Water Resources Management Authority

Republic of Kenya

NATIONAL WATER RESOURCES SITUATION REPORT FOR FY2015/2016

30TH JULY 2016

FOREWORD

This report outlines the achievements by Water Resources Management Authority (WRMA) in the management of water resources during the financial year 2015/16. It gives emphasis to what WRMA has achieved through its effort and in collaboration with stakeholders in improving water resources management in terms of quantity and quality. This has been realized through data collection, analysis, planning and studies.

WRMA is continuously improving its data monitoring network in order to avail more reliable data to planners, designers, users, investors and regulators. This is done through increased investments into water resources monitoring, infrastructural rehabilitation and upgrading of existing network.

WRMA has started installing telemetric hydro-met monitoring stations for real time data collection to reduce the lapses in decision making due to lack of timely data sourcing and modelling. This will also assist in timely querying of inaccurate data. This is being achieved through installation of automatic equipment that is using GSM technology on transmission. The data collected will be displayed in web portals and data centres. Real time data will also be crucial for setting early warning systems for water related disasters like floods and droughts. This is a function which WRMA has fully embraced and piloted in three sub-catchments. This will be taken to the next level in the coming year.

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1 INTRODUCTION

1.1 Overview

Water resources availability determines the patterns of human settlements and socio-economic development in Kenya. Through the JICA assisted study of the National Water Master Plan 2030, the available water Resources availability has been assessed (both ground and surface water) as shown below.

Available Water Resources by Catchment Area

(Units in MCM/yr.)

Catchment Area	Area (sq.km)	2010	2030	2050
LVNCA	18,374	4,742	5,077	5,595
LVSCA	31,734	4,976	5,937	7,195
RVCA	130,452	2,559	3,147	3,903
ACA	58,639	1,503	1,634	2,043
TCA	126,026	6,533	7,828	7,891
ENNCA	210,226	2,251	3,011	1,810
Total	**575,451**	**22,564**	**26,634**	**28,437**

Table 1.1: Available Water Resources by Catchment

Source: National Water Master Plan (NWMP 2030)

The projected increase in available water resources in 2030 and 2050 is attributed to the projected increased rainfall due to impacts of climate change.

Surface water in Kenya is the backbone of hydro-electric power generation, major irrigation schemes and water supplies. This includes the 7 forks hydropower schemes in the Tana River basin, Bura, Mwea, Kano and Perkerra irrigation schemes. The water supplies are for Nairobi, Mombasa, Kisumu, Eldoret, Nakuru and other Urban and Rural Water Supplies.

Groundwater resources has also played a key role in development of Domestic, agricultural, industrial, municipal and rural settlements. It is a major source of water for

Mombasa, Nakuru and Nairobi. Most of the drinking water supplies especially in the rural arid areas are sourced from groundwater systems.

The reliability of the water resources for different uses is highly dependent on the physical and chemical composition. Point and non-point water pollution is a key challenge in ensuring accessibility of safe water resources in Kenya. Water Resources Management Authority (WRMA) ensures equitable access to water in right quality and quantity for the production, environment and basic human needs. In some parts of the country high levels of dissolved chemicals especially for groundwater makes it unfavorable for portable water.

Water Resources Management Authority has the mandate to ensure that water resources are conserved and protected against adverse impacts to ensure the availability in terms of quality and quantity. Different approaches have been employed to achieve this amongst them catchment rehabilitation programs, done in partnership with WRUAs though the implementation of Sub- Catchment Management Plans. Another approach is Effluent discharge Management of known effluent dischargers through application of effluent discharge standards. A plan is developed through which an effluent discharger progressively works towards meeting the standards within a specified timeline and eventually obtaining an effluent Discharge permit.

1.2 This Report

This report outlines the achievements and experiences by WRMA in the management of water resources during the financial year starting from 1st July 2015 to 30th June 2016

1.3 Data Availability

Hydrological data is usually collected, digitized, stored in the database and analyzed on demand and used during compilation of water resources reports, decision making in determining applications for water use among other uses. Every month a copy of regional data base is transmitted to the national database for archiving and future retrieval. Data available include surface water, water quality, groundwater and water use. Further, the data is analyzed to guide decision making. Majority of the customers are served at the regional offices but a few visit the national offices for data enquiry and advice. The WRMA hydrological year book provides meta data on available data in WRMA data base for each monitoring station and can be viewed in our website; www.wrma@wrma.or.ke

The data available at different functional levels:

1. Sub regional office
    - Groundwater – Water levels
    - Surface Water – River Water levels, Rainfall, Evaporation
    - Water Quality, Point effluent discharges, and Pollution – in-situ water quality measurements
    - Water use – Abstractions, authorization and permit data
2. Regional office
    - Groundwater – water levels, aquifer maps, borehole completion records,
    - Hydro- geological reports, special studies reports
    - Surface Water Quality and Pollution – in-situ measurements, laboratory analytical Results, pollution surveys reports, status of water quality, special studies reports
    - Water- River water level and discharge, rainfall, evaporation, point/daily Effluent Discharges, special studies reports
    - Water use – abstraction survey data, authorizations and permit data, self-assess on periodic actual water abstractions
3. National office
    - National Data base containing the above data/reports from all the Regions and sub Region

2 CLIMATE

2.1 Description of Monitoring Network

WRMA operates a weather monitoring network comprising of rainfall, evaporation and climate stations. During the year under review, 166 of 270 rainfall stations were operational, 47 of 65 evaporation stations were operational and 22 of 32 climate stations were operational.

Weather monitoring Stations

	Rainfall	**No. Operational**	**Evaporation**	**No. Operational**	**Climate**	**No. Operational**
LVS	58	56	20	20	10	9
LVN	72	22	10	3	5	0
RVCA	22	18	7	6	4	4
Athi	47	28	10	5	2	0
Tana	45	27	14	11	2	0
ENNCA	26	15	4	2	9	9
Total	**270**	**166**	**65**	**47**	**32**	**22**

Table 2.1: Description of weather monitoring network

The weather monitoring stations operated by WRMA are strategically located at various parts in the catchments. WRMA also obtains data from various stakeholders such as private institutions, government and learning institutions. The data collected from these stations is used for modelling and planning purposes. It is also available to the public at a fee.

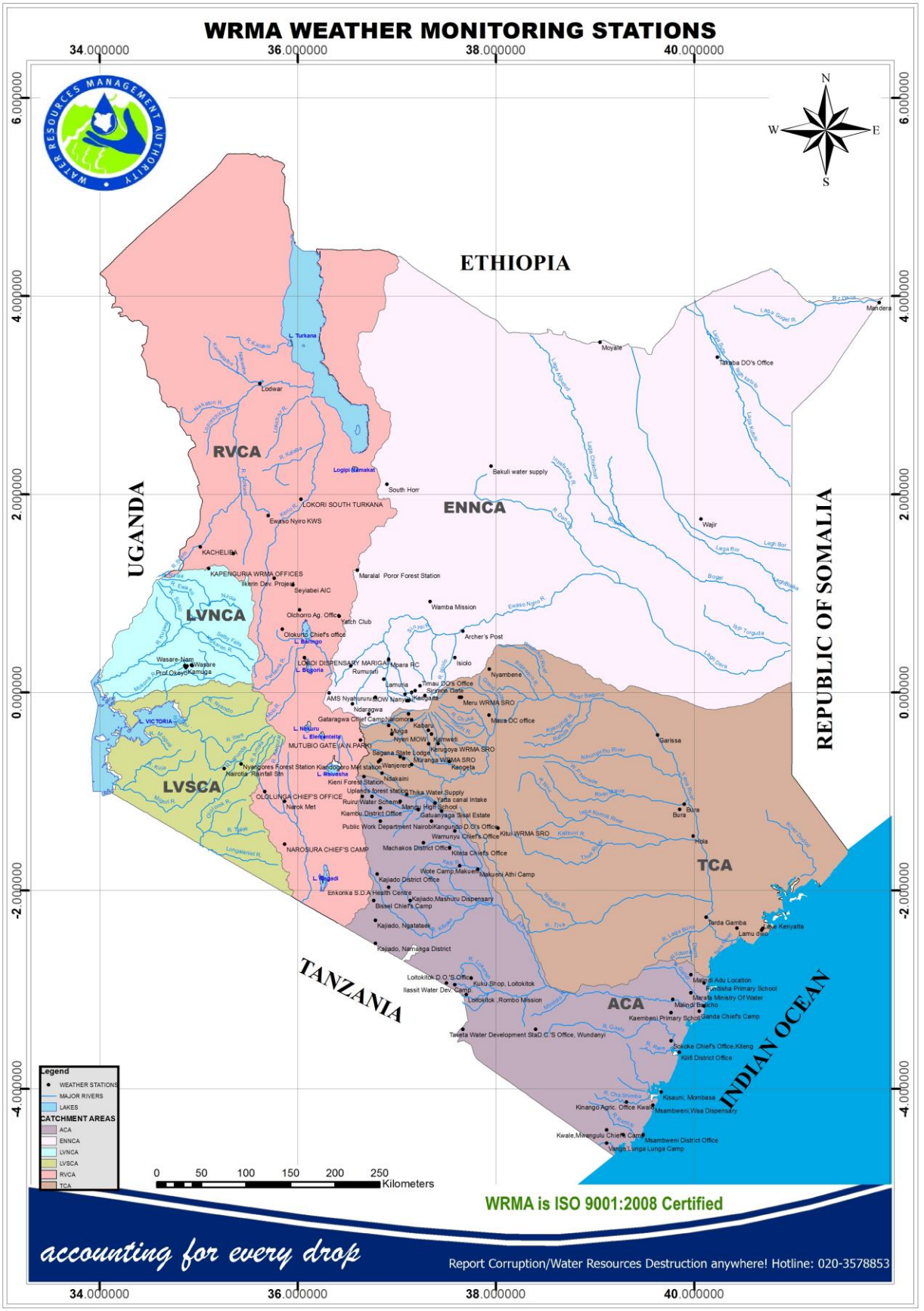


Figure 2.1: Rainfall monitoring network

2.2 Improvements to Network

Climatic monitoring frequently experiences losses due to flooding, ageing and vandalism. To improve on this and maintain the integrity of data collected, WRMA has been regularly maintaining and improving the monitoring network.

During the year under review, 15 rainfall stations were rehabilitated, 3 evaporation stations and 8 automatic climate station installed together with telemetric River gauging Stations. The RGS with climate stations are 1GD03 Nyando, 1JG04 Sondu, 1KB05 Gucha Migori, RGS 1LA04 Mara, 3AH13 Sabaki, 4G01 Garissa and ----Njoro.

Rehabilitation of stations was carried out as follows:

- LVSCA, at Bomet water supply, Mara WRUA mulot, Governors camp, Mpata, Olerai, Ololaimutia, Talek gate, Keekorok lodge, Sekenani gate, Lemek, Nairotia, and Nyangores forest.
- In LVNCA, one rainfall station was installed at chesoni and onother relocated from new bungoma to Chebosi Boys High School.
- In RVCA one rainfall station was rehabilitated at Narok Water Supply
- In Tana, 3 No. evaporation and 1 rainfall stations were rehabilitated.
- In ENNCA, Middle Ewaso Ng'iro Sub Regional office got into an arrangement with Uhuru Flowers located in the upper part of the sub region to be sharing rainfall and climatic data from their station. The farm is to provide daily rainfall, temperature and humidity data.

Below are photographs of some of the installations.

Figure 2.2 Site preparation and fencing at Chebosi H. School Bungoma , Rain-gauge setting and sensitisation of teacher

Tana region Office Sub-Met Station

Removal of pan *Filling with water after rehabilitation*

Figure 2.3: Rehabilitation of Tana office Sub-met station

SAGANA FISH FARM 9037096				
				
Before	**Empting the Sagana water pan**	**Station During maintenance**	**Station After installing**	

Figure 2.4: rehabilitation of sagana water pan

2.3 Analysis of Rainfall, Evaporation & Climate

A comparative analysis of rainfall received from some of the rainfall monitoring stations during the year under review is as shown below;

Athi Stations

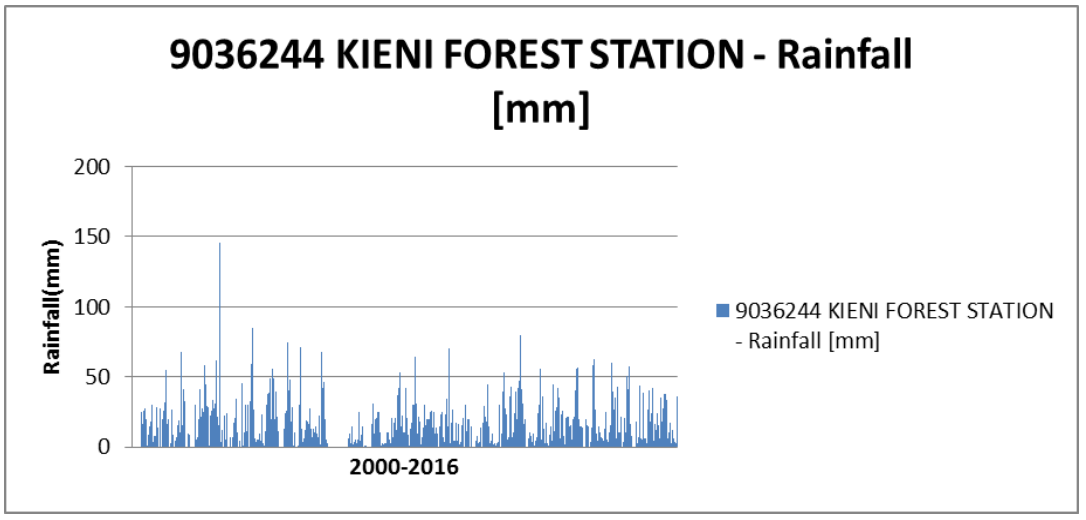


Figure 2.5 Kieni Forest rainfall trend

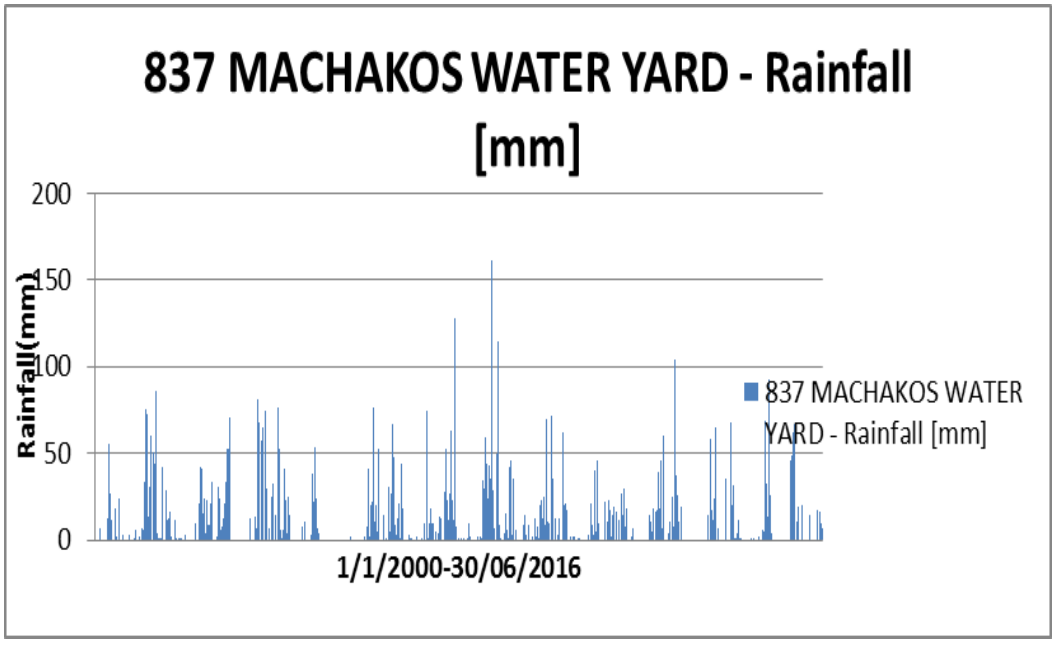


Figure 2.6 Machakos Water Yard rainfall trend

ENNCA Stations

Nanyuki Sub Met Station

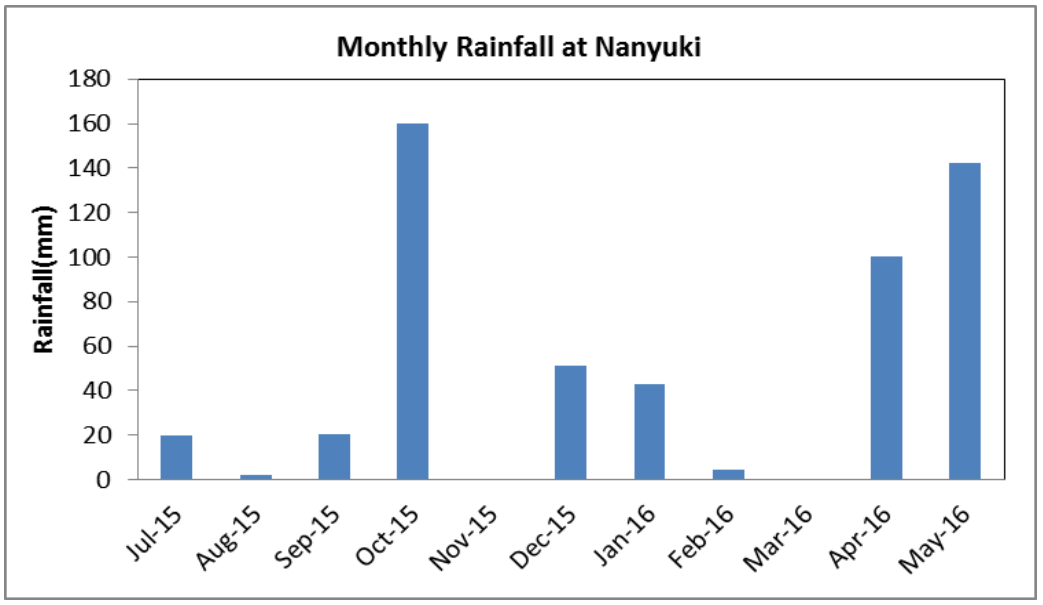
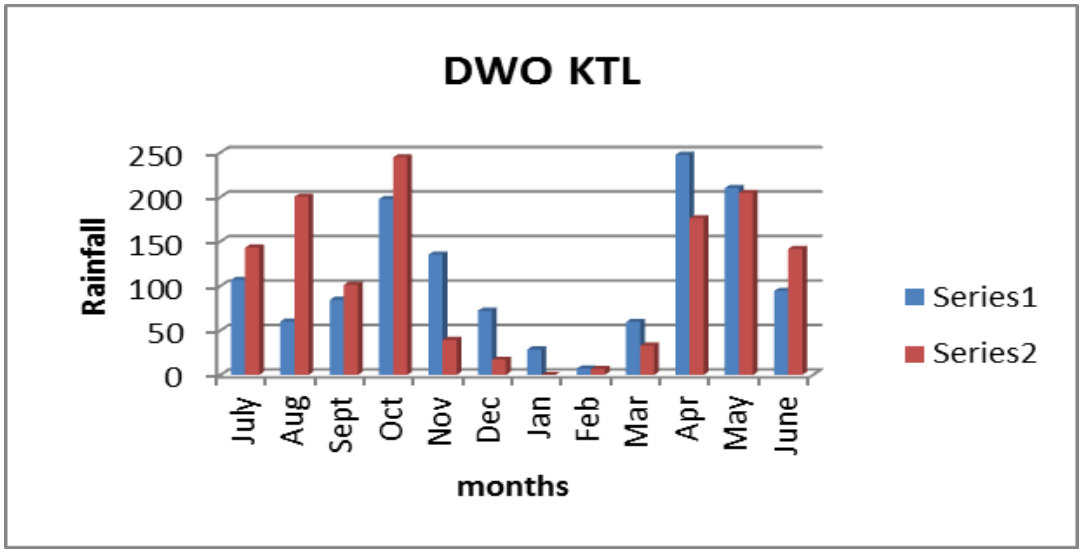


Figure 2.7 Nanyuki monthly rainfall for 2015/16

The data for the months of November 2015 and March 2015 were missing. However, the available data showed that the months of August 2015 and February 2016 received the lowest rainfall of 42mm while high rainfall of 160.3mm was recorded in October 2015. The long rain and short rain periods received moderate rainfall.

