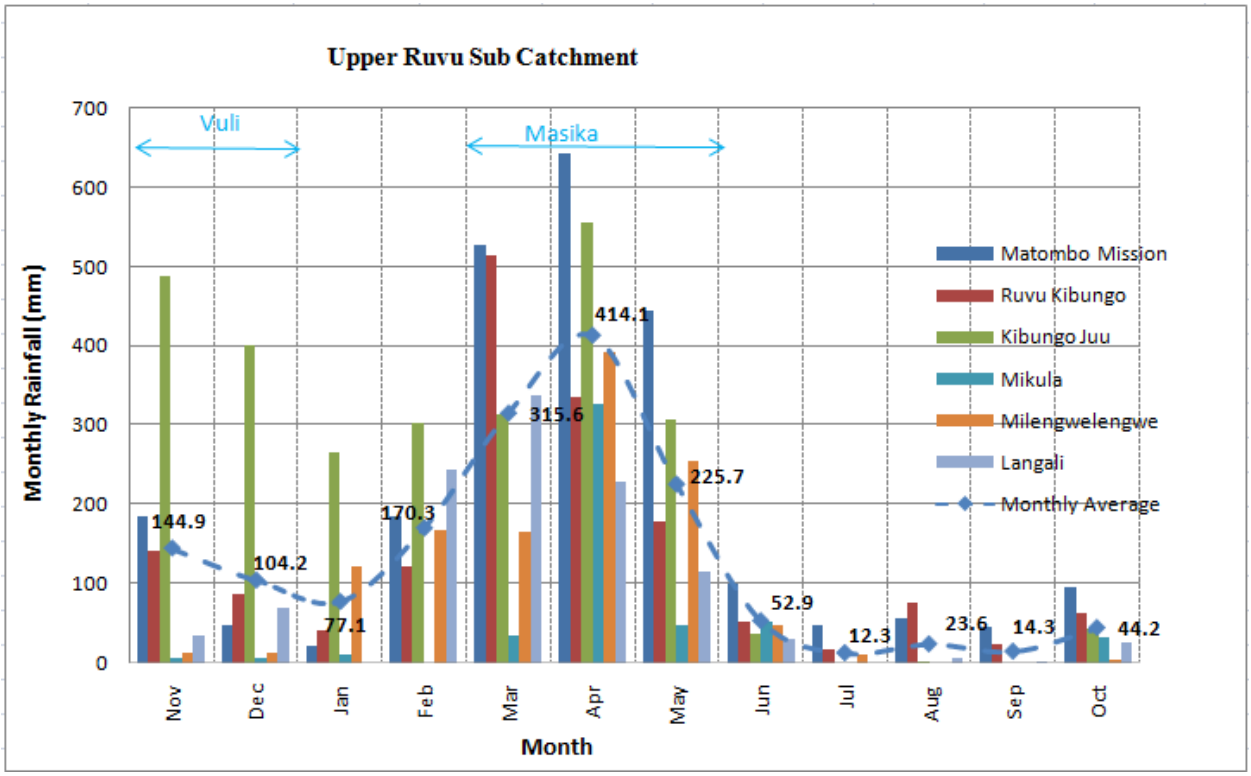


Figure 11 Rainfall distribution in Ngerengere sub-catchment and Upper sub-catchment covering the period of November 2016 to October 2017.

Table 4 Average of all representative stations and monthly Rainfall in Ngerengere

Station Name	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Mondo	193.3	58.1	86.4	198.8	103.6	847.2	597.9	62.6	0	17.2	46.7	32.1
Morning Side	81.6	58.8	17.7	126.8	183.5	513.5	519.9	59.3	13.7	91.3	22.6	33.4
Ruhungo	29	111	3	5	159	835	767	43	3	44	8	30
Mlali	21	14.5	39	85.8	211	461.9	85.7	36	0	0.5	7.5	33
Morogoro Maji	27.4	10.3	23.5	51.8	97.8	279.6	123.3	31.3	3.8	29.4	7.9	24.7
Mongwe	56	74.7	0	116.5	348.3	453.8	250.4	104.6	0	0	25.7	31
Monthly Average	68.1	54.6	28.3	97.5	183.9	565.2	390.7	56.1	3.4	30.4	19.7	30.7

Table 5 Average of all representative stations and monthly Rainfall in Upper Ruvu

Station Name	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Matombo Mission	184.4	47.7	22.5	184.5	527.1	644.1	445.6	99.7	47.0	55.8	45.3	95.0
Ruvu Kibungo	142.4	86.3	40.9	122.7	514.6	336.8	179.8	51.9	16.5	76.7	23.3	62.4
Mikula	5.5	7.1	11.5	0.0	34.0	327.6	48.7	51.6	0.0	0.0	0.0	33.8
Milengwel.	13.5	14.0	122.1	167.0	164.8	392.3	255.6	47.7	10.1	0.2	0.0	3.5
Langali	35.7	69.5	0.0	244.4	338.1	228.2	115.7	29.5	0.0	6.2	2.9	26.4
Kibungo Juu	487.8	400.8	265.6	303.4	315.1	555.4	308.5	37.0	0.0	2.5	0	44.1
Monthly Average	144.9	104.2	77.1	170.3	315.6	414.1	225.7	52.9	12.3	23.6	14.3	44.2

Table 6 Comparison of Annual Rainfall and MAP for representative stations in Ruvu Catchment

Station No.	Station Name	Mean Annual Precipitation (MAP) 1960-2010 [mm]	Nov 2016-Oct 2017		
			Annual Rainfall in 2016/2017 [mm]	%	Description
9637045	Mondo	2531.2	2243.9	88.6	Average
9637046	Morning Side	2298.1	1722.1	74.9	Average
9637048	Ruhungo	858.7	2037	237.2	Above average

Station No.	Station Name	Mean Annual Precipitation (MAP) 1960-2010 [mm]	Nov 2016-Oct 2017		
			Annual Rainfall in 2016/2017 [mm]	%	Description
9637051	Mlali	793.6	995.9	125.5	Above Average
9637052	Morogoro Maji	750.6	710.8	94.7	Average
9637049	Mongwe	1250.0	1461	116.9	Above Average
9737006	Matombo Mission	1569.4	2398.74	152.8	Above average
9737026	Ruvu Kibungo	1605.7	1654.3	103.0	Above average
9737024	Kibungo Juu	2556.3	2720.21	106.4	Above average

Coastal Rivers Catchment

Coastal Rivers catchment have bimodal rainfall pattern, where the *Vuli* started in mid-October to December, then followed by the *Masika* rains from March to May.

The catchment has been presented by three rainfall stations (**Figure 12**). In hydrological year of 2016/2017 (Nov 2016 – Oct 2017) the catchment receive a total rainfall average of 1071mm per annual whereby Ubungo Maji station observed to have the highest rainfall amount followed by Kisarawe FDC and Kisarawe Boma which were 1115.85mm, 1061.3mm and 1035.8mm respectively (

Table **8**). In comparison to Mean Annual Precipitation, The catchment has received rainfall below the average.

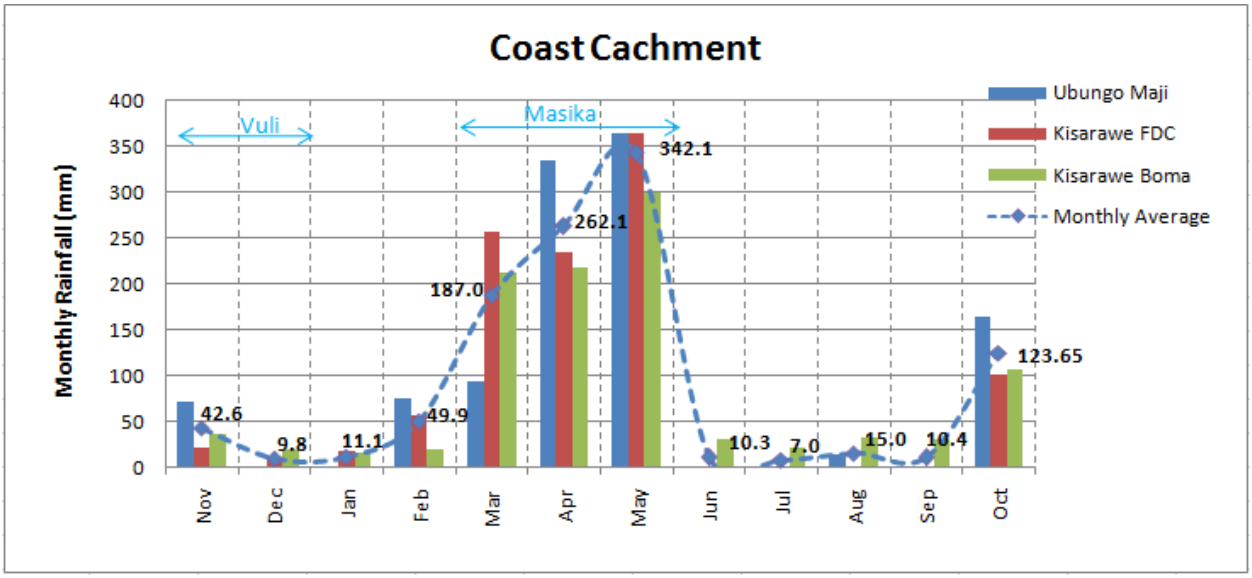


Figure 12 Rainfall distribution in Coastal rivers catchment covering the period of November 2016 to October 2017

Table 7 Average of all representative stations and monthly Rainfall in Coast

Station Name	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Ubungo Maji	71.2	0	0	75.6	92.6	334.6	363.3	0	0.5	13.6	0	6.2
Kisarawe FDC	21.5	10.8	17.7	55.5	256.7	234.7	364.3	0	0	0	0	10.1
Kisarawe Boma	35.2	18.7	15.5	18.7	211.6	217	298.7	30.8	20.6	31.4	31.2	16.4
Monthly Average	42.6	9.8	11.1	49.9	187.0	262.1	342.1	10.3	7.0	15.0	10.4	10.9

Table 8 Comparison of Annual Rainfall and MAP for representative stations in Coast Catchment

Station No.	Station Name	Mean Annual Precipitation (MAP) 1960-2010 [mm]	Nov 2016-Oct 2017		
			Annual Rainfall in 2016/2017 [mm]	%	Description
9636048	Ubungo Maji	1669.5	1115.85	66.8	Below average
	Kisarawe FDC	1437.8	1061.3	73.8	Below average
	Kisarawe Boma	1516	1035.8	68.3	Below average

River discharges and Water levels

Wami River

The upper part of Wami Basin (Kinyasungwe River) is characterised by intermittent river flows since the rainfall pattern is unimodal rainfall characteristics also could be explained by soil characteristics which suggests groundwater recharge. Therefore Most of the rainfall is converted to groundwater due to supposedly high infiltration rates of the soils.

The middle part Mkondoa sub catchment represented by Wami at Dakawa station and Wami sub catchment represented by Wami at Mandera station (although is not operate by time being, it

need rehabilitation of 0-1 gauge) are characterised by perennial flow which is attributed to high rainfall and good aquifers which favour river recharge during the dry season.

Due to non operational for Wami Mandera (1G2) station the catchment is presented by Wami at Dakawa (1G1) gauge were the annual average flows recorded in the hydrological year 2016/2017 at 1G1 stations is below compared to Long term average **Table 9,** although the peak is above compared to long term average flow for months of March to June while for the month of December 2016 to January 2017 the situation was so worth because the flow recorded was extreme low compared to the past hydrological years, (**Table 9 Comparison of Average flows for each month and LTAR for representative stations in Wami River**). This may be due to climate change and Sedimentation caused by human activities upstream the gauge.

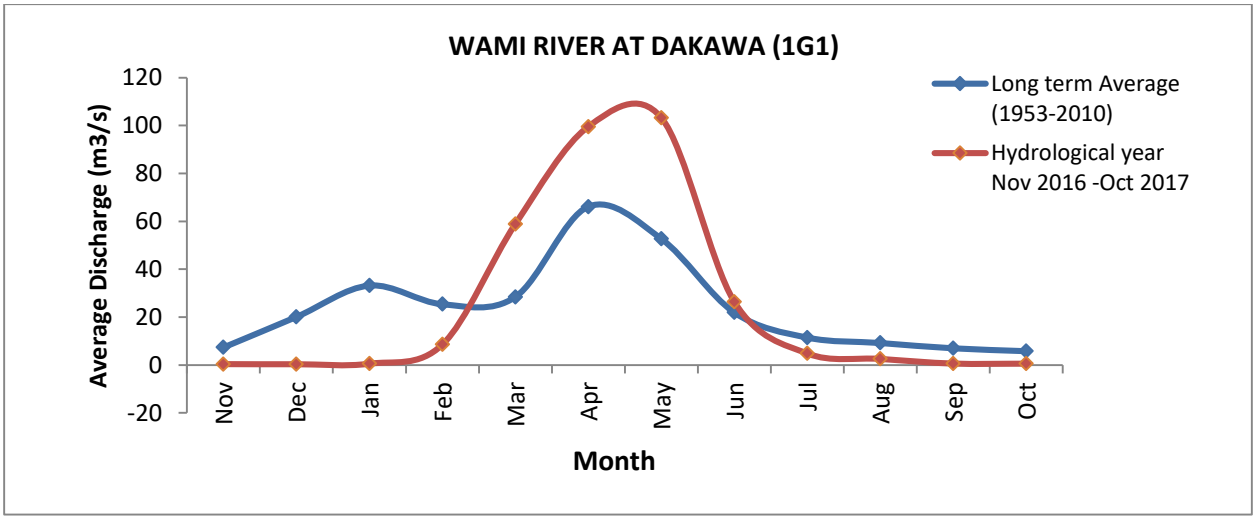


Figure 13 Comparison of Average discharge and Long-term Average for representative Stations (Wami at Dakawa- 1G1) in Wami River.

Table 9 Comparison of Average flows for each month and LTAR for representative stations in Wami River.

2016/2017	1G1 (m^3/s)	LTA for 1G1(m^3/s)
November	0.40	7.38
December	0.35	20.11
January	0.58	33.20
February	8.56	25.40
March	58.86	28.46
April	99.50	66.14
May	103.24	52.72
June	26.46	21.98
July	4.86	11.49

August	2.58	9.23
September	0.63	7.02
October	0.58	5.82
Annual Average Flow	25.55	24.08
% of LTA	**94.25%**	

Note: LTA = Long – term Average

Ruvu River

.