Lake Victoria North Catchment Rainfall Trend



KEY

Series 1: Rainfall data for FY 20152016 Series 2: Rainfall data for FY 2014/2015

Figure 2.6 Kitale DWO rainfall comparison for 2 years

In Kitale the year under review experienced more rainfall than the previous year during long rains of March to April. In the first half of the year the rains were less.

Rift Valley Catchment Rainfall trends

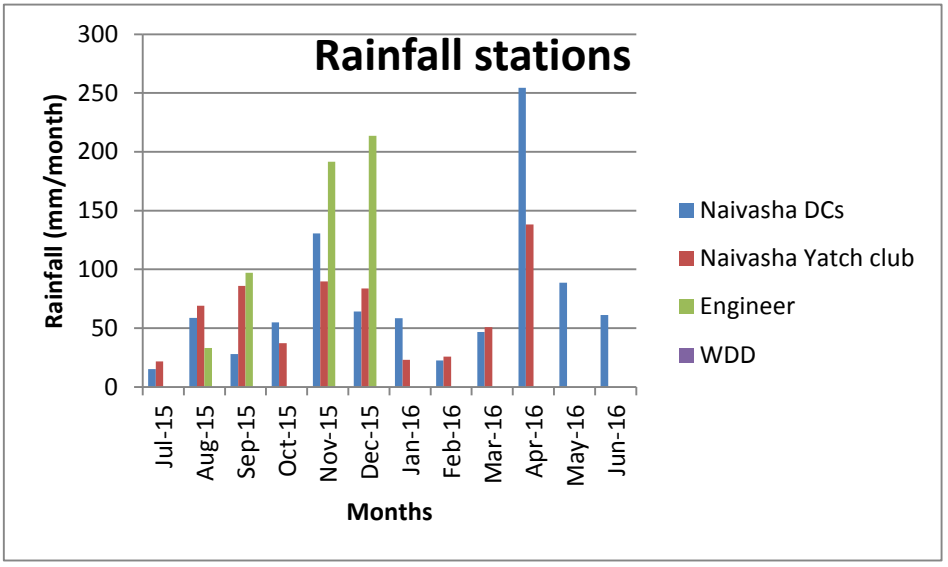


Figure 2.7: Yearly rainfall comparison for 4 stations in Naivasha

In the Naivasha DC (9036002) Station, there was lower rainfall at the beginning of 2015 as compared to 2016 the same period. However the rains subsided in February 2016 while in the same period in 2015, the rains continued. Most of the stations recorded high rainfall in the months of November and December.

Tana Catchment Rainfall trends

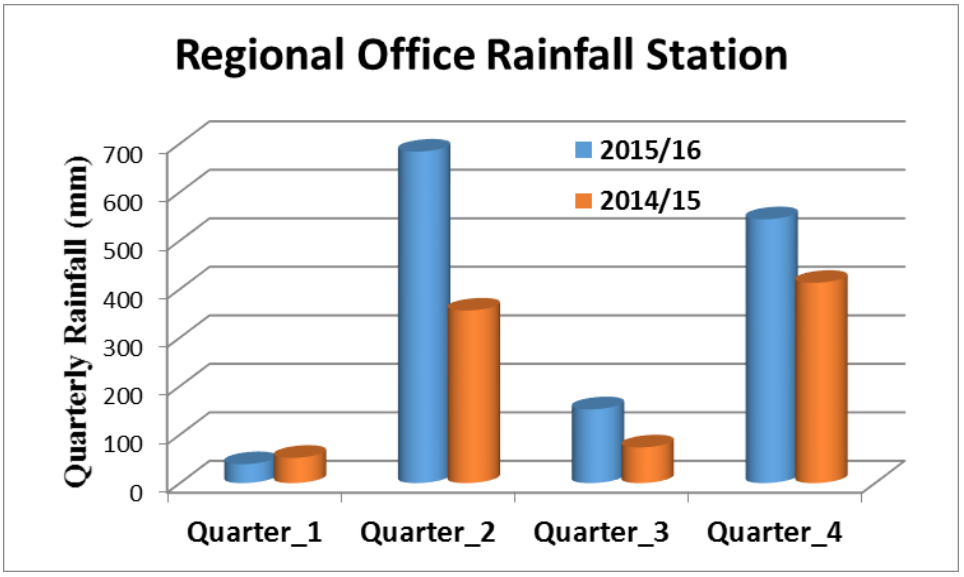


Figure 2.8: Tana Region office rainfall comparison for 2 years

The highest rainfall occurred in quarter 2 at Embu Region rainfall station. Overall the year under review recorded more rainfall than the previous year.

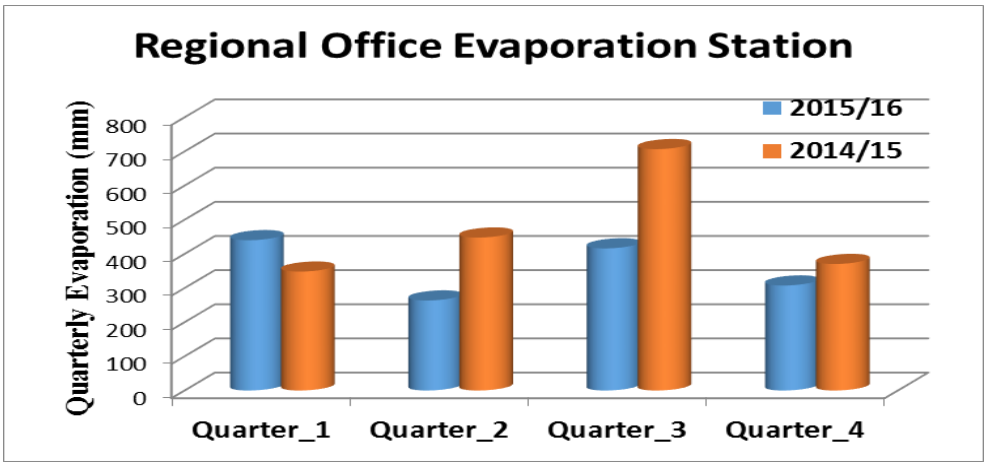


Figure 2.9 Tana region office evaporation comparison for 2 years

Evaporation at the Regional Office station indicates that the highest rainfall amounts occurred in Quarter 2. Evaporation amounts during the report period were lower than similar period the previous year.

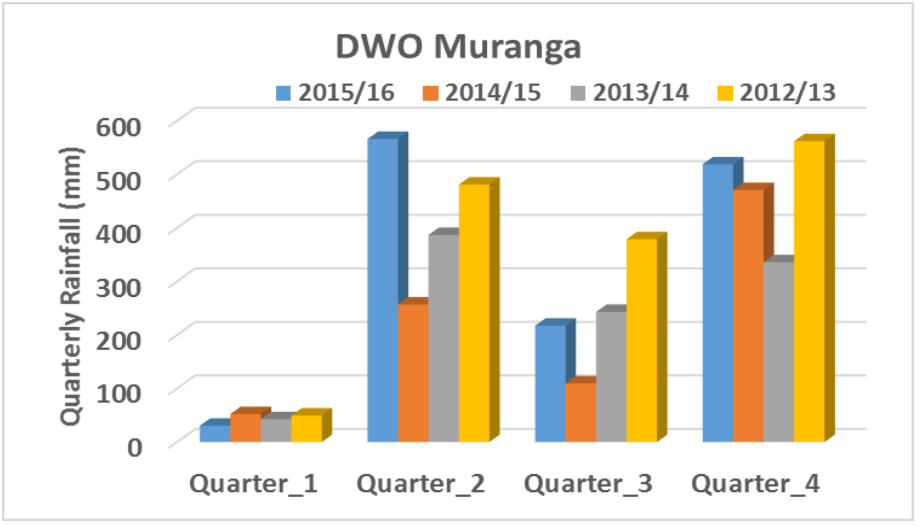
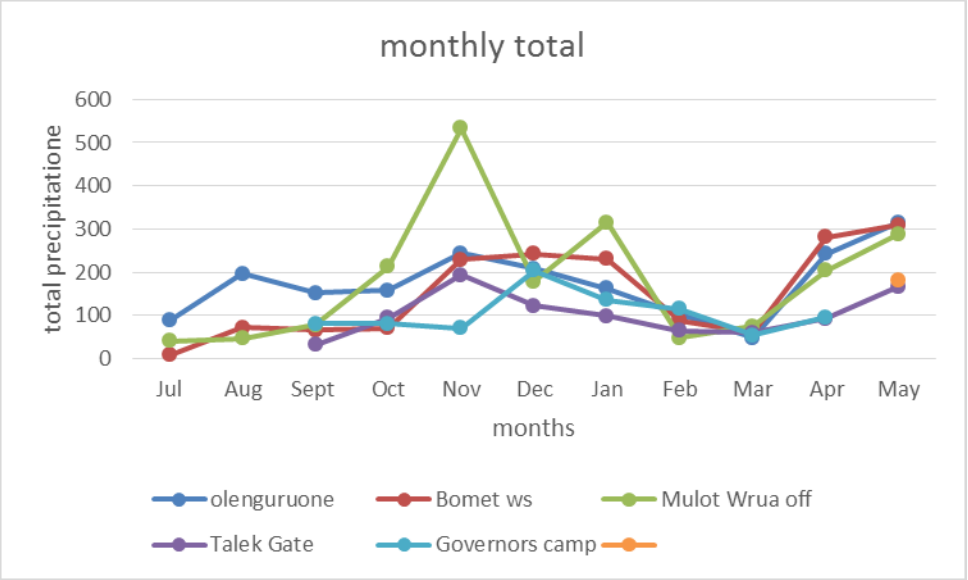


Figure 2.10 DWO Muranga comparative quarterly rainfall for 4 years

During the report period, the highest rainfall amounts occurred in the 2nd quarter at Muranga whereas the year 2012/2013 recorded the highest rainfall for quarter 4.

Lake Victoria South Catchment Area Rainfall comparison



The first quarter of the year experienced dry weather but the situation changed when the expected elnino rains arrived in the month of November which continued to early January 2016. Again in the season of the long rains, the catchment received medium to high rainfall. This implies that there was enough water in the Rivers, pans and other storage facilities that satisfied the requirements for all uses.

2.4 Comments on Special Events

No Extreme Events were recorded during the year under review

2.5 Special Studies

No studies were undertaken during the year under review.

3 SURFACE WATER RESOURCES

3.1 Description of Monitoring Network

Map of RGS Monitoring Stations

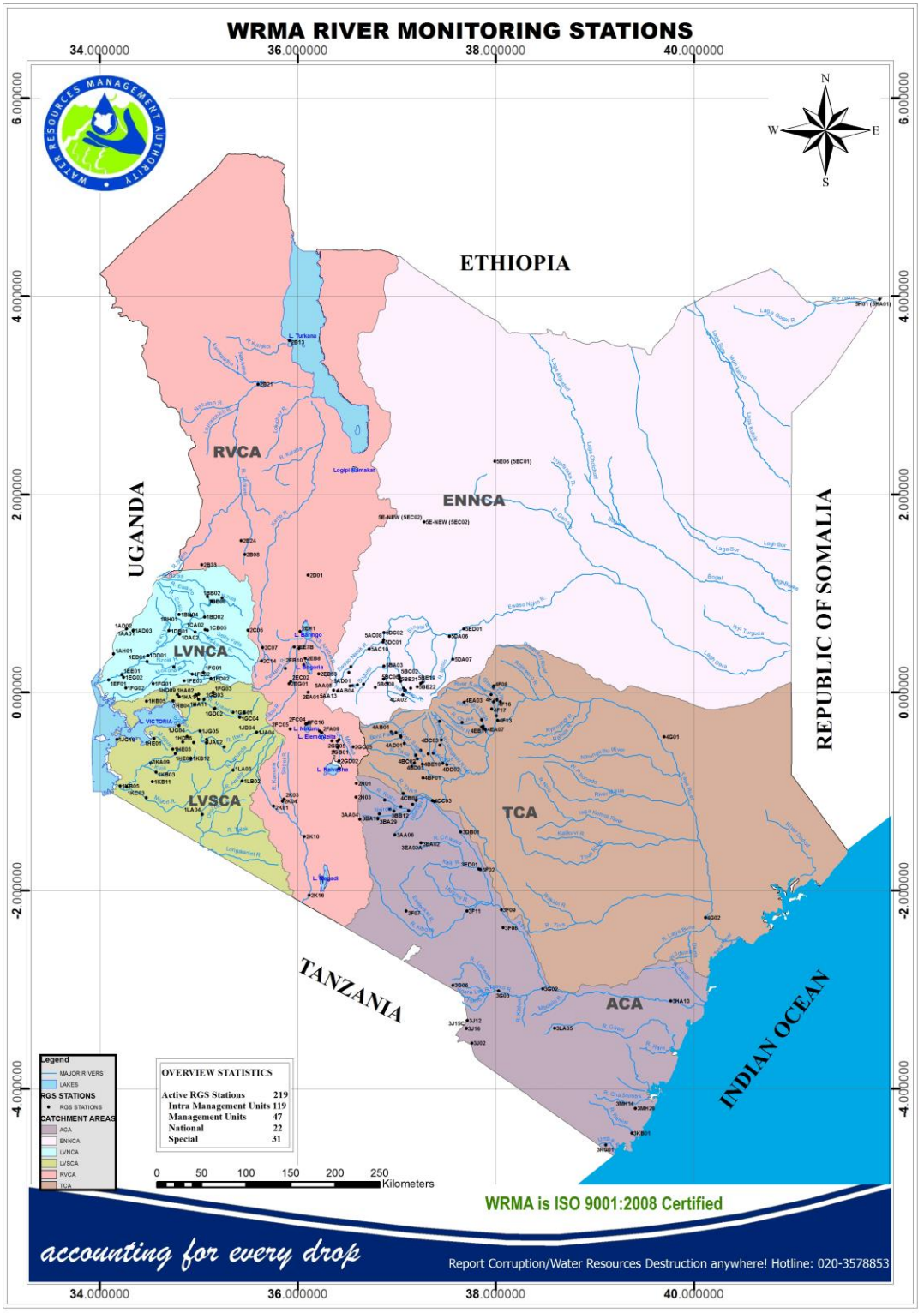


Figure 3.1: RGS Monitoring Network

CMS Monitoring Stations

REGION	NATIONAL	MU	INTRA MU	SPECIAL	TOTAL	% OPERATIONAL
LVN	5	6	10	7	28	75
LVS	5	13	19	1	38	85
RVCA	7	13	21	1	41	50
ACA	3	4	20	3	31	60
TCA	1	7	21	18	47	85
ENNCA	1	5	31	1	38	95
Total	**22**	**48**	**122**	**31**	**223**	**75**

Table 3.1: Monitoring network Categories per Region

3.2 Improvements to Network Infrastructure

During the year under review, 12 RGS were upgraded to telemetric status, nine (9) stations rehabilitated and nine installed.

Automation of RGS 4G01 – Tana at Garissa

The Station Before Installation | During Installation | Completed Work

Figure 3.2:Installation work at RGS 4G01Tana River

Figure 3.3: Rehabilitation works of Yala at Bondo Station (1FG02) in LVSCA

Figure 3.4: Concrete post installed at Mwache 3 MB02 and Gauge reader being trained reading in Athi Catchment.

3.3 Improvements to Data Quality

The availability of automatic equipment which log on hourly basis has ensured that all events are captured in the upgraded stations mentioned earlier. However, this can only be sustained if the stations are visited regularly and the batteries changed promptly to avoid losing data.