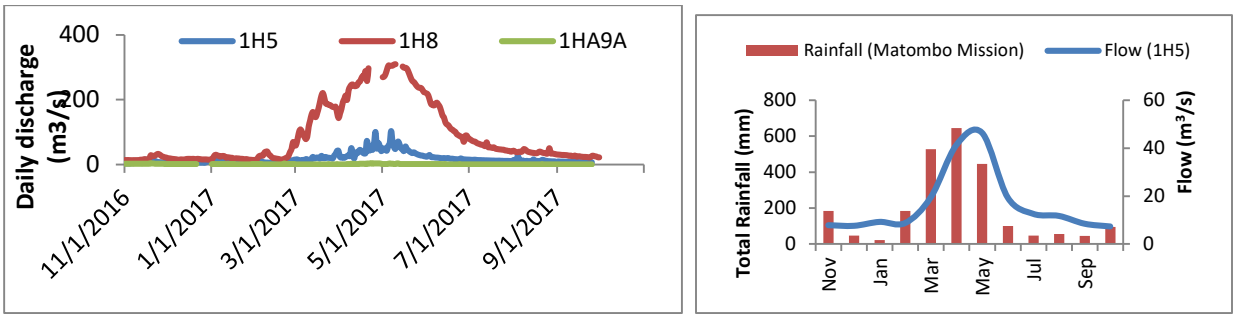


Figure **14,** represents the flow regime at the upstream station (1H5) as well as 1HA9A and a downstream station (1H8) of Ruvu River. Where by a downstream stations shows a more stable flow regime compared to an upstream stations.

In comparison with the annual average flow generally at both stations in Ruvu River the annual average flow of 2016/2017 hydrological year recorded to be below the Long-term average except Ruvu at Morogoro Rd bridge (1H8). When analysis were done seasonally it was observed that during the rainy season (March – May) the flow was recorded above average which means the rainfall received were above normal **(**

Figure 15, Table below). A similar trend was also observed in rainfall distribution.

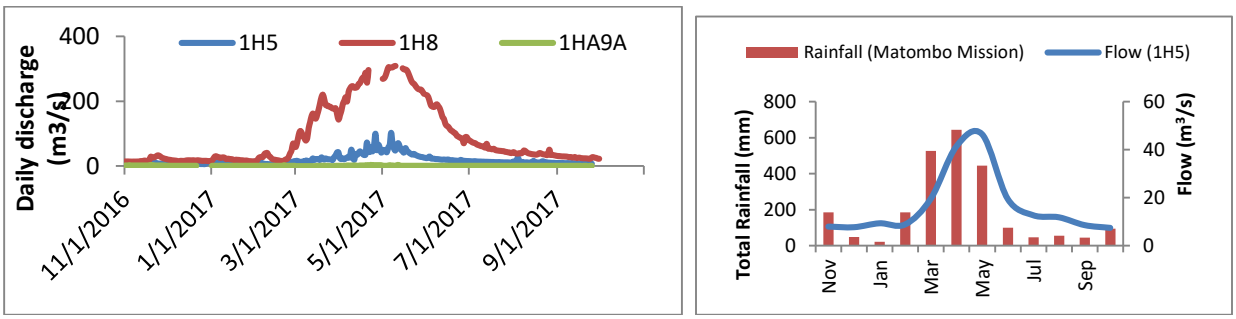


Figure 14 on the left, daily flow regime in Ruvu River as recorded at Ruvu Kibungo, Ngerengere Konga and Ruvu Morogoro Road Bridge. On the right represent the relationship of Flow and Rainfall at Ruvu Kibungo (1H5) station.

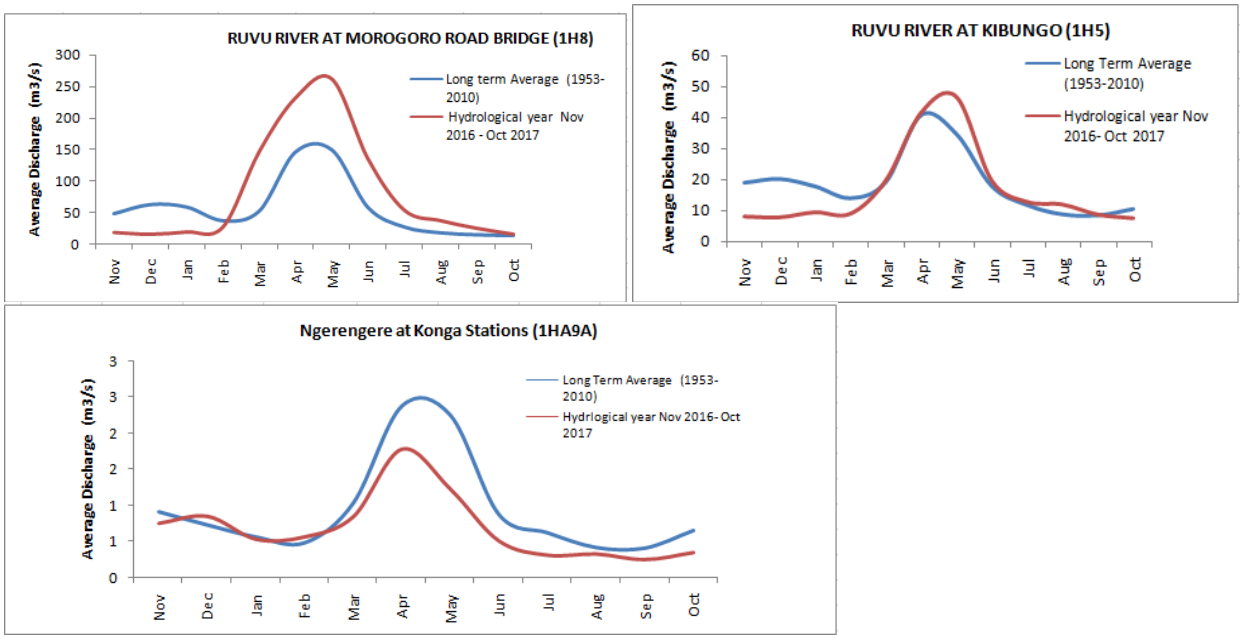


Figure 15 Comparison of Average discharge and Long-term Average for representative stations in Ruvu River, namely Ruvu at Morogoro Rd Bridge(1H8), Ruvu at Kibungo (1H5) and Ngerengere River at Konga

Months	LTA for 1H8	1H8(16/17)	% of LTA	1H5(16/17)	LTA for 1H5	% of LTA	LTA for 1HA9A	1HA9A (16/17)	% of LTA
Nov	48.85	19.50	39.93	7.9	18.92	41.75	0.91	0.75	82.40
Dec	63.17	16.63	26.32	7.65	20.1	38.06	0.73	0.85	116.34
Jan	59.28	20.27	34.19	9.28	17.73	52.34	0.56	0.53	94.95
Feb	37.71	27.99	74.22	8.82	13.96	63.18	0.48	0.57	117.60
Mar	52.99	147.43	278.22	19.54	19.14	102.09	1.04	0.84	81.53
Apr	145.92	232.50	159.33	41.37	40.6	101.90	2.39	1.77	74.34
May	149.31	262.45	175.77	46.39	34.51	134.42	2.26	1.22	54.19
Jun	58.33	135.48	232.26	19.43	17.78	109.28	0.87	0.51	58.33
Jul	27.78	54.52	196.26	12.62	11.75	107.40	0.62	0.31	50.66
Aug	18.66	38.05	203.89	11.78	8.75	134.63	0.42	0.33	79.47
Sep	15.55	26.03	167.37	8.52	8.4	101.43	0.41	0.25	62.34
Oct	14.29	16.76	117.28	7.37	10.47	70.39	0.65	0.35	53.60
Annual	**57.65**	**83.13**	**142.09**	**16.72**	**18.51**	**88.07**	**0.94**	**0.69**	**77.15**

Water Storage in Mindu Dam

Daily water level fluctuation in Mindu dam is represented by the graph below (**Figure 16**) while the general characteristics of the dam showing its storage, Dam crest and Dead storage is shown in **Table 10** below.

Generally the water level fluctuations in the Mindu dam is highly correlated to the rainfall pattern in the catchment, where by highest levels of about 507.29m were recorded in May 2017 and Minimum level of 503.94m was recorded in February, where only 2m was remain to reach the dead storage, the situation was so worth and very critical it never happen for 25 years ago since March 1992 where the minimum water level was 503.79m m.s.l. Consequently the rainfall characteristics for one station within the Mindu Dam catchment showed a similar characteristic.

Table 10 Characteristics of Mindu Dam

Dam	**Storage (Mil. m^3)**	**Max. WL (2016/2017) (masl)**	**Min. WL (2016/2017) (masl)**	**Dam crest Level(masl)**	**Dead storage level(masl)**
Mindu	1900	507.29	503.94	512	501

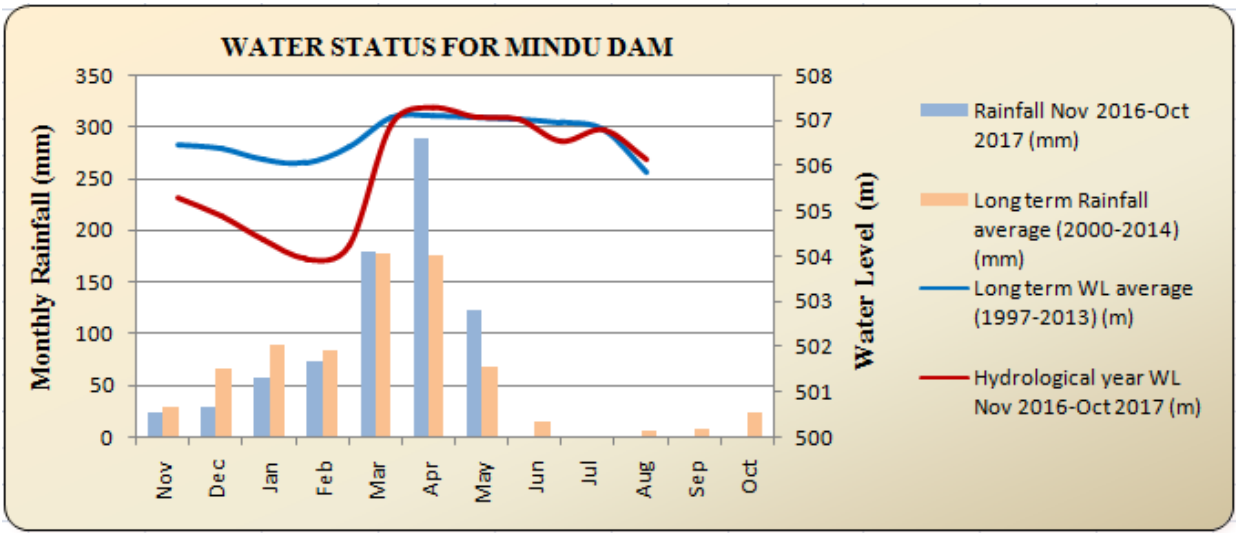


Figure 16 Comparison of Water Levels in Mindu Dam and Rainfall characteristics at one station within Mindu catchment.

Groundwater levels for selected monitoring stations.

Total of 5 boreholes monitoring groundwater level in Makutupora sub-catchment was selected where the trend of hydrological showing that the water table continue to decrease while the

demand increases this may cause increase the cone of depression outside the catchment for discharge the field especial the month of May and June where the pump age is higher compare to the other months, (**Error! Reference source not found.)** below illustrates clearly. These fluctuations are highly link with the pump age taking place on production wells.

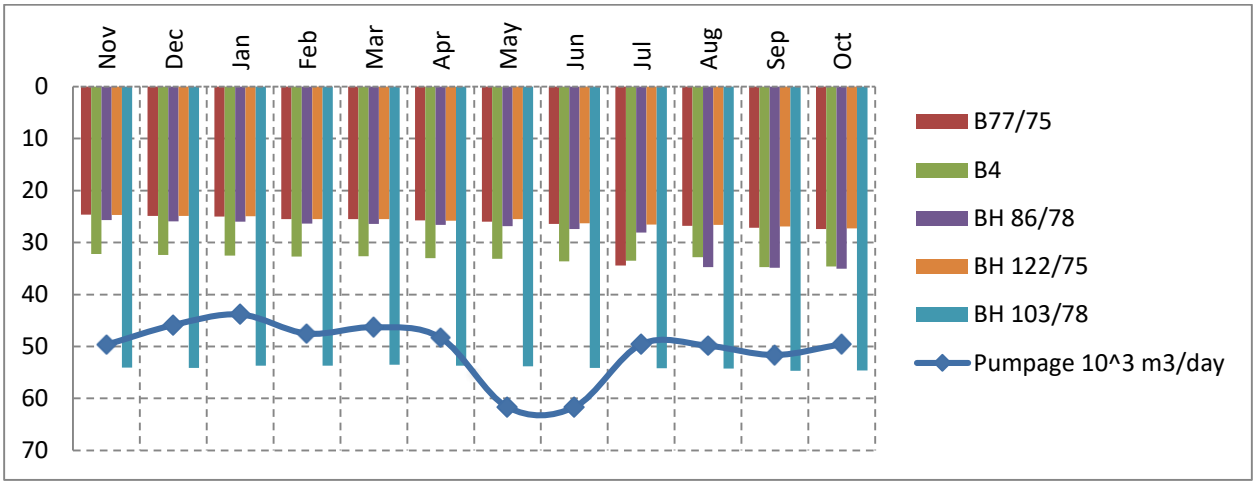


Figure 17 Groundwater levels fluctuations of 5 monitoring boreholes with pumpage in Makutupora sub-catchment 2016/2017

Water use/allocations within Wami/Ruvu Basin

Ruvu Cachment

The Catchment is potential for both ground and surface water were both sources are usefully for domestic water supply, industrial uses and irrigation for residents of Morogoro, DaresSalaam City, Kibaha and Bagamoyo towns and also to the people residing along the river. The population growth coupled with increasing water demand for domestic, industrial and irrigation uses is posing challenges in the allocation of the scarce resource in the basin. Figure 18 shows the spatial distribution of the water abstraction points in the Basin.