Gauging campaign is done to validate and improve rating equations. The gauging plan for the regions entails sustained discharge measurement at the newly installed or rehabilitated stations in order to develop and/or improve the rating curves. This was done quarterly by the Regions but the data needs to be entered in the database for updating of the rating curves.

During the year under review, **Tana catchment** updated rating equations for 14 stations as follows:

Updated rating curves for 2015/16

S/N	Station ID	Station Name
1	4AD04	Gura
2	4BD06	South Mathioya
3	4BD07	North Mathioya
4	4BE01	Maragua
5	4BE03	Irati
6	4BE08	Gikigie
7	4BE09	Maragua
8	4BE10	Tana at Rukanga
9	4BF01	Saba Saba
10	4CB05	Thika
11	4DD02	Thiba
12	4F13	Tana at Grand Falls
13	4G01	Tana at Garissa
14	4G02	Tana at Garsen

Table 3.2: Stations with updated rating curve in Tana Catchment

Gauging campaigns

Figure 3.5: Flood flow monitoring by use of ADCP at Chania 4CA03 and Gura 4 AD01 in Tana Catchment

3.4 Assessment of Surface Water Resources

3.4.1 Mean Monthly Flows

ENNCA

Four different sub catchments were analysed in Ewaso Nyiro North and depicted different stream flow characteristics throughout the year. Teleswani River had the highest flow recorded in the month of January 2016 which contrary to expectations of low because the month is normally dry. This could be attributed to the rains experienced in the upper reaches at the onset of short rain period which extended to the month of January.

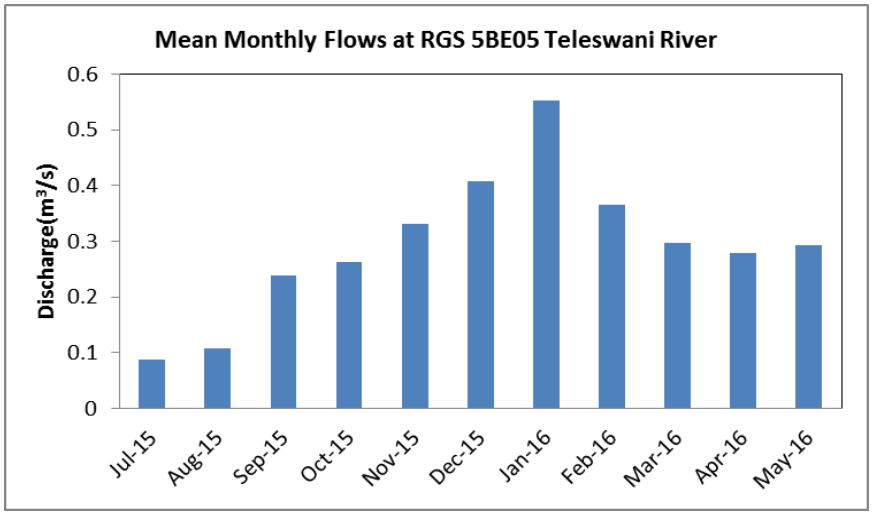


Figure 3.6: Mean monthly flow at RGS 5BE05, Teleswani River

Nanyuki River desplayed a typical trend which conformed to the rainfall trend in the catchment with the months of October, November and December receiving high flows. This river has has stable flow and does not dry up at this point. The river flow diminishes downstream due to increased farming activities.

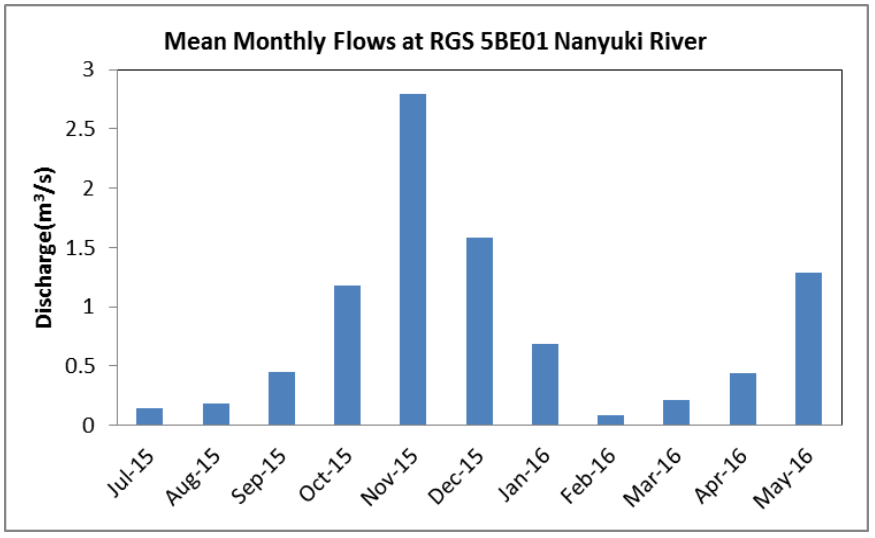


Figure 3.7: Mean monthly flow at RGS 5BE01, Nanyuki River

Ontulilii is a small river whose normal flow is normally less than 0.5m^3/s. It desplayed similar characteristics as Nanyuki River with high flows recorded during the OND period. The highest flows were recorded in the month of November 2015 which had a mean flow of 0.63m^3/s.

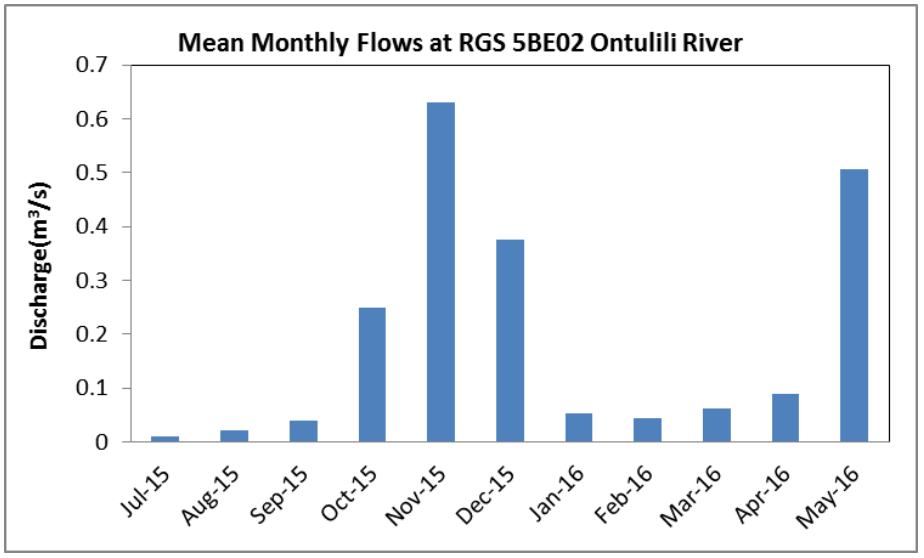


Figure 3.8: Mean monthly flow at RGS 5BE02, Ontulili River

Comparing the mean monthly flow for the period 2014/15 and 2015/16 at Timau River RGS 5BE06, it was established that the flow was significantly higher during the period July 15-June 2016 in the Months of July to October and January. This are the dry months when irrigation activities are rampant. The increase in flow could therefore be attributed to enforcement for illegal abstraction or higher rainfall received in 2015/16 during this period.

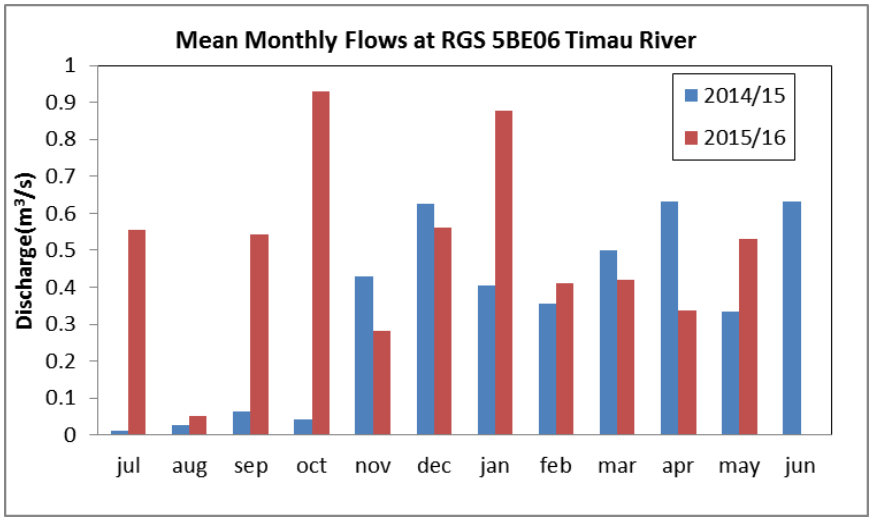


Figure 3.9: Mean monthly flow at RGS 5BE02, Ontulili River

3.4.2 Flow variability

ENNCA

Temporal comparisons of flow for the year under review with the previous year at the four RGS indicate an increase in flow as demonstrated in Figure 11. The hydrograph of RGS 5BE05, Teleswani River however shows erratic flow during the 2015/2016 as opposed to 2014/15 which display the typical rain seasons; high flows in MAM and OND and low flows in July to September and January to February.

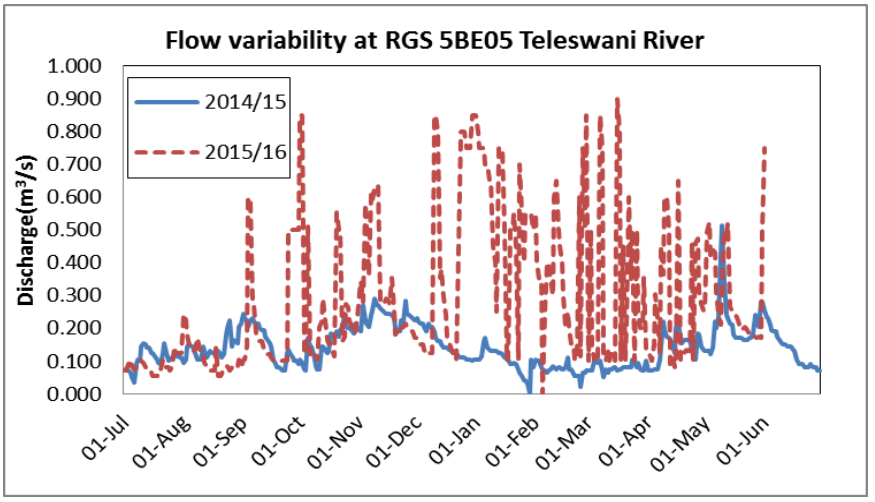


Figure 3.10: Comparison of flow in 2014/5 and 2015/16 at Timau River

The flow characteristics in Timau, Nanyuki and Ontulili Rivers are shown in Figures 3.7, 3.8 and 3.9 respectively. Whereas the Nanyuki and Ontulili hydrographs depict clear seasonality, Timau flow is erratic meaning that the flow could be 'artificial' and is controlled upstream. The River is susceptible to over abstraction and violation of the reserve as seen in the months of July to October 2014 and the same period in 2015 when the flow was almost zero.

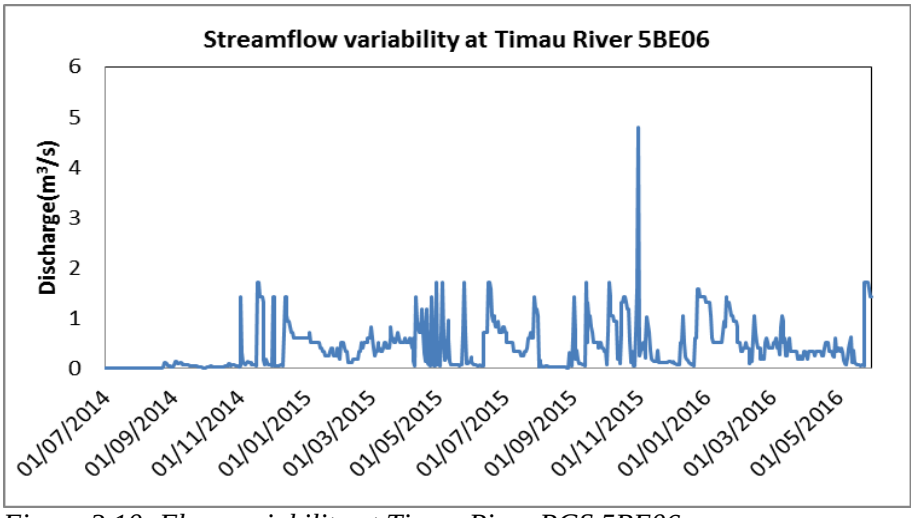


Figure 3.10: Flow variability at Timau River RGS 5BE06

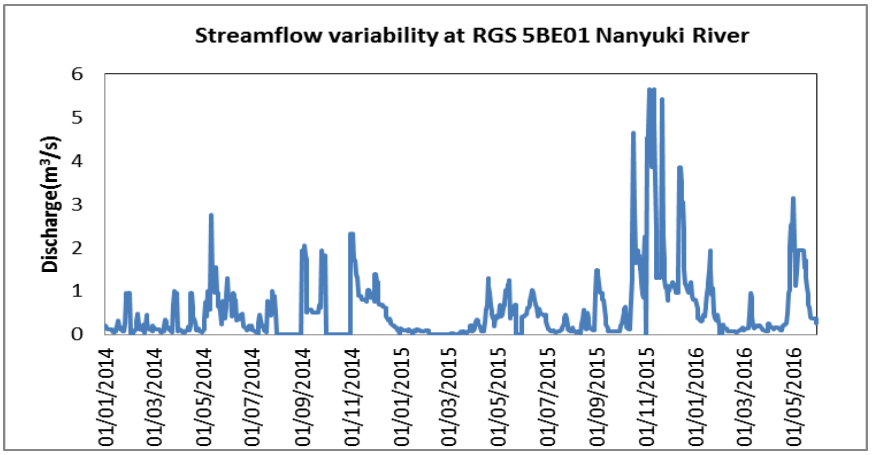


Figure 3.11: Flow variability at Nanyuki River RGS 5BE01

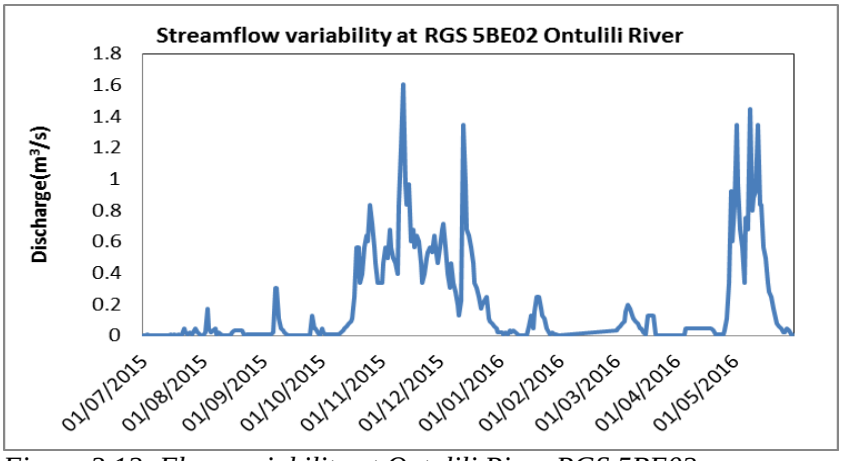


Figure 3.12: Flow variability at Ontulili River RGS 5BE02

LVSCA

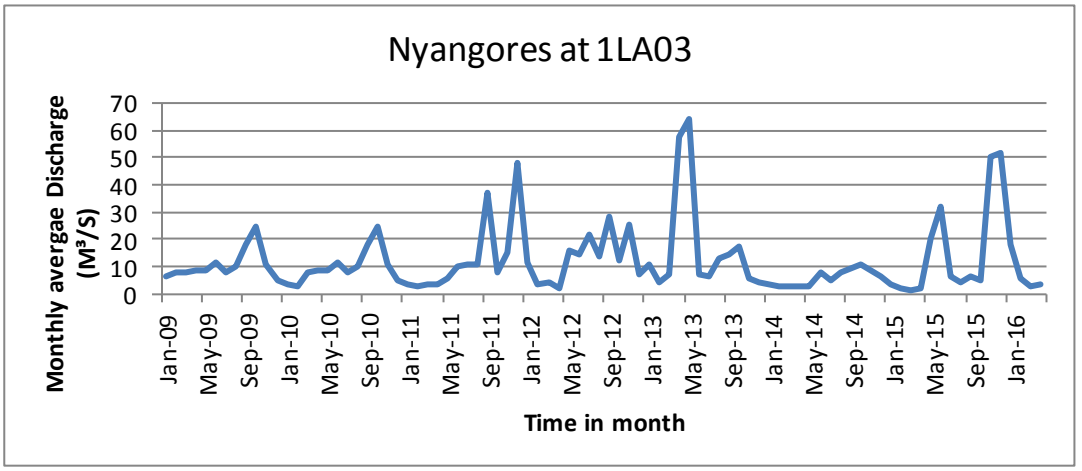


Fig 3.13: Flow Variability for Nyangores 1LA03

The flows for the period under review were above average for river Nyangores in Lake Victoria South Catchment compared to the previous years.