The total of 154 Water use permit were issued by Board (83 surface water abstraction with total uptake of 417,415,680m3 per year and 71 Bore hole with total abstraction of 189,584,510m3 per year).

Therefore the available water for the other user may be still available in all Months although we recommend more abstraction to be taken in Months of high available water by constructing storage infrastructure like dam to store and used during dry period to overcome deficit.

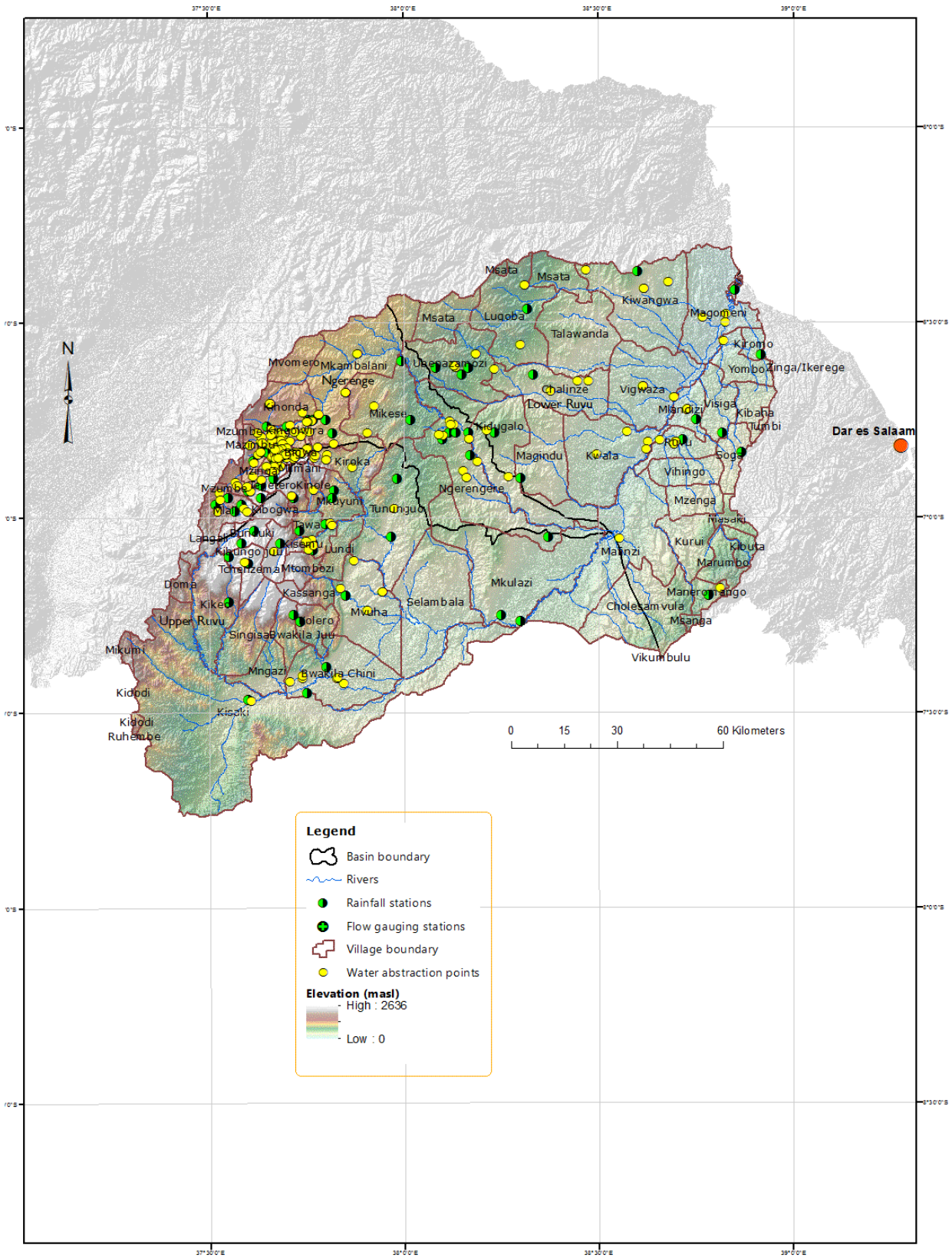


Figure 18: Spatial distribution of water permits

Table 11 clarifies the amount of water available for other uses within the Ruvu River**.**

Station	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Average Flow (1H8A)	30.3	48.9	52.7	40.7	67.3	288.1	226.2	65.9	39.7	29.2	22	27.4
Minimum Flow (1H8)	0.06	0.04	0.99	1.32	23.84	48.73	25.75	24.29	4.23	1.09	0.5	0.12
Minimum EFA (Ruvu/Kongo)	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Total Uptake	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
Available water	17.1	35.7	39.5	27.5	54.1	274.9	213.0	52.7	26.5	16.0	9.0	14.2

Wami Catchment

The Catchment is potential for both ground and surface water sources were it saves the different users such as domestic water supply, industrial uses and irrigation for residents of Dodoma, Morogoro and Pwani as well as people residing along the river. The total of 180 water use permit were issued by Board (71 surface water abstraction with total uptake of 885,363,955m^3 per year and 109 Bore hole with total abstraction of 53,192,039m^3 per year).

Therefore the available water for the user may be available in Month of January to July only while the month of November, December, August, September and October the available water may be used available for priority user (domestic) and Environmental purpose only so we recommend no water use permit will be offered for that period as shown in ***Table 12*** and users are advice to construct the storage infrastructure like dams especially during rainfall season to harvest water and stored so as to be used during the dry period to overcome the deficit.

Table 12 clarifies the amount of water available for other uses within the Wami River.

Station	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Average Flow (1G2)	14.2	28.8	47.4	60.2	52.06	64.3	190.2	138.9	46.5	24.9	19.7	15.3
Minimum Flow (1H8)	3.79	3.38	1.12	2.39	3.02	5.64	40.52	47.97	13	8.12	5.87	4.26
Minimum EFA (Gama)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Total Uptake	27.99	27.99	27.99	27.99	27.99	27.99	27.99	27.99	27.99	27.99	27.99	27.99
Available water	0.0	0.8	19.4	32.2	24.1	36.3	162.2	110.9	18.5	0.0	0.0	0.0

Coast Catchment

The Catchment is potential for ground water sources were it saves the different users such as domestic water supply, industrial uses and irrigation for residents of Dar es Salaam and Pwani. The total of 48 Bore hole with total abstraction of 1,402,453m^3 per year were issued by Board.

4.0 GENERAL REMARKS AND WAY FORWARD

4.1 Challenges and interventions

Few primary stations were chosen which can fairly give information of the different parameters of interest, in collecting water resources data (rainfall, surface and ground water levels, ratings, water quality and weather) WRBWO faced the following challenges:-

- Many stations (Rainfall, weather and groundwater levels) lack long-term information thus become cumbersome to discuss the variation happening.
- Gauging station lacks proper rating curves therefore it is difficult to tell trend of water discharges.
- Automatic stations (Groundwater, weather, and gauging) are not continuous visited due to insufficient of fund (amount and timely) therefore ensuring their functionality and accuracy become very challenging.