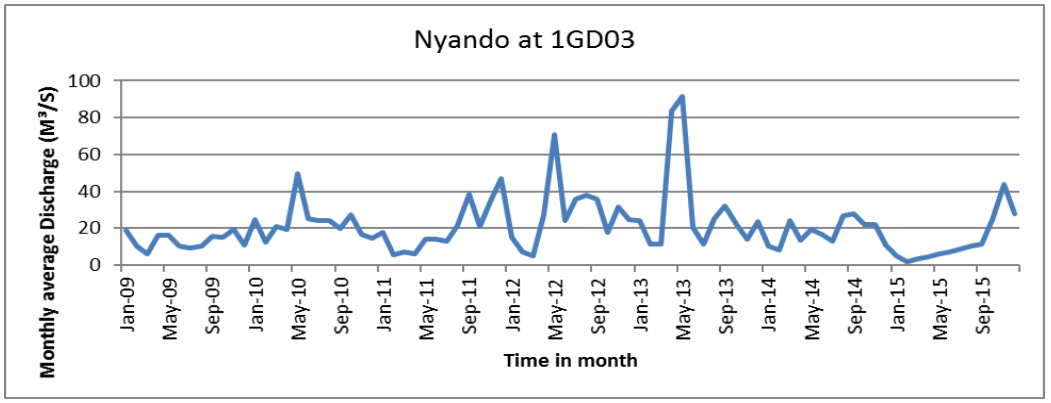


Fig 3.14: Flow variability for Nyando River at 1GD03

The Flow for Nyando River was just average compared with the previous years.

3.4.3 Trends for certain stations

Year to Long Term Comparison in Tana

Station	Years of Data	Mean for 2015/2016 (m3/s)	Long Term Mean (m3/s)	Maximum Recorded Value	Minimum Recorded Value
Tana 4G01	1944-2016	255.74	164.88	1974.02	0.2158
Maragua 4BE01	1946-2015	8.48	10.04	998.33	0.0550
4BE10 Tana Rukanga	1979-2016	32.85	35.36	383.09	1.76
Thiba 4DD02	1966-2016		22.419	291.441	0.133
Thiba 4DA10	1967-2015		9.93	100.58	0.0274
Tana 4F13	1962-2015	176.67	188.81	2140.06	0.42
Tana Garsen 4G02	1950-2016	8.68	136.61	447.0578	1,33
Station	Years of Data	Mean for Year XX (m3/s)	Long Term Mean (m3/s)	Maximum Recorded Value	Minimum Recorded Value

Table 3.3: Long term flow statistics for Tana

Athi Water Levels

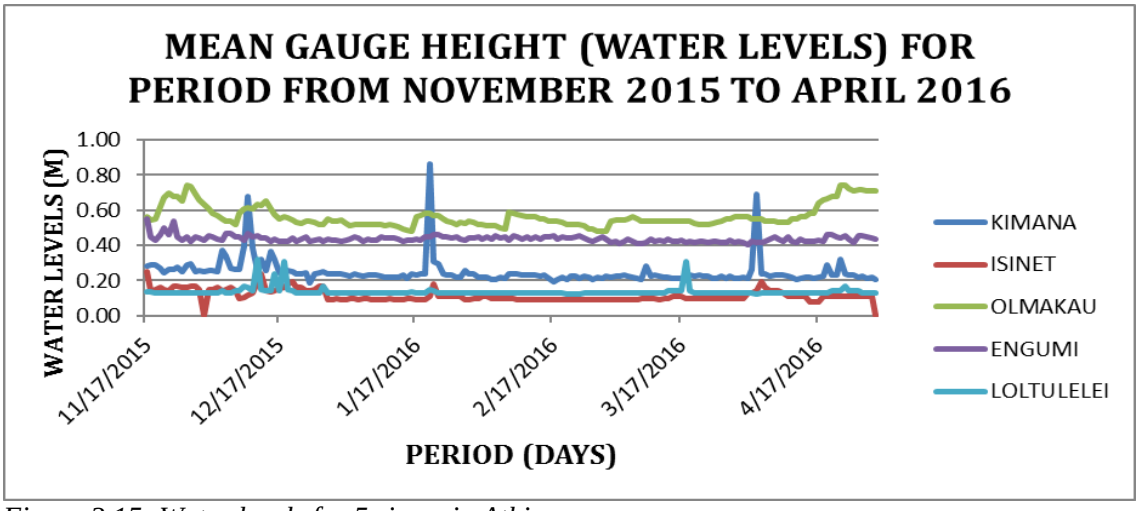


Figure 3.15: Water levels for 5 rivers in Athi

The water levels were average during the year under review

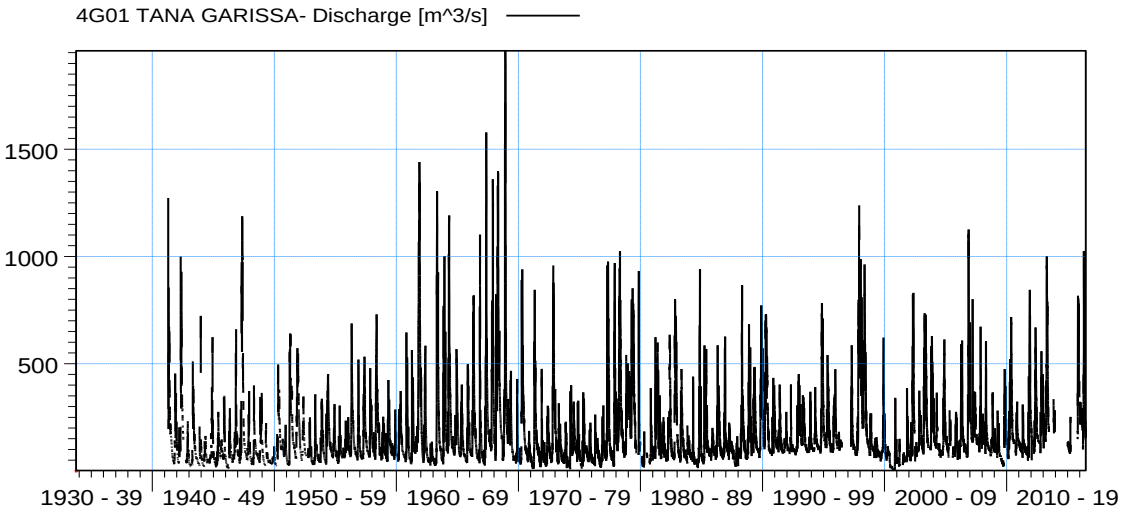
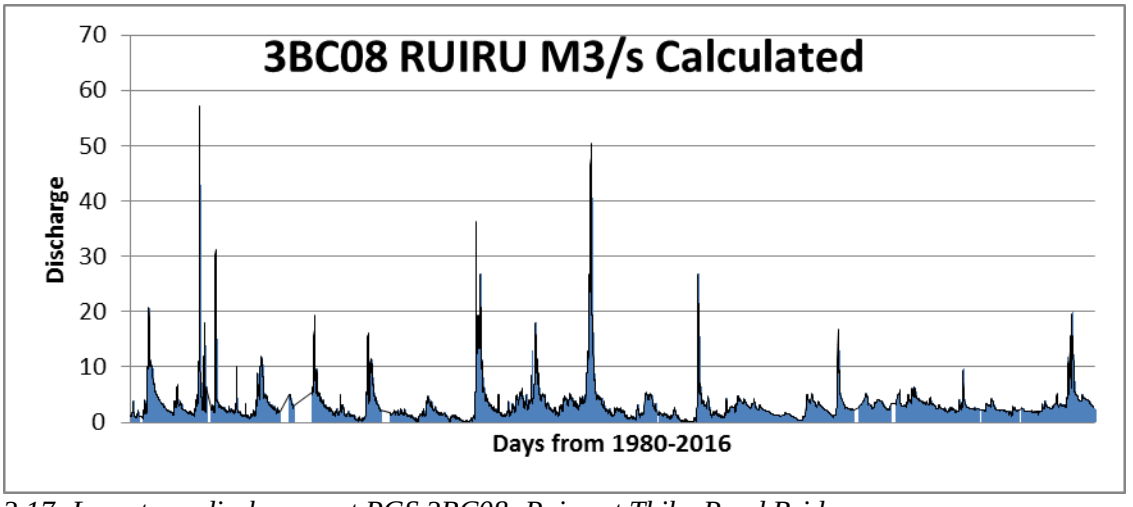


Figure 3.16: Long term dicharges at RGS 4G01 – Tana at Garissa

Average dischages were recorded in Tana River at garissa during the year under review.



3.17: Long term discharges at RGS 3BC08- Ruiru at Thika Road Bridge

3.5 Comments on Special Events

3.5.1 Flooding

Lake Victoria North

Some flooding experienced in East Yimbo of Bondo Sub County and Sabwani in Trans Nzoia County (Yala and Sabwani Rivers) due to heavy downpour on the upper catchments.

Assessment was done on 12th and 13th May 2016. The visited areas were Sikhendu, Kipkorion, Mitua, Namanjalala, Ngazi and Taito (Mukuyu). The damages caused by flood in the areas are indicted in the table below.

S/ No	Area	date flood Assessment	Damages	Remarks
1	Sikhendu	12/05/2016	-Approximately 80 acres of maize destroyed -Two temporal bridges washed away	Flood depth estimated at 1 metre
2	Kipkorion	12/05/2016	-Approximately 20 acres of maize destroyed -One temporal bridge washed away	Flood depth estimated at 0.5 metre
3	Mitua	12/05/2016	-Approximately 100 acres of maize destroyed	Flood depth estimated at 1 metre
4	Maliki	12/05/2016	-Approximately 150 acres of maize destroyed	Flood depth estimated at 1 metre
5	Ngazi	13/05/2016	-Approximately 30 acres of maize destroyed	Flood depth estimated at 1 metre
	Taito(Mukuyu)	13/05/2016	-Approximately 150 acres of maize destroyed	Flood depth estimated at 1 metre

Table 3.4: Flood Assessment in LVNCA

Figure 3.18: Backwater flow from Yala River around Aduwa area in Bondo Sub County on 12/5/2016.


Figure 3:19: maize farm flooded at Maliki and maize farm flooded at Taito

Flooding in Tana region

Floods were reported in several areas during the April, May rains in Tana Catchment area. The areas are tabulated in the Table below.

Sub-region	County	Areas Flooded	Cause of floods
Lower Tana	Garissa	Balambala, Garissa Town, , Fafi, Masalani, Mansabubu, Hara, Kotile, Korisa,	Flash floods due to heavy rainfall on the upper areas of Tana and spilling of Kiambere Dam
	Tana River	Hola ,Wenje ,Garsen ,Tana Delta	Bursting of Tana river banks
	Lamu	Areas around Lake Kenyatta, Panda Nguo, Witu	Bursting of Tana River banks
Upper Tana	Muranga	Gakira area in Kigumo sub county	Heavy rainfall experienced causing landslides
Kathita-Mutonga	Meru	Maua	Heavy rainfall causing floods in areas which were wetlands and has no outlet
Thiba	Kirinyaga	Kagio police station bridge, Rwamuthambi bridge	Heavy rainfall causing floods

Table 3.5: Flooded areas in Tana Catchment

Flood area around Garissa Show Grounds on 3rd May 2016

Residents of Widsor area salvaging their properties from floods

Evacuation of the entrapped residents of Delley village using canoe

Established evacuation Centre for residents of Bakuyu Village at Young Muslims School

Figure 3.20: Flooded areas in Tana

Flooding in Athi Catchment

- The Coastal Athi sub region recorded rainfall on 17th November, 2015 of 45.6mm at our rainfall station in Changamwe which caused floods in this area is due to the poor drainage system.
- River Sabaki levels rose to above 2m causing flooding between 15th and19th December 2015 in the Lower Sabaki areas of Magarini.
- Heavy rains on the slopes of Mt. Kilimanjaro led to overflowing of River Lumi and Njoro Kubwa springs which caused flooding to Kimorigo, Mboghoni, Mata and Kitobo areas in Taveta between 24th and 27th April 2016.

  A 3 hour intense storm coupled with blocked drains in Nairobi City caused flooding in the City on 28th April 2016

3.5.2 Violation of the Reserve

During the last half of the period under review, the 5DA sub catchment (Isiolo, Ngare Ndare, Ngare Nything, Marania rivers) of ENNCA experienced depressed discharge compared to the long term discharge. The water resource status was in the "Alert" state at the start of the period but deteriorated to "Alert" by early March 2016. Incidences of reserve violation were experienced with the rivers drying up completely at some points. Intensive enforcement and patrols, within the resources constraints in the office, were undertaken to ensure that water resources conflicts did not progress to violence.

3.6 Special Studies

LVNCA

There was a special study carried out on the sediment load monitoring for Kuywa/Terem River System under Western Kenya Community Driven Development and Flood Mitigation Project (WKCDD/FM).

The objective of sediment loads monitoring is therefore to evaluate the effectiveness of investments in sustainable land use practices on sediment loads in the catchment and percentage annual reduction in the sediment load in the rivers within the targeted micro catchment.

WRMA has established 20 monitoring stations (mostly miscellaneous) for the programme with an aim of monitoring the impacts of interventions on the reduction of sediment loads. The interventions are undertaken at prioritized micro-catchments through adoption of appropriate soil and water conservation practices in the Nzoia Basin. Most of the projects are implemented in Kuywa, Sosio and Terem/Emia micro-catchments. The study has been going on since 2008 but with an interruption in between when the project was temporarily stopped and finally ended by end of March, 2016. (See chapter 4.6)

Tana

Water Resources Assessment Programme (WRAP) for Garissa County was on going during the report period. The consultant has submitted the final report which was yet to be disseminated to the stakeholders. The programme involved assessment of Surface and ground water resources in Garissa County in terms of quantity and quality, and also pollution survey. The data collection and transmission was done through the open Data Kit (ODK) and hard copies of the data being retained.

4 SURFACE WATER QUALITY

Water quality is the chemical, physical, and biological characteristics of water. It is influenced by a number of factors mainly natural and anthropogenic activities. Some of the factors affecting water quality in the region include waste discharges from municipal and industrial sources, agrochemical (fertilizer and pesticide) residues from farms, surface run off containing pollutants from urban areas and market centers, and sediments mainly via erosion of roads, farms and degraded catchments. Changes in land use patterns including urban development, informal settlements and atmospheric fallout also affect water quality.

4.1 Description of Monitoring Network

Table 4.1 shows the number of surface water quality monitoring stations per region in the country. The network consists of 252 stations, 79.67 % of which are currently operational. LVNCA has an extra 22No miscellaneous stations whose purpose is to monitor sediment load for Kuywa River Sub-catchment. Figure 1 shows spatial distribution of the Monitoring Network for surface water quality nationally.

Table 1: Surface Water Monitoring Stations

Region	**National**	**MU**	**Intra-MU**	**Special**	**Total**	**% Operational**
ACA	3	5	20	3	31	79
LVN	5	10	19	2	36	100
LVS	5	14	26	2	47	85
ENNCA	1	5	30	4	40	90
TCA	1	39	9	7	56	67
RVCA	7	13	21	1	42	57
				Total	**252**	**79.67**

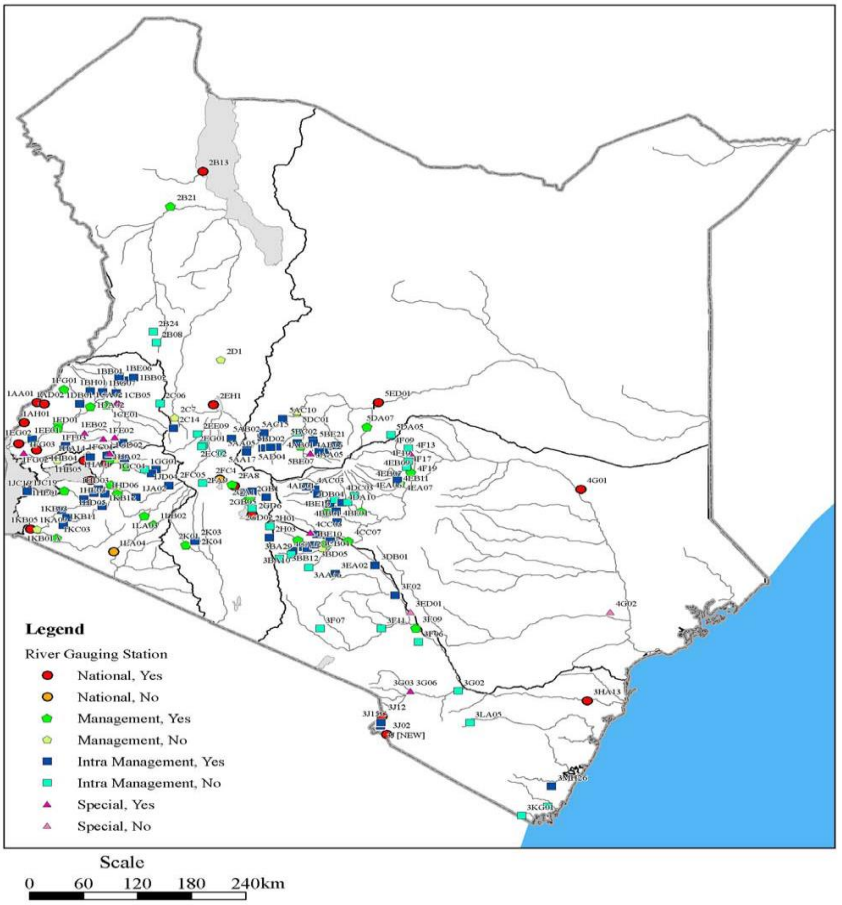


Figure 4.1: Description of Monitoring Network

The surface water quality stations are distributed throughout the regions and cover major river basins (e.g. Tana, Ewaso Ngiro North, Athi, Lumi, Turkwel, Njoro, Malewa, Ewaso Ngiro South, Mara, Sonu Miriu, Nyando Yala, Nzoia, Sio) and lakes. The lakes are Chala, Jipe, Turkana, Elmentatita, Naivasha, Nakuru, Baringo, Bogoria, and Victoria. In the Lake Victoria there is an additional 22 in-lake monitoring stations as shown in Figure 4.2.

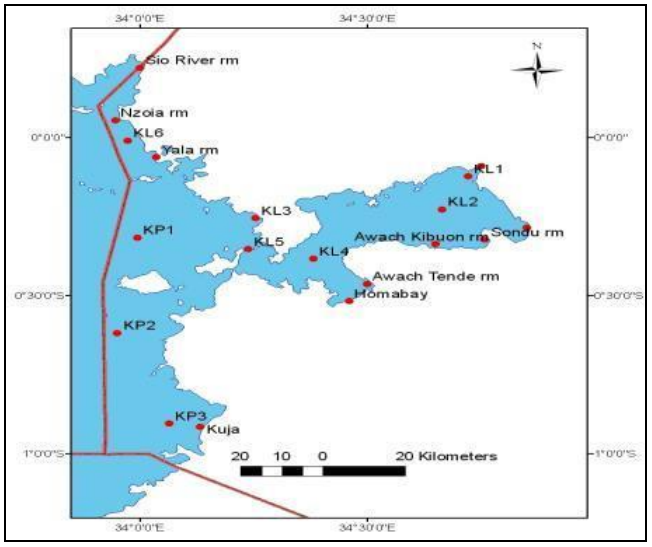


Figure 4.2 In-lake Monitoring stations

Note: KL=Kenya Littoral (shallow water station) mainly in Winam Gulf
KP=Kenya Pelagic (deep water station) in the open lake.

Monitoring of the impacts of point source pollution is undertaken on the final treated effluent, and in the receiving water 500m upstream and downstream of discharge points.

4.2 Improvements to Network Infrastructure

In LVSCA two stations were automated, 1LB02 at Nyangores and Amala at Longisa Water Supply (Mara basin). The purpose was to monitor water Quality for real time data. In the same region rehabilitation was done to monitoring stations 1IG04 at Talek, Sondu Miriu River and 1GD03, Nyando River and 1KB05, Gucha-Migori River. In TCA, six new stations were established namely; Rundu at Kagumo Bridge, Rwamuthambi at Kabonge Riakianja Bridge, Murubara at Ahiti Domba Bridge, Thiba at Ndindiruku Bridge, Murubara at Gathigiriri Prison Bridge and Mururi stream at Embu-Mwea Highway.

No improvements to the monitoring network infrastructures were done in ENNCA, RVCA, LVNCA and ACA.

4.3 Improvement to data Quality

33 Water Quality & Pollution Control staff underwent two day training, in two groups, on the use of water quality field equipment and sampling techniques held in Naivasha and Mombasa respectively. The training was aimed at enhancing skills with the goal of improving data quality.

The Regional Laboratories participated in the QC/QA programme organized by the Central Water testing Laboratory, Nairobi where referenced similar materials were sent to various WRMA Laboratories for analysis and comparisons of the generated data.

Kakamega Laboratory, LVNCA underwent rehabilitation with the support of GIZ in which fume extractors were installed in the the fume cupboard. This has enhanced the number of parameters which can be analysed and has also created a good working environment in the Laboratory. LVNCA also received sampling bottles, chemicals, reagents and protective materials to support abstraction and pollution surveys for R. Kimondi and Siyonga sub catchments from the Kenya Water Security and Climate Resilience Program. WRMA HQs procured assorted chemicals for the Regional Labs during the year under review.

LVEMP new Laboratory situated at Lake Victoria South Water Services Board (LVSWSB) premises was handed over to WRMA, Kisumu regional Office. This has greatly expanded analytical services and increased the number of parameters to be analyzed.

4.4 Assessment of Surface Water Quality

Water Quality assessment was undertaken for Regular Gauging Stations (RGS) countrywide. This involved sampling and in-situ measurements but on a limited scale due to logistical constraints. The common water quality parameters measured were: Temperature, pH, Electrical conductivity, turbidity, total suspended solids and Nitrates. LVSCA and LVNCA are able to analyze nutrient parameters i.e. Total Nitrogen and Total Phosphorous (TN & TP). Figure 3 to Figure 11 below show trends of some parameters at various monitoring stations. Long term data for National stations and Management Units are shown in the Annexes. Lakes were not monitored although there are stations established. Lake Victoria stations have not **been** monitored for 4 years.

4.4.1 Lake Victoria (South) Water Quality

LVSCA was not able to undertake in-lake water quality monitoring during the year under review due to lack of funds. Monitoring of the Lake Victoria beaches was undertaken at five stations namely, Usenge Beach, Wich Lum Beach, Misori Beach, Luanda Kotieno Beach and Asembo Bay Beach (Table 2).

Physico-Chemical parameters at Lake Victoria Beaches

Name of Beach	pH	DO	Turbidity	Ec	TP	TSS	Salinity
Usenge Beach	7.2	4.4	27.5	119	0.12	3	0.05
Wich Lum Beach	7.7	6.8	32.3	120	0.45	2	0.05
Misori Beach	7.0	5.2	30.7	130	0.11	3	0.06
Luanda Kotieno Beach	7.6	7.9	44.7	142	0.43	18	0.06
Asembo Bay Beach	8.5	8.2	107.0	163	0.59	40	0.07

Table 2: Physico-chemical Parameters at Lake Victoria Beaches

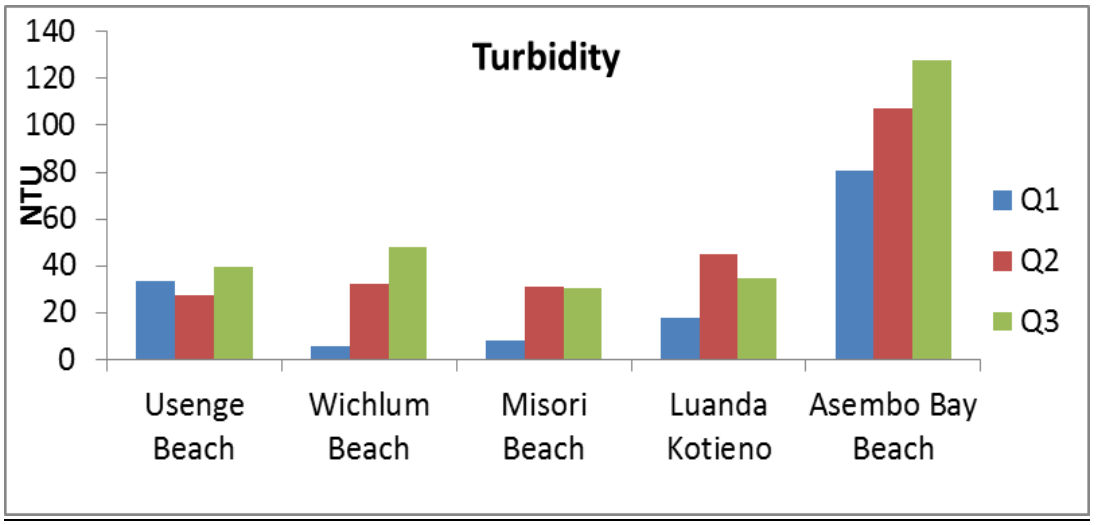


Figure 4.3: Water turbidity at beaches in Lake Victoria (quarterly data)

All the beaches showed higher turbidity in quarter 3 compared to quarters 1 and 2. No assessment was done in quarter 4. The turbidity could be influenced by the dominant wind at the time of determination. In the afternoon, there is a strong wind from the Lake onto land and this creates a high turbulent at the beaches. The turbulences stir up both the settled and suspended sediments at the beaches and also drift the algae blooms to the shore causing high turbidity at the beaches. There is also the impact of rotten vegetation at the beaches. All this coupled together may cause a significant impact on turbidity. The scenario may change in the evening or morning when it's calm.

4.4.2 Tana River Water Quality

Water Quality Parameter Trends for 4G01

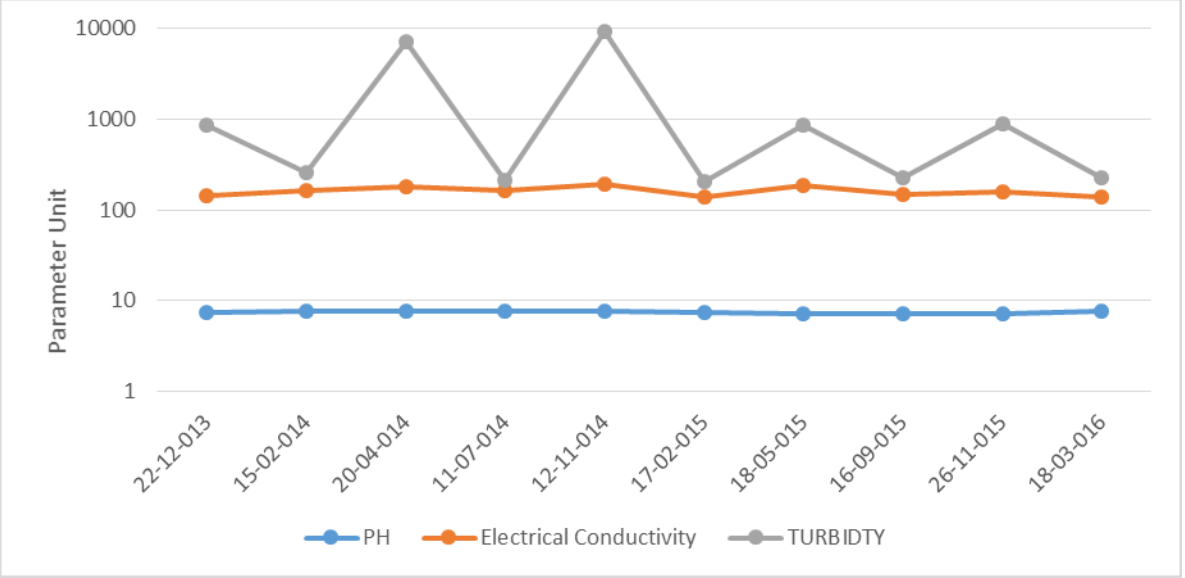


Figure 4.4: Conductivity, Turbidity and pH of River Tana at Garissa (RGS 4G01)

The higher Turbidity was noticeable in the wet months of April. May and November. This may be due to erosion via runoff in the Upper Tana catchment attributed to degradation of the catchment. The pH and conductivity remained unchanged indicating that there were no major high mineral inputs. There is no data for lower Tana where the situation may be different.

4.4.3 Water Quality of Ewaso Nyiro North River

ENNCA did not assess water quality of Ewaso Ngiro River at Archer's post (5ED01) which is the national station and Isiolo River at 5DA07. The stations have not been monitored since June 2014 due to challenges with facilitation.

Figure 5 shows the electrical conductivity of Ewaso Ng'iro River at 5BC04, Depatas (Laikipia). The station monitors part of Abadare and part of Mt. Kenya areas. Irregular monitoring results in data gaps that making it impossible to discern trends.

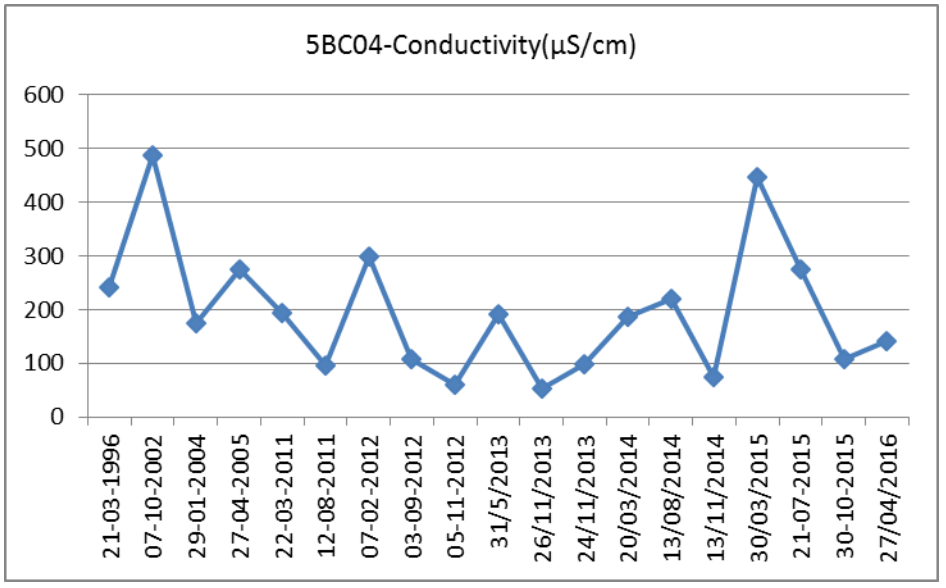


Figure 4.5: Ewaso Ng'iro River at 5BC04, Depatas in Laikipia - Conductitvity

Nanyuki River at 5BE20 monitors waters from Mt. Kenya area. Figure 6 shows conductivity trends in the river. Seasonal variations with higher values in the wet season are expected due to runoof laded with agrochemicals from farm lands.

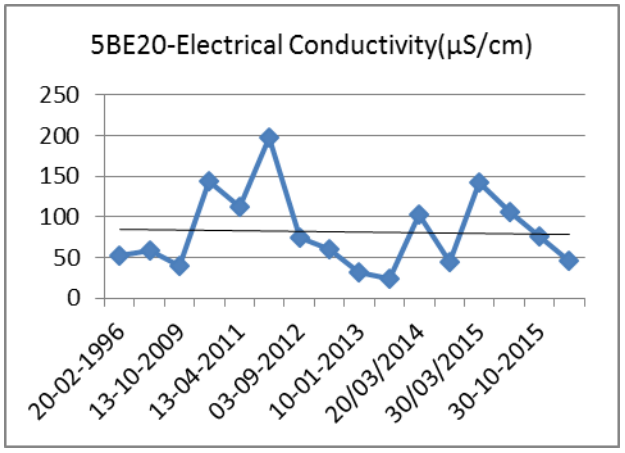


Figure 4.6: Conductivity of Nanyuki River at 5BE20

4.4.4 Water quality of the Rift Valley water resources

The Perkerra and Kerio rivers were monitored for total suspended solids that were found to be generally high. The catchment are in need of conservation both on farm and off-farm.

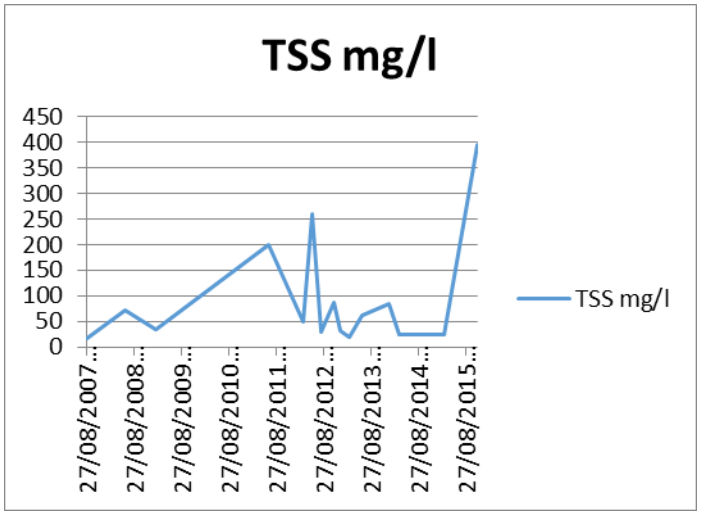


Figure 4.7: Total suspended solids in Kerio River (2FC7)

Other station data eg. Lakes Elementaita, and Baringo were not updated during the reporting year.

4.4.5 Water Quality of Lake Victoria North Rivers

During the year under review Electrical Conductivity ranged from 50 µS/cm to 270 µS/cm signifying low mineralised river water in the region (Figure 8). For MU stations Electrical Conductivity ranged from 62 µS/cm to 71 µS/cm at Kuywa at Matisi and R. Nzoia at Webuye respectively. The range is however within the acceptable limits for all the water uses. For National stations, the highest value was recorded at R. Malakisi at 148 µS while lowest was at R. Yala at Bondo bridge at 87 µS. There were not significant differences.

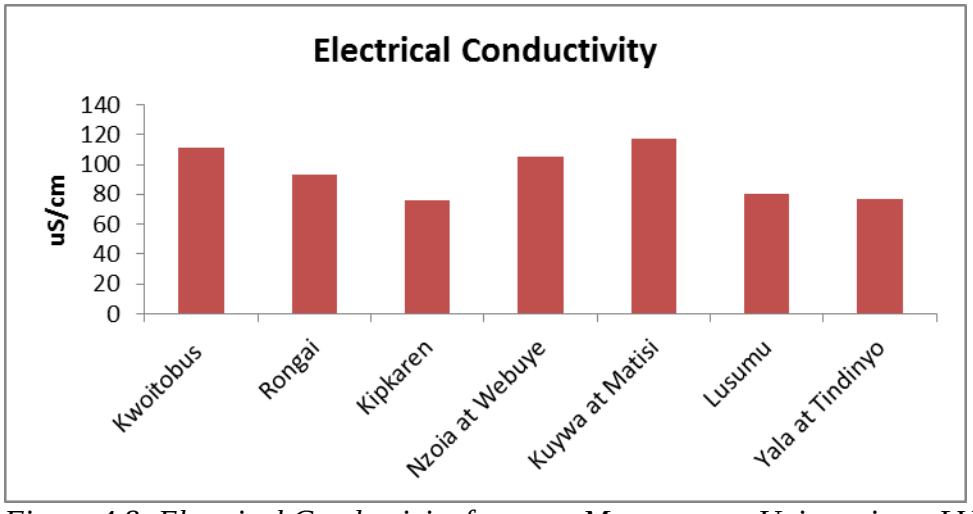


Figure 4.8: Electrical Conductivity for some Management Unit stations, LVNCA.

Nitrates were monitored in some water bodies. Sources of Nitrates include mainly domestic sewage, agricultural run-off and agro-industrial effluents. Excessive nitrates in surface waters usually

indicates domestic or agricultural pollution. Nitrate addition to surface waters can lead to excessive growth of aquatic weeds.