Key interventions include the following:

- Replacement of battery for all automatic Rain (Hobo) in Morogoro.
- Water quantity data were collected using the hydrometric and rainfall stations and finally stored into database.
- Rehabilitation of primary stations namely; Wami at Mandera, Diwale at Ngomeni (0-1) gauge and other 10 secondary stations under Wami catchement
- Checking old rating curves and validating rating curves by supporting from WARIDI.
- Purchasing of ADCP instrument for Flow measurement especially during high flow supported by WARIDI
- More study/research on ground water is required to know the source and available storage recharge so as to have sufficient supply for Dodoma urban

- Database management using Acquires, Nile Basin Decision Supporting System (NBDSS) and GIS.
- Training personnel in database management.
- Training gauge readers to read manual gages, record ground water levels, to identify any equipment problems; provide security and to perform minor station maintenance.
- Improving monitoring through frequent visits to the same of stations.

5.0 ANNEXES

5.1Status of Rainfall StationWami/Ruvu Basin

S/No	Station ID.	Station Name	Station Latitude (Degree)	Satation Longitude (Degree)	Station Altitude (m)	Status	
						Status of AWL Gauge	Status of Staff Gauge
1	1G1	Wami at Dakawa	-6.44783	37.53343	361	Functional	Functional/sedimentation
2	1G2	Wami at Mandera	-6.24638	38.38732	87	Not Functional	Not Functional
3	1G5A	Tami at Msowero	-6.53173	37.21375	440	Not Installed	Not Functional
4	1G6	Kisangata at Mvumi	-6.58897	37.17288	436	Not Functional	Not Functional
5	1G8	Wami at Rudewa	-6.67917	37.12418		Not Installed	Not Functional
6	1GA1A	Lukigura at Kimamba Rd. Br.	-5.81396	37.80101	512	Not Functional	Functional
7	1GA2	Mziha at Mziha	-5.89588	37.78001	443	Functional	Functional
8	1GB1A	Diwale at Ngomeni	-6.13764	37.59020	387	Not Functional	Not Functional
9	1GB2	Mkindo at Mkindo	-6.24762	37.55250		Not Installed	Not Functional
10	1GD2	Mkondoa at Kilosa	-6.83173	36.97824	495	Functional	Not Functional
11	1GD16	Kinyasungwe at Kongwa/Dodoma	-6.21775	36.32700	855	Not Functional	Not Functional
12	1GD21	Kinyasungwe at Itiso	-5.59	36.00		Not Installed	Not Functional
13	1GD29	Mkondoa at Mbarahwe	-6.60	36.78		Not Installed	Not Functional

14	1GD30	Lumuma at Kilimalulu	-6.68	36.67		Not Functional	Not Functional
15	1GD35	Miyombo at Kivungu	-6.90987	37.02422	477	Not Functional	Functional
16	1GD36	Mkata at Mkata	-6.75907	37.36130	399	Not Functional	Functional
17	1GD37	Great Kinyasungwe at Ikombo	-5.7160	36.0849		Not Functional	Functional
18	Local LKiC	Little Kinyasungwe at Chihanga	-5.9047	35.8439		Vandalised	Functional
19	Local LKiM	Little Kinyasungwe at Mayamaya	-5.81948	35.80410	1153	Functional	Functional
20	1H3	Ruvu at Kidunda	-7.26395	38.24558	86	Not Functional	Functional
21	1H5	Ruvu at Kibungo	-7.02370	37.80948	203	Functional	Functional
22	1H8A	Ruvu at Morogoro Rd. Br.	-6.69080	38.69427	24	Functional	Functional
23	1H10	Ruvu at Mikula	-7.27967	38.11447	80	Not Functional	Functional
24	1HA1A	Ngerengere at Utari Bridge	-7.01806	38.32478	101	Vandalised	Vandalised
25	1HA3	Ngerengere at Kingolwira	-6.75177	37.75762	425	Not Installed	Functional
26	1HA8A	Morogoro at Morogoro	-6.84562	37.67247	547	Vandalised	Functional
27	1HA9A	Ngerengere at Konga	-6.90653	37.59944	531	Functional	Functional/sedimentation
28	1HA15	Ngerengere at Mgude	-6.76507	38.14570	180	Not Installed	Functional
29	Local MzM	Mzinga at Mzinga				Not Functional	Not Functional
30	Local NgL	Ngerengere at Lukwambe	-6.59937	37.99728	332	Not Functional	Not Functional
31	1HB2	Mgeta at Mgeta	-7.03	37.57	975	Functional	Functional

32	Local MgD	Mgeta at Duthumi	-7.41009	37.77803	138	Not Functional	Not Functional
33	1HC2	Mvuha at Ngagama	-7.19999	37.83795	138	Vandalised	Functional
34	1HC2A	Mvuha at Tulo School	-7.24065	37.91766		Not Functional	Functional
35	Local MfK	Mfizigo at Kibangile	-7.02970	37.80005	207	Not Functional	Functional
36	Local MfL	Mfizigo at Lanzi	-7.08922	37.68515	898	Not Functional	Not Functional
37	1J5	Kizinga at Mbagala/Buza	-6.90145	39.24128		Not Installed	Not Functional
38	1J6	Mzinga at Majimatitu	-6.95083	39.24633		Not Functional	Not Functional
39	New	Mngazi at Vigolegole	-7.11	37.77	345	Not Installed	Functional
40	New	Mbezi at Kalundwa(Kinole)	-6.92478	37.77185	496	Not Installed	Functional
41	1HA7A	Mlali at Mlali	-6.96326	37.53483	584	Not Installed	Functional
42	New	Mtombozi at Mtombozi	-7.44	37.63	165	Not Installed	Functional
43	New	Lukulunge at Konga	-6.9141	37.5909	539	Not Installed	Functional

5.1Status of Rainfall StationWami/Ruvu Basin

S/No	Station Name	Remarks	Lat.	Long	Elevation (m)	Available Data	Missing data	MAP (mm)

5.1Status of Rainfall StationWami/Ruvu Basin

S/No	Station Name	Remarks	Lat.	Long	Elevation (m)	Available Data	Missing data	MAP (mm)
1	Berega Mission Hospital	Automatic Rainfall	-6.18030	37.14683	832			
2	Buigiri Primary School	Operational	-6.13	36.03	1066			
3	Chamkoroma Primary School	Operational	-6.33	36.67				
4	Chihanga Primary School	Operational	-5.969	35.953				
5	Chilonwa Primary School	Operational	-6.03	36.13				
6	Dabalo Primary School	Operational	-5.78	36.13	1524			
7	Dodoma Maji	Operational	-6.18782	35.75320	1141			**565.4**
8	Hobwe	Operational	-6.98	37.57	740	**1954-2012**		**1011.99**
9	Hombolo Primary School	Operational	-5.88	35.92	1097	**1964-2010**	**1978-2009**	**182.14**
10	Ibwaga Primary School	Operational	-6.295	36.557				
11	Ikowa (Azimio Primary School)	Operational	-6.18	36.23				