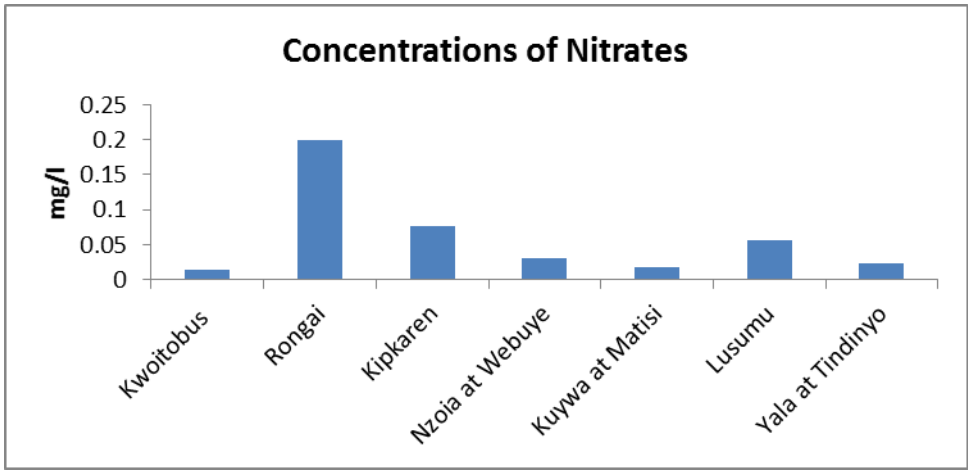


Figure 4. 9: Concentrations of Nitrates in various rivers, LVNCA

The average concentrations of Nitrates (NO_3) ranged from 1.2 mg/l to 4.08 mg/l in R. Yala at Tindinyo and R. Nzoia at Webuye respectively. Management Unit stations that registered high average concentrations of Nitrates were Rongai and Kipkaren while those with low concentrations included Lusumu and Kuywa. R. Rongai is a river draining most of the farm lands of Trans Nzoia and its environ.

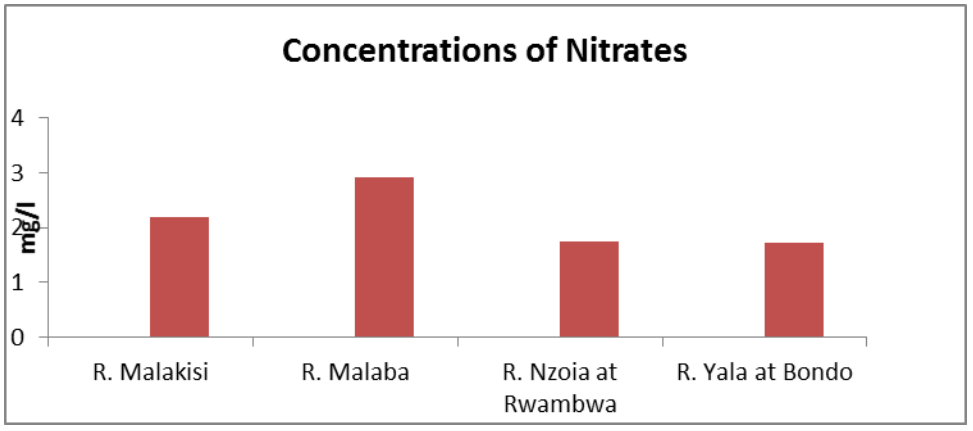


Figure 4.10: Average concentrations of Nitrates for National Stations

For national stations, R. Malaba recorded the highest average concentrations of Nitrates while R. Nzoia recorded the lowest.

Total suspended solids (TSS) consists of materials originating from the surface of the catchment area, eroded from river banks and or re-suspended from the river beds and indicates the degree of catchment degradation. Figure 11 shows the TSS some stations.

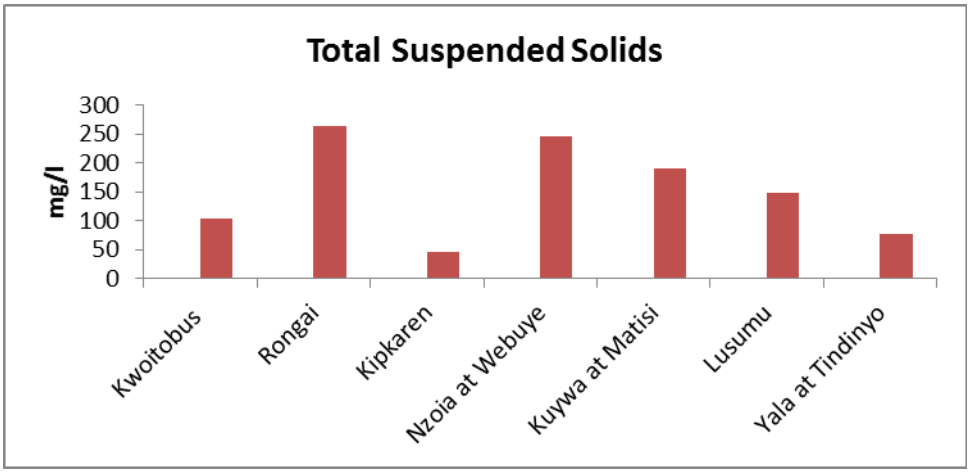


Figure 4.11: Average concentrations of TSS in some rivers in LVNCA

4.5 Comments on Special Events

High sediment loads and turbidity were reported in Tana River at Garissa bridge station. This could be due to sediment from the catchment runoff, and the river re-suspension and bank erosion.

Western Kenya Community Driven Development and Flood Management Project

In the Kuywa sub-basin in LVNCA there are 22 special stations established for purposes of monitoring interventions in catchment restoration. The region undertook two sediment loads assessments in Kuywa Terem system in September 2015 and February 2016.

The stations exhibited seasonal variations in concentrations of suspended solids, turbidity and nutrients (Figure 12). The concentrations followed the rainfall patterns but were significantly lower than baseline data at the start of the monitoring in 2013. During the dry months of January to March, the rivers had low turbidity hence the water was clear since runoff from the farms was low.

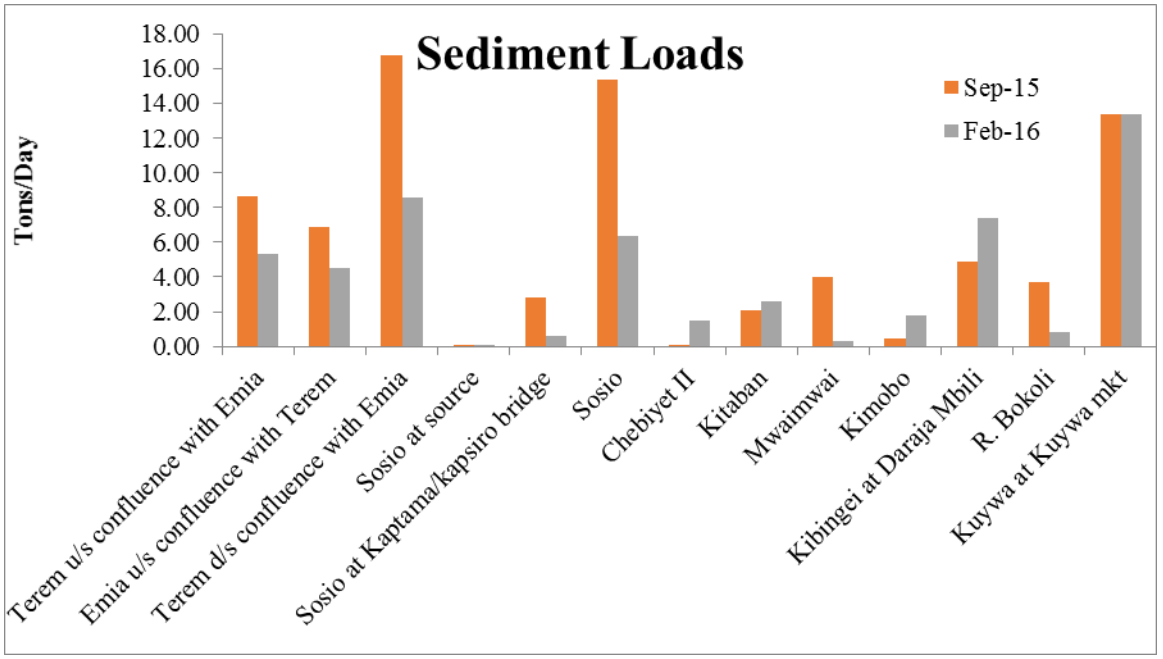


Figure 4.12: Comparative sediment Loads in the Kuywa Terem sub-catchmet

The highest sediment load was registered at Kuywa market. Other stations with high sediment loads were Kibingei and Terem downstream the confluence with Emia at Kopsiro bridge at 7.4 tons/day and 8.6 tons/day respectively. Comparing the two assessments, in February all the stations recorded lower loads compared to September except for Kitabani, Kibingei, Kimobo and Chebiyet II. The largest difference was observed in Kibingei at Daraja Mbili at 2.5 tons/day. The difference could be as a result of cattle being driven to be watered directly in the river. This may cause the release of the sediments from the stream banks and beds. No differences were observed at Sossio at source and Kuywa at Kuywa market. Sossio at source is a reference station situated at the forest and there are limited human activities despite encroachment into the forest.

Lake Naivasha basin

A PhD student from Twente University in Holland installed pesticide samplers in Lake Naivasha, and in the middle and upper catchment of Malewa River. This is to investigate the possibility of pollution by pesticides in water resources especially in the Lake and to identify the possible sources of the pesticides.

A Master's degree student from Kenya Marine & Fisheries Research Institute in conjunction with WRMA, Naivasha Office carried out a research on the Phosphates & Nitrates concentrations in Lake Naivasha.

5 GROUNDWATER RESOURCES

5.1. Description of Monitoring Network:

The table below shows the monitoring boreholes distribution per Region

	Strategic	Major	Minor	Special	Total	% Operational
LVSCA	1	14			15	**100**
LVNCA	0	5	5	7	17	**88**
ATHI	8	16	6		30	**63**
RVCA	8	12	11	2	1	**34**
Tana	1	3	3	0	7	**17**
ENNCA	5	3	4	0	12	**75**

Table 5.1: Distribution of monitoring network in the Regions

Lake Victoria South Catchment Area is composed of three types of aquifer

- Recent Alluvium and lake sediments
- Tertiary Volcanics
- The Bukoban System

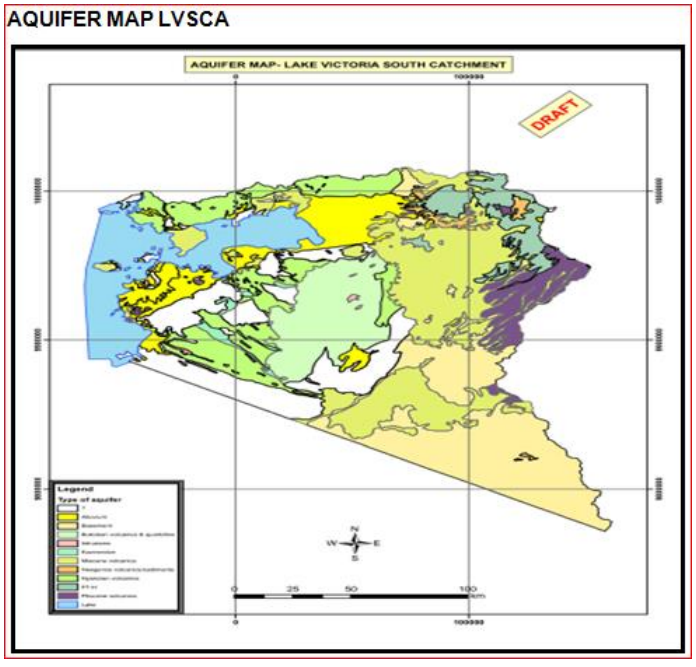


Figure 5.1: Aquifer map of Lake Victoria South Catchment

Lake Victoria North Catchment Area is composed of Uasin Gishu Phonolites, Nyanzian Volcanics and Kavilondian System

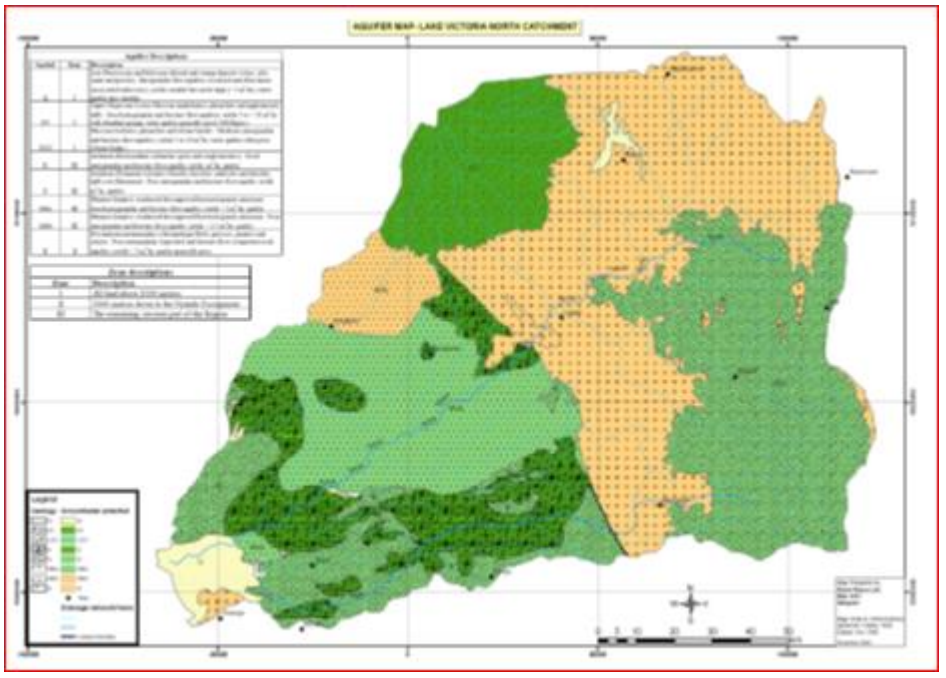


Figure 5.2: Aquifer map of Lake Victoria North Catchment

Athi Catchment Area has the Nairobi Suite aquifer system composed of Pleistocene to Miocene volcanics, chyulu volcanics, Mt Kilimanjaro volcanics, coastal sediments and Precambrian basement systems

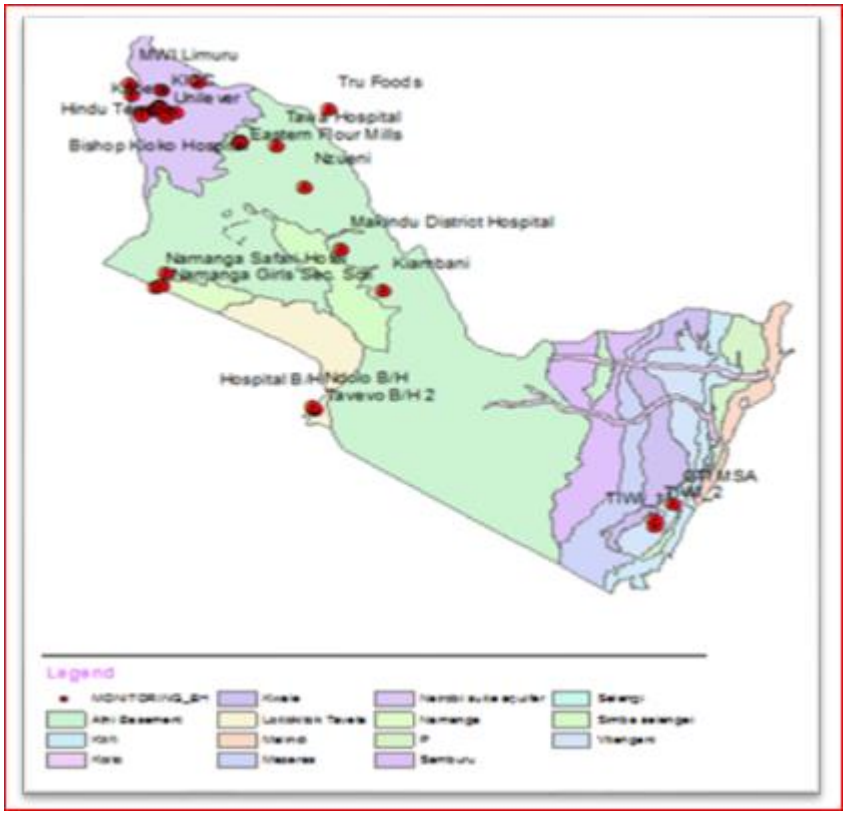


Figure 5.3: Aquifer map of Athi Catchment Area

Tana Catchment aquifers are composed of Mt. Kenya Volcanics aberdare volcanics Nyambene volcanics on the upper parts, Precambrian basement in the middle parts, colluvium deposits in the lower parts, coastal sediments and sand dunes

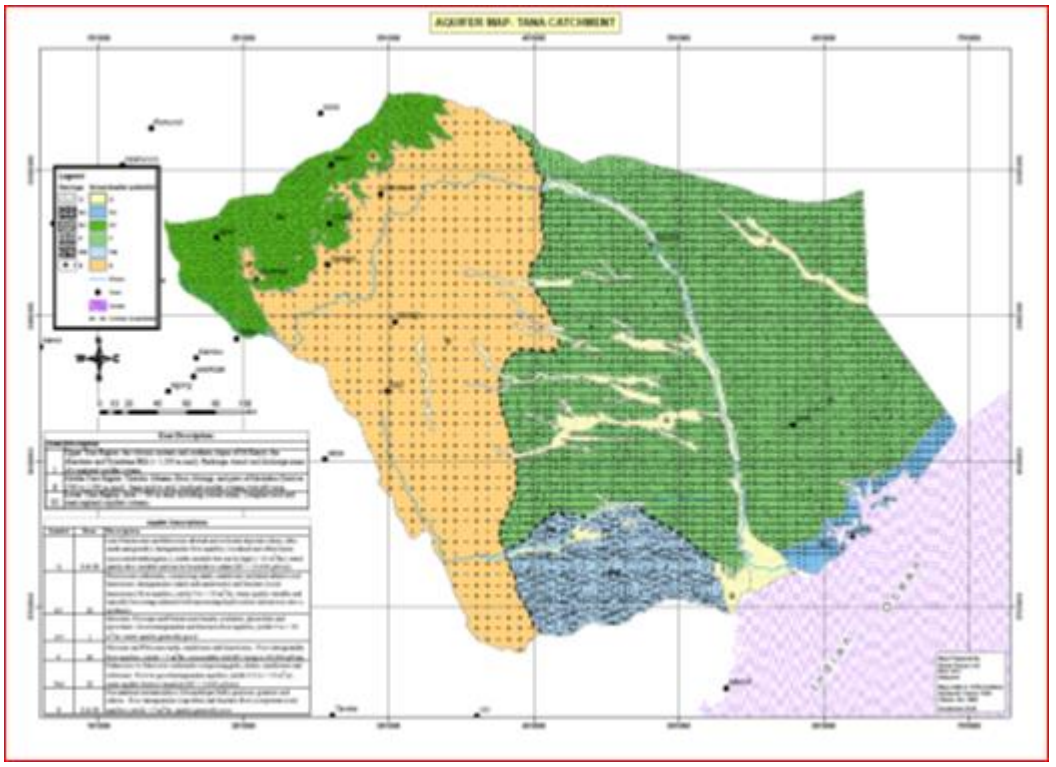


Figure 5.4: Aquifer map of Tana Catchment Area

Ewaso Ngiro North Catchment Area aquifers are composed of Mt. Kenya and Aberdares volcanics, in the upper parts, colluvium deposits along the southern parts and quarternary sediments along the northern parts

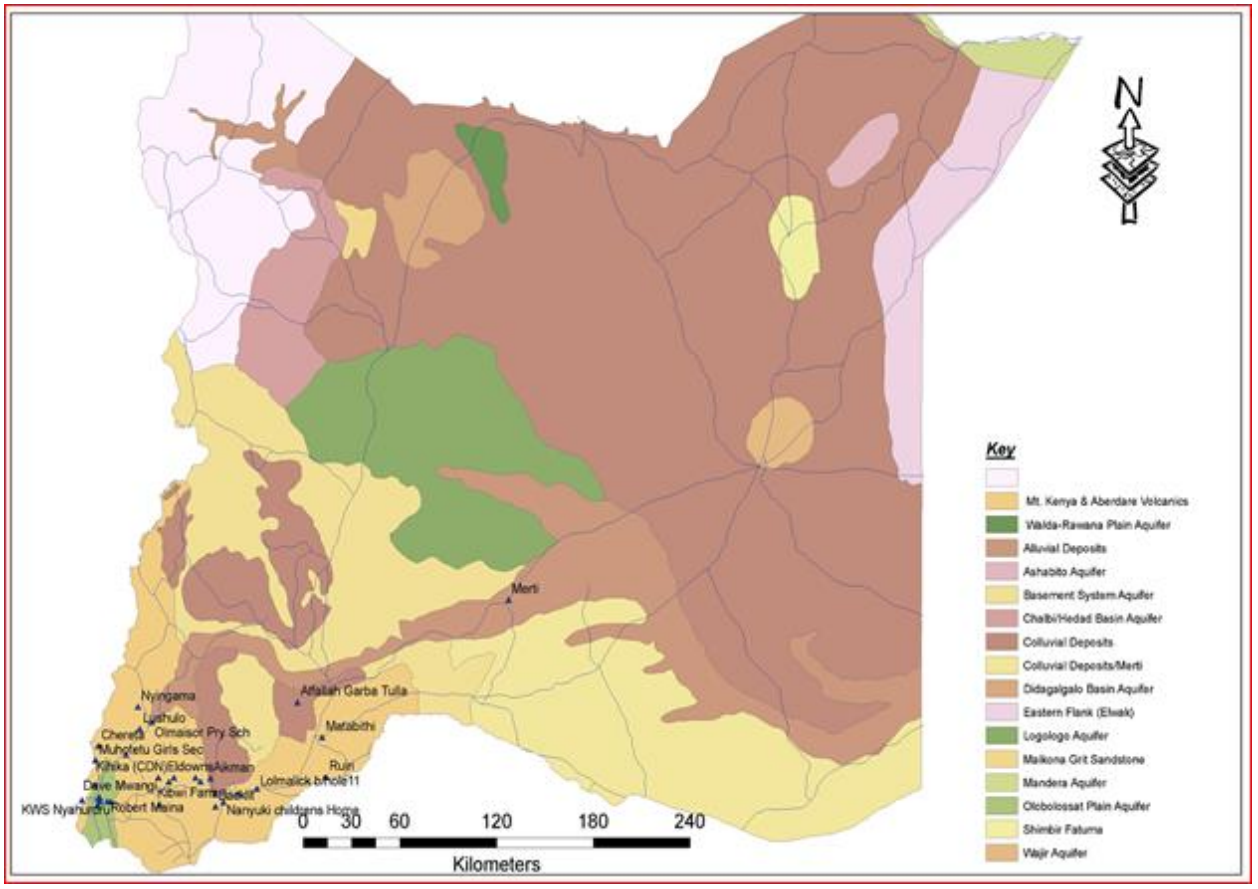
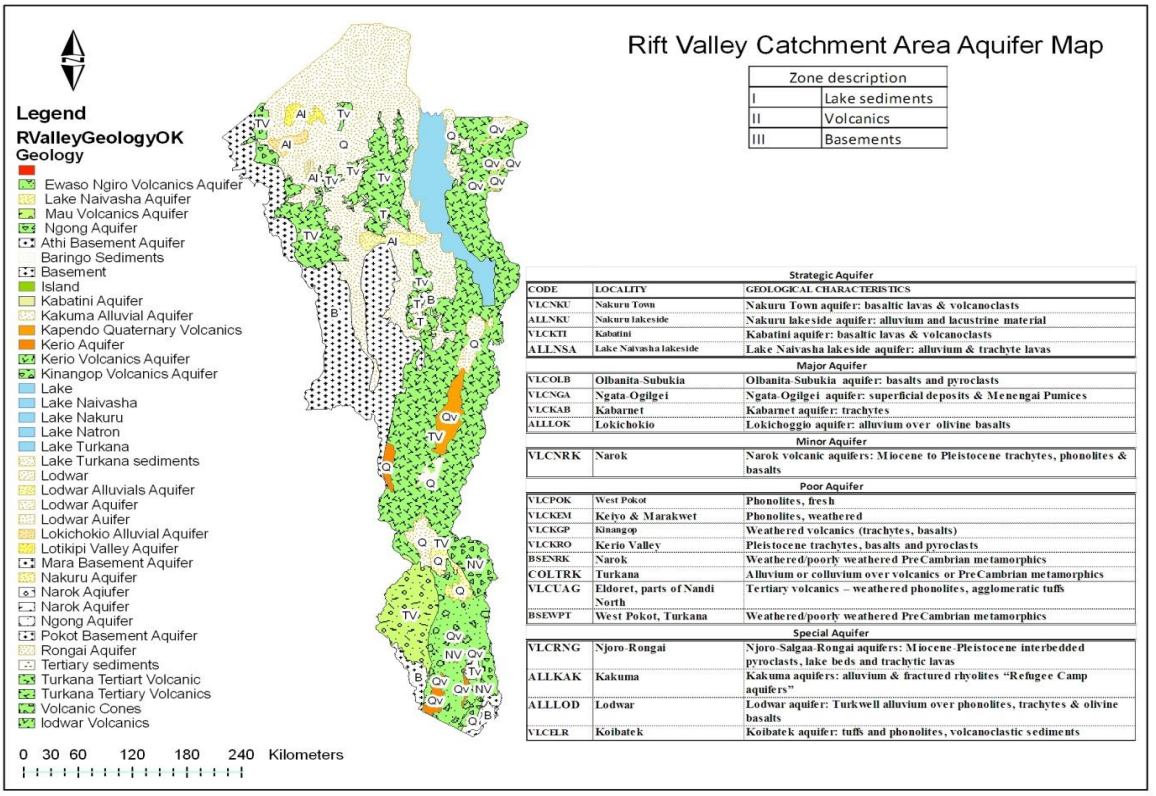


Figure 5.5: Aquifer map of Ewaso Ngiro North Catchment Area

Rift valley aquifers have all classes of aquifers, ranging from strategic to major. These include Kabartini and kakuma. The Ground water quality in these aquifers range from good (highlands) to poor (Kerio valley).The yield range from 1.5 m3/hr (Ravine) to 138 m3/hr (Kabartini)



Strategic Aquifer		
CODE	LOCALITY	GEOLOGICAL CHARACTERISTICS
VLCNKU	Nakuru Town	Nakuru Town aquifer: basaltic lavas & volcanoclasts
ALLNKU	Nakuru lakeside	Nakuru lakeside aquifer: alluvium and lacustrine material
VLCKTI	Kabatini	Kabatini aquifer: basaltic lavas & volcanoclasts
ALLNSA	Lake Naivasha lakeside	Lake Naivasha lakeside aquifer: alluvium & trachyte lavas
Major Aquifer		
VLCOLB	Olbanita-Subukia	Olbanita-Subukia aquifer: basalts and pyroclasts
VLCNGA	Ngata-Ogilgei	Ngata-Ogilgei aquifer: superficial deposits & Menengai Pumices
VLCKAB	Kabarnet	Kabarnet aquifer: trachytes
ALLLOK	Lokichokio	Lokichoggio aquifer: alluvium over olivine basalts
Minor Aquifer		
VLCNRK	Narok	Narok volcanic aquifers: Miocene to Pleistocene trachytes, phonolites & basalts
Poor Aquifer		
VLCPOK	West Pokot	Phonolites, fresh
VLCKEM	Keiyo & Marakwet	Phonolites, weathered
VLCKGP	Kinangop	Weathered volcanics (trachytes, basalts)
VLCKRO	Kerio Valley	Pleistocene trachytes, basalts and pyroclasts
BSENRK	Narok	Weathered/poorly weathered PreCambrian metamorphics
COLTRK	Turkana	Alluvium or colluvium over volcanics or PreCambrian metamorphics
VLCUAG	Elgoret, parts of Nandi North	Tertiary volcanics – weathered phonolites, agglomeratic tuffs
BSEWPT	West Pokot, Turkana	Weathered/poorly weathered PreCambrian metamorphics
Special Aquifer		
VLCRNG	Njoro-Rongai	Njoro-Salgaa-Rongai aquifers: Miocene-Pleistocene interbedded pyroclasts, lake beds and trachytic lavas
ALLKAK	Kakuma	Kakuma aquifers: alluvium & fractured rhyolites "Refugee Camp aquifers"
ALLLOD	Lodwar	Lodwar aquifer: Turkwell alluvium over phonolites, trachytes & olivine basalts
VLCELR	Koibatek	Koibatek aquifer: tuffs and phonolites, volcanoclastic sediments

Figure 5.6: Aquifer map of Ewaso Ngiro North Catchment Area

5.2 Improvement to Network Infrastructure

There were 6 new monitoring stations that were established and rehabilitated in Ewaso Ngiro North Catchment Area, and two new stations were upgraded and installed with automatic data loggers in Lake Victoria South Catchment area

5.3. Assessment of Groundwater

5.3.1. Water Levels

Lake Victoria North

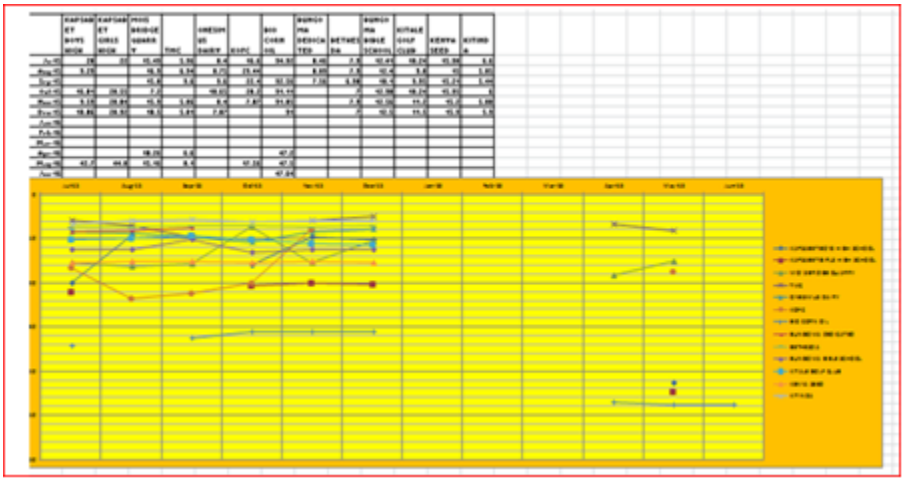


Figure 5.7: Water Levels in Lake Victoria North Catchment Area

Despite the data inconsistency brought about by time lapse after pumping stopped, the general trend looks stable with no alarming deviations except for Bio Corn borehole whose level seems to be going down for the last three months at very alarming rates that need to be investigated further.

Lake Victoria South

Groundwater hydrographs illustrate the historical record of aquifer water levels measured within a well. However, a long term record is very important in the evaluation of water level trends and estimation of recharge –discharge water balance. The data available is scanty and inconsistent and may not have significant impact on the trends on aquifers.

In general terms there were no alarming reports of groundwater depletion and the situation can be considered to be stable.

Rift Valley

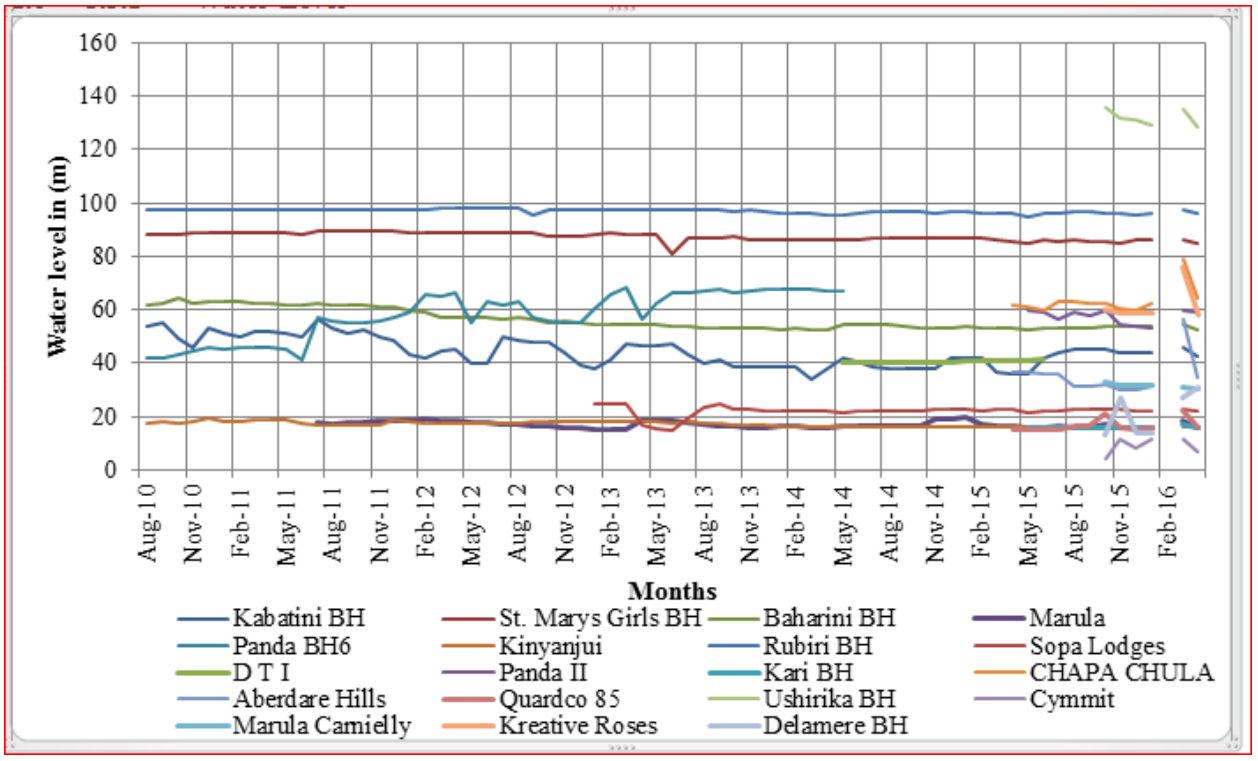


Figure 5.8: Water levels in Rift Valley Catchment Area

The trend has been relatively constant in most of the stations that are being monitored. This is an indication that the rate of abstraction and recharge are equal.

Three stations **Rubiri Borehole** (to represent behaviour of the Southlake area), **Marula Borehole** (to represent behaviour of the Northlake area), **and Kabatini Borehole** (to represent behaviour of the Kabatini Aquifer), were used.

Trends:

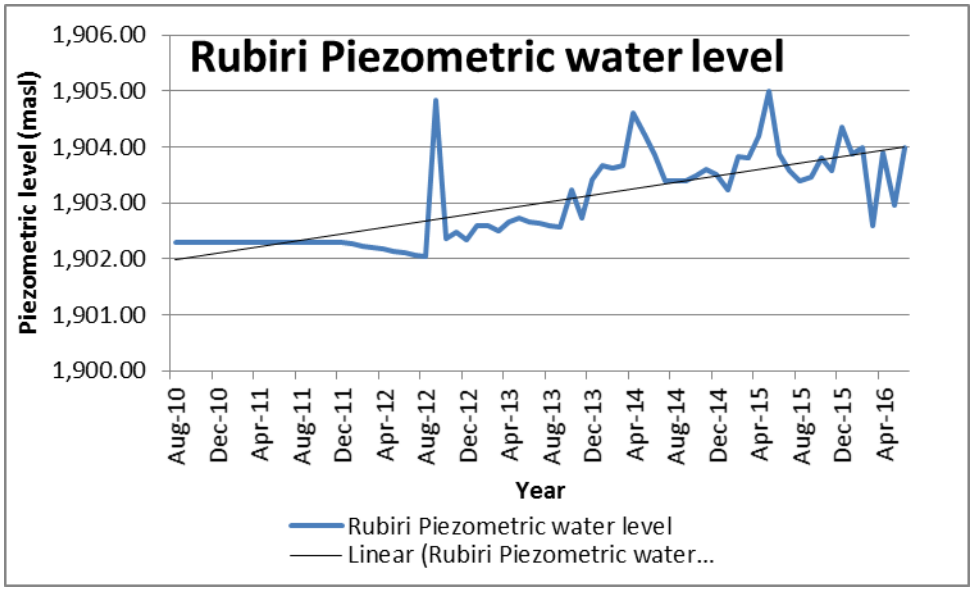


Figure 5.9: Water levels for Rubiri borehole

Trends of the Rubiri Community borehole from the year August 2010 to date were used. The water levels depict a gradual rise in Water levels, showing a higher rate of recharge compared to abstraction.