5.1Status of Rainfall StationWami/Ruvu Basin

S/No	Station Name	Remarks	Lat.	Long	Elevation (m)	Available Data	Missing data	MAP (mm)
12	Itiso Primary school	Operational	-5.63	36.03	1219			
13	Kibungo	Operational	-7.02	37.80	270	**1961-2013**		**1475.48**
14	Kikombo Primary School	Operational	-6.220	35.990				
15	Kimango Farm	Operational	-6.75025	37.75513	468			
16	Kisarawe Agr	Operational						**1111.6**
17	Kisarawe Boma	Operational	-6.91139	39.07583	278			**1111.6**
18	Lukose	Auto Operational (ICRAF project)	-6.84057	38.17123	172			
19	Matombo p/s	Operational	-7.08	37.77	390	**1971-2013**		**1569.4**
20	Mayamaya Primary school	Operational	-5.844	35.839				
21	Mlali	M/Auto Operational (ICRAF project)	-6.9662	37.53602	588	**1961-2013**		**793.6**
22	Mondo	Operational	-6.95	37.63	1120	**1954-**	**1961**	**2531.24**

5.1Status of Rainfall StationWami/Ruvu Basin

S/No	Station Name	Remarks	Lat.	Long	Elevation (m)	Available Data	Missing data	MAP (mm)
						2013		
23	Mongwe	Operational						**1250.0**
24	Morning site juu	Operational	-6.90	37.67	1450	**1961-2013**		**2298.1**
29	Morogoro Maji	Operational	-6.81755	37.66040	513	**1961-2013**		**750.6**
31	Ruhungo	Operational	-6.92	37.63	880			**858.7**
32	Ubungo Maji	Manual	-6.78	39.20		**1967-2013**		**1003.2**
33	Utari Village	Operational	-6.99209	38.29058	91			
35	Wami at Mandera	Automatic Rainfall	-6.24638	38.38732	85			
36	Wami Prison Farm	Automatic Rainfall	-6.39649	37.46294	399	**1971-2013**	**1972and 1973**	**1044.3**
37	Wami Rail Stn Met	Operational	-6.23155	38.70923	37			**912.2**
38	Zanka Primary School	Operational	-5.88	35.75	1133			**559.2**

5.2 Total monthly Rainfall 2016/2017 for Representative stations

		2016		2017										
NO	**STATION NAME/MONTH**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**TOTAL**
01.	Dodoma Maji	0	12.6	94.7	206	103.2	3.7	0	0	0	0	0	0	420.2
02.	Wami/Prison	6	60.2	36.4	126.3	352.5	197.3	196.9	34	0	1.7	2.5	26	1039.8
03.	Murad Sadiq	22.3	43	40	112.2	318.1	324	221.2	76.1	3.9	26.3	24.6	14.3	1226
04.	Zanka Pr/School	0	13.1	120	153.6	179.8	22.1	27.4	0	0	0	0	0	516
05.	Mondo	193.3	58.1	86.4	198.8	103.6	847.2	597.9	62.6	0	17.2	46.7	32.1	2243.9
06.	Morning Side	81.6	58.8	17.7	126.8	183.5	513.5	519.9	59.3	13.7	91.3	22.6	33.4	1722.1
07.	Ruhungo	29	111	3	5	159	835	767	43	3	44	8	30	2037
08.	Mlali	21	14.5	39	85.8	211	461.9	85.7	36	0	0.5	7.5	33	995.9
09.	Morogoro Maji	27.4	10.3	23.5	51.8	97.8	279.6	123.3	31.3	3.8	29.4	7.9	24.7	710.8
10.	Mongwe	56	74.7	0	116.5	348.3	453.8	250.4	104.6	0	0	25.7	31	1461
11.	Matombo Mission	184.4	47.7	22.5	184.5	527.1	644.1	445.6	99.7	47.04	55.8	45.3	95	2398.74

5.2 Total monthly Rainfall 2016/2017 for Representative stations

		2016		2017										
NO	**STATION NAME/MONTH**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**TOTAL**
12.	Ruvu Kibungo	142.4	86.3	40.9	122.7	514.6	336.8	179.8	51.9	16.5	76.7	23.3	62.4	1654.3
13.	Kibungo juu	487.8	400.8	265.6	303.4	315.1	555.41	308.5	37	0	2.5		44.1	2720.21
14.	Ubungo Maji	71.2	0	0	75.6	92.6	334.6	363.3	0	0.5	13.6	0	164.45	1115.85
15.	Kisarawe FDC	21.5	10.8	17.7	55.5	256.7	234.7	364.3	0	0	0	0	100.1	1061.3
16.	Kisarawe Boma	35.2	18.7	15.5	18.7	211.6	217	298.7	30.8	20.6	31.4	31.2	106.4	1035.8
17.	Mikula	5.52	7.1	11.5	0	34	327.6	48.7	51.6	0	0	0	33.8	519.82
18.	Langali Primary School	35.7	69.5	0	244.4	338.1	228.2	115.7	29.5	0	6.2	2.9	26.4	1096.6
19.	Milengwelengwe	13.5	14	122.1	167	164.824	392.3	255.6	47.7	10.1	0.2	0	3.5	1190.82
20.	Dabalo Dam	0	25	190	133	197.9	36.2	4.1	0	0	0	0	0	586.2
21.	Kutukutu Sec. School	25.6	25.6	78	50.1	131.3	230.5	151.2	7.3	2.1	18.2	14.5	3.9	738.3
22.	Ikombo	0	28.5	126.3	26.2	36.4	27.5	0	0	0	0	0	0	244.9
23.	Mziha Primary school	41.2	50.5	36.3	2.3	144.8	320	441.1	35.3	7.8	24.6	15.8	25.5	1145.2

5.3 Status of Gauging Station Wami/Ruvu Basin

Sn.	Station Name	Status of AWL Gauge	Status of Staff Gauge	Latitude	Longitude	Elevation (m.a.s.l)	Available data
1	Diwale at Ngomeni	Not Functional	Not Functional	-6.13764	37.59020	387	OCT 1964-1989
2	Great Kinyasungwe at Ikombo	Functional	Functional	-5.7160	36.0849		
3	Kinyasungwe at Godegode	Not Functional	Not Functional	-6.541	36.574		
4	Kinyasungwe at Itiso	Not Installed	Not Functional	-5.59	36.00		
5	Kinyasungwe at Kongwa/Dodoma	Not Functional	Not Functional	-6.21775	36.32700	855	
6	Kisangata at Mvumi	Not Functional	Not Functional	-6.58897	37.17288	436	
7	Kizinga at Buza	Not Installed	Not Functional				
8	Little Kinyasungwe at Chihanga	Vandalised	Functional	-5.9047	35.8439		
9	Little Kinyasungwe at Mayamaya	Functional	Functional	-5.81948	35.80410	1153	
10	Lukigura at Kimamba Rd. Br.	Not Functional	Functional	-5.81396	37.80101	512	
11	Lumuma at Kilimalulu	Not Functional	Not Functional	-6.68	36.67		
12	Masena at Ibumila	Not Functional	Not Functional	-5.903	36.390		
13	Mdukwe at Mdukwe	Not Functional	Not Functional	-6.795	36.930		
14	Mfizigo at Kibangile	Not Functional	Functional	-7.02970	37.80005	207	
15	Mfizigo at Lanzi	Not Functional	Not Functional	-7.08922	37.68515	898	
16	Mgeta at Duthumi	Not Functional	Functional	-7.41009	37.77803	138	

17	Mgeta at Mgeta	Functional	Functional	-7.03	37.57	975	
18	Miyombo at Kivungu	Not Functional	Functional	-6.90987	37.02422	477	
19	Mkata at Mkata	Not Functional	Functional	-6.75907	37.36130	399	
20	Mkindo at Mkindo	Not Installed	Not Functional	-6.24762	37.55250		
21	Mkondoa at Kilosa	Not Functional	Not Functional	-6.83173	36.97824	495	
22	Mkondoa at Mbarahwe	Not Functional	Not Functional	-6.60	36.78		
23	Mkondoa at Railway Bridge	Not Functional	Not Functional	-6.762	36.933		
24	Morogoro at Morogoro	Vandalised	Functional	-6.84562	37.67247	547	
25	Mvuha at Ngagama	Vandalised	Functional	-7.19999	37.83795	138	
26	Mvuha at Tulo School	Not Functional	Functional	-7.24065	37.91766		
27	Mziha at Mziha-Kimamba	Functional	Functional	-5.89588	37.78001	443	
28	Mzinga at Majimatitu	Not Installed	Functional				
29	Ngerengere at Kingolwira	Not Functional	Functional	-6.75177	37.75762	425	
30	Ngerengere at Konga	Functional	Functional	-6.90653	37.59944	531	
31	Ngerengere at Lukwambe	Not Functional	Not Functional	-6.59937	37.99728	332	
32	Ngerengere at Mgude	Not installed	Functional	-6.76507	38.14570	180	
33	Ngerengere at Utari Bridge	Vandalised	Not Functional	-7.01806	38.32478	101	AUG 1951-1992
34	Ruvu at Kibungo	Functional	Functional	-7.02370	37.80948	203	1952-1992
35	Ruvu at Kidunda	Not Functional	Functional	-7.26395	38.24558	86	

36	Ruvu at Mikula	Not Functional	Functional	-7.27967	38.11447	80	1967-2008
37	Ruvu at Morogoro Rd. Br.	Functional	Functional	-6.69080	38.69427	24	1958-JUNE 2010
38	Tami at Msowero	Not install	Not Functional	-6.53173	37.21375	440	
39	Wami at Dakawa	Functional	Functional	-6.44783	37.53343	361	1954-2010
40	Wami at Mandera	Not Functional	Not Functional	-6.24638	38.38732	87	1952-2010

5.4 Discharge Monthly Average (m^3/s) 2016/2017

		2016		2017										Average
NO	**STATION NAME/MONTH**	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	
1	**Wami at Dakawa 1G1**	0.40	0.35	0.58	8.56	58.86	99.50	103.24	26.46	4.86	2.58	0.63	0.58	**25.55**
2	**Ngerengere at Konga 1HA9A**	0.75	0.85	0.53	0.57	0.84	1.77	1.22	0.51	0.31	0.33	0.25	0.35	**0.69**
3.	**Ruvu at Kibungo 1H5**	7.90	7.65	9.28	8.82	19.5	41.37	46.39	19.4	12.6	11.8	8.52	7.37	**16.72**
4.	**Ruvu at Morogoro Rd Bridge 1H8**	19.5	16.6	20.3	28.0	147.4	232.5	262.5	135.5	54.5	38.1	26.0	16.8	**83.13**

5.6 Daily Water level in Mindu Dam

	2016		2017									
	Nov	**Dec**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun**	**Jul**	**Aug**	**Sep.**	**Oct.**
1	505.52	505.12	504.57	504.09	503.75	505.98	507.20	507.12	507.05	507.02	507.01	
2	505.50	505.10	504.57	504.08	503.72	506.07	507.18	507.13	507.05	507.02	507.01	
3	505.48	505.08	504.56	504.07	503.70	506.10	507.16	507.13	507.05	507.02	507.01	
4	505.46	505.06	504.54	504.04	503.69	506.20	507.18	507.12	507.05	507.04	507.00	
5	505.44	505.04	504.52	504.03	503.68	506.28	507.28	507.11	507.04	507.04	507.00	
6	505.42	505.02	504.50	505.01	503.67	506.34	507.40	507.11	507.04	507.03	506.90	
7	505.40	505.00	504.48	504.99	503.67	506.34	507.29	507.10	507.04	507.03	506.82	
8	505.38	504.98	504.47	503.95	503.65	506.68	507.40	507.10	507.03	507.03	506.82	
9	505.36	504.96	504.45	503.97	503.68	506.90	507.38	507.10	507.03	507.03	506.75	
10	505.34	504.94	504.47	503.93	503.67	507.15	507.37	507.10	507.03	507.02	506.70	
11	505.32	504.93	504.45	503.90	503.65	507.15	507.47	507.10	507.03	507.02	506.64	

12	505.30	504.92	504.43	503.88	50.36	507.18	507.46	507.09	507.03	507.01	506.60	
13	505.29	504.91	504.41	503.86	503.65	507.10	507.45	507.09	507.03	507.01	506.60	
14	505.27	504.90	504.40	503.84	503.66	507.08	507.45	507.09	507.03	507.01	506.56	
15	505.26	504.88	504.38	503.82	503.64	507.07	507.44	507.08	507.03	507.01	506.54	
16	505.24	504.86	504.36	503.80	503.62	507.21	507.42	507.08	507.03	507.02	506.54	
17	505.22	504.84	504.35	503.78	503.64	507.10	507.40	507.08	507.02	507.02	506.54	
18	505.20	504.82	504.34	503.76	503.68	507.09	507.37	507.08	507.02	507.02	506.54	
19	505.21	504.80	504.31	503.74	503.80	507.10	507.35	507.07	507.02	507.02	506.90	
20	505.26	504.78	504.29	503.72	504.51	507.35	507.32	507.07	507.02	507.02	506.90	
21	505.28	504.76	504.27	503.70	504.82	507.28	507.29	507.07	507.02	507.07	506.90	
22	505.27	504.74	504.25	503.70	505.00	507.18	507.25	507.07	507.02	507.10	506.90	
23	505.26	504.72	504.23	503.69	505.10	507.20	507.23	507.06	507.01	507.08	506.89	
24	505.24	504.70	504.21	503.73	505.20	507.22	507.20	507.06	507.01	507.08	506.89	
25	505.22	504.68	504.19	503.78	505.25	507.18	507.18	507.06	507.01	507.06	506.86	
26	505.21	505.66	504.17	503.77	505.29	507.25	507.18	507.06	507.01	507.04	506.86	
27	505.20	504.64	504.15	503.76	505.30	507.25	507.17	507.05	507.01	507.04	506.86	

28	505.19	504.62	504.13		505.46	507.18	507.17	507.05	507.01	507.02	506.85	
29	505.17	504.61	504.11		505.59	507.16	507.16	507.05	507.01	507.02	506.85	
30	505.15	504.60	504.10		505.78	507.19	507.14	507.05	507.01	507.01	506.83	
31	505.00	504.59	504.11				507.13		507.02	507.01		
Mean	**505.29**	**504.88**	**504.35**	**503.94**	**504.23**	**506.92**	**507.29**	**507.08**	**507.03**	**506.55**	**506.80**	
Maximum	**50517.0**	**505.7**	**504.6**	**505.0**	**505.8**	**507.4**	**507.5**	**507.1**	**507.1**	**507.1**	**507.0**	
Minimum	**505.0**	**504.6**	**504.1**	**503.7**	**503.4**	**506.0**	**507.1**	**507.1**	**507.0**	**507.0**	**506.5**	