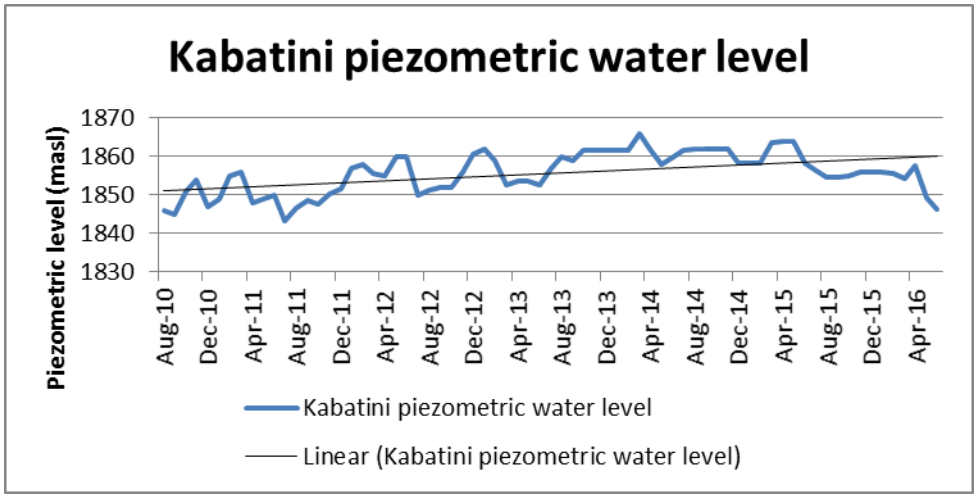


Figure 5.10: Water levels for Kabatini Borehole

Trends of the Kabatini borehole from the year August 2011 to date were used. The water levels depict rising water levels after December 2012.

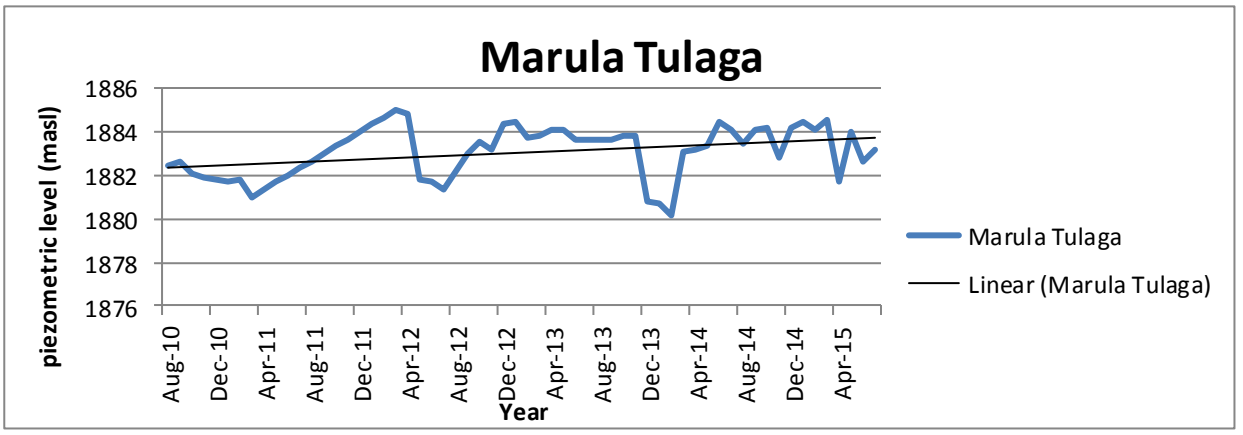


Figure 5.11: Water levels in Rift Valley Catchment Area

Trends of the Marula borehole from the year July 2011 to date were used. The water levels depict lower levels between July 2012 – March 2013, but lately, the trend line clearly depicts water levels are not dropping, but rising

Subati Borehole 3 Water Level Trends

	April	Ma	June
2015	14	14	13.5
2016	12.7	12.8	12.7

Figure 5.12:Comparison Of Water Rest Level For 2015 And 2016

Subati Borehole 5 Water Level Trends

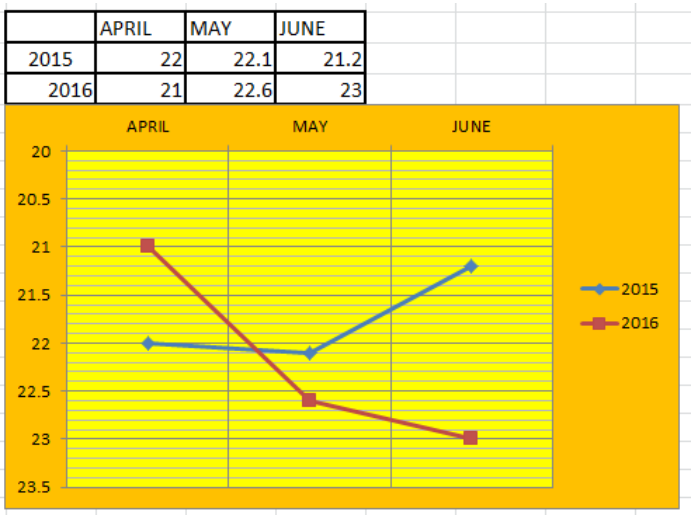


Figure 5.13:Comparison Of Water Rest Level For 2015 And 2016

A comparison of water levels for the same period in 2015 and 2016 shows a rise of approximately 1.5 metres in Subati 3 borehole and a drop of the same margin in Subati 5 borehole. This could be attributed to abstraction rates for the two boreholes or instrumentation error but further investigations are necessary to establish the true cause for this kind of trend.

Athi Catchment Area

A few boreholes were selected to represent the ground water level trends in respective part of the region. On the whole the general trends have been as follows

- **Upper Athi** zone drainage areas 3BC to 3DA covering Ruiru, Juja and Donyo Sabuk areas
- **Nairobi Aquifer Suite:** These are to be found within Nairobi area and Upper Athi sub-Regions. The water level trends in boreholes within each aquifer zone are shown in the figures below

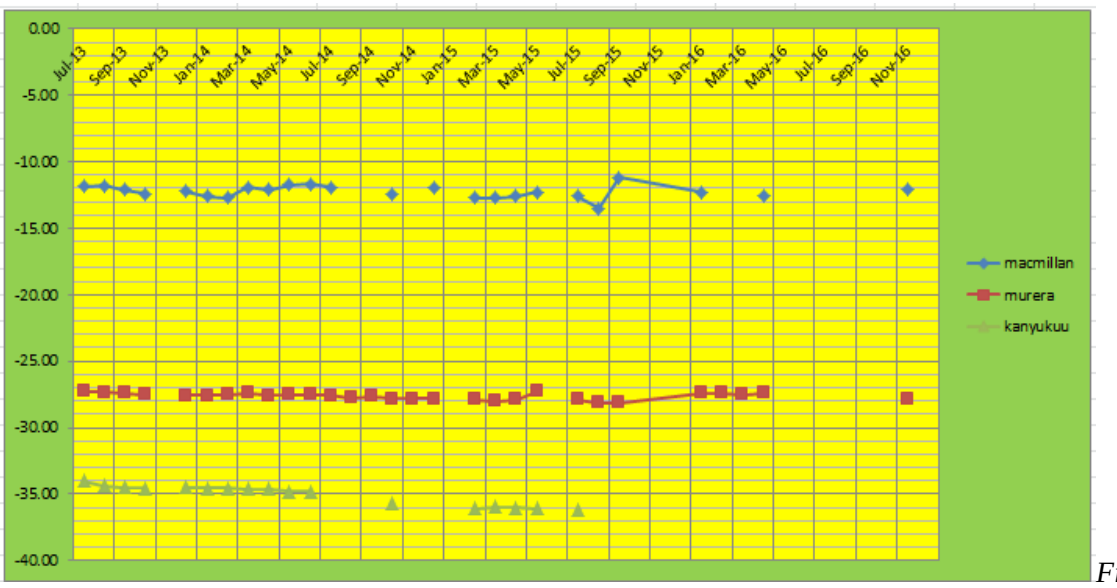


Figure 5.14: Comparison Of Water Rest Level for Boreholes in upper Athi

Data available for the last three years indicate stable conditions within the Upper Athi sub-basins of the Nairobi Suite Volcanic formations as depicted by Macmillan and Murera boreholes above. However the basement aquifers within this sub-catchment depict dropping levels of groundwater as depicted by the trend of Vinya Wa Kanyukuu borehole. This could be attributed to increased water demand and hence more abstraction or anthropogenic activities within the aquifer recharge areas reducing the recharge and causing a deficit in the water balance budget. More investigations are needed to establish the cause and determine the necessary remedial measures.

- **Nairobi area Sub-basin Drainage areas 3AA to 3BB** covering the areas of Limuru, Kikuyu, Nairobi City, Karen, Ruai, Athi River and Kitengela areas.

  Six boreholes were selected to represent various parts of the Nairobi City. KICC represents the trends within the City centre. Riverside shows the trends within Westlands and Chiromo area while Unilever represents the trends at industrial area. Kabete water Supply borehole represents the trends of lateral inflows from the Limuru Rironi area, Kabansora represents the trends within Embakasi area while Jorgen represents the trends within Karen area. Eastleigh, Parklands, Kitengela and athi River areas do not as yet have monitoring boreholes and there is need to establish one for every one of these areas.

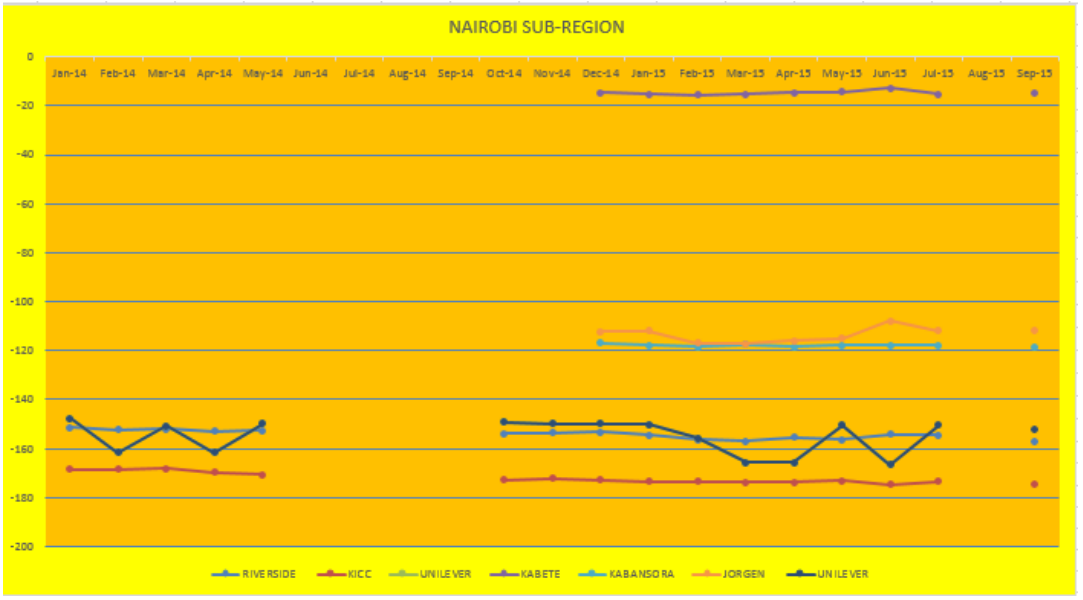


Figure 5.15: Comparison Of Water Rest Level for Boreholes in Nairobi sub-region

From the trends depicted above the most affected areas are the city centre and westlands areas whose water levels have dropped by six and five metres respectively within the last three years. This may be attributed to increased reliance on groundwater within these areas there has been rising demand for groundwater throughout the Region also Nairobi area has the most applications for ground water abstraction permits.

It is recommended that the safe yield for the aquifer within Nairobi City be evaluated and abstraction rates be controlled and adherence to permit conditions enforced accordingly.

- **Coastal sediments:** These are to be found within the Coastal Athi Sub-Region.

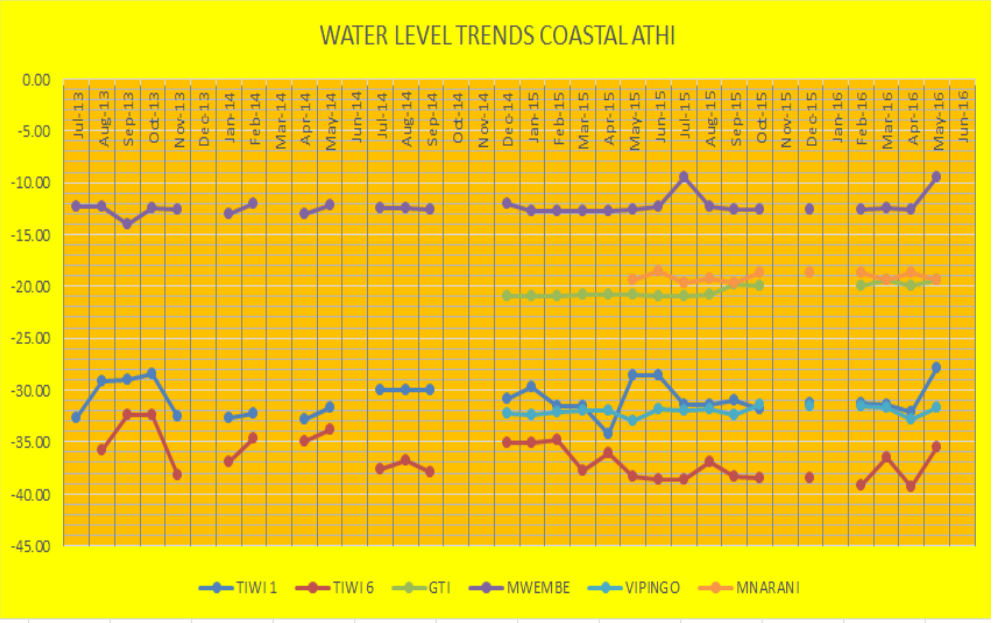


Figure 5.16: Comparison Of Water Rest Level for Boreholes in coastal Athi

Except for Tiwi 6 which has shown slight decline in water levels for the last three years the Long term trends have generally been constant but with slight seasonal fluctuations in coastal Athi boreholes.

- **Athi Basement:** these are to be found within Machakos Makueni and Kajiado areas where only Tawa and Nzueni boreholes have been occasionally monitored, however the readings observed are very inconsistent as the boreholes have been inconsistently been pumped and not enough time has been given for recovery before the readings were taken.

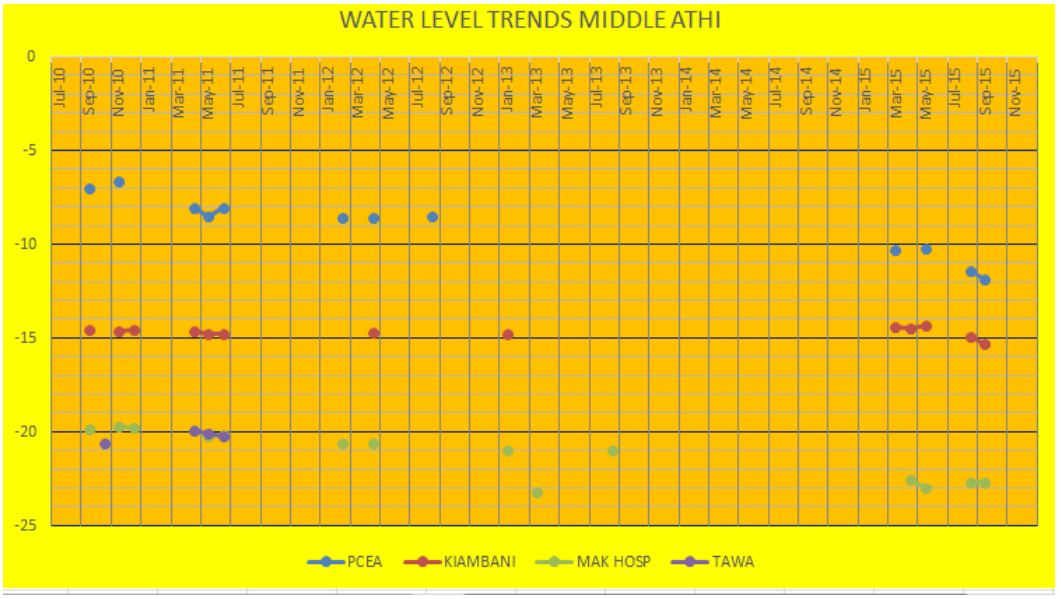


Figure 5.17: Comparison of Water Rest Level for Boreholes in Middle Athi

Generally, Athi Basement Series borehole are showing gradual decline in water levels over the last three years this may be attributed to any one or all of the following reasons

I. . Increased abstraction as a result of increased water demand

II. Reduced aquifer recharge rate as a result of unfavourable human activities within the aquifer recharge zone.

III. Reduced recharge rate as a result of climate change which may include increased evapotranspiration or decreased precipitation

Further investigations are required to determine the true cause of the declining levels. .

- **Kilimanjaro Volcanics:** these are to be found within Loitokitok area of Nolturesh – Lumi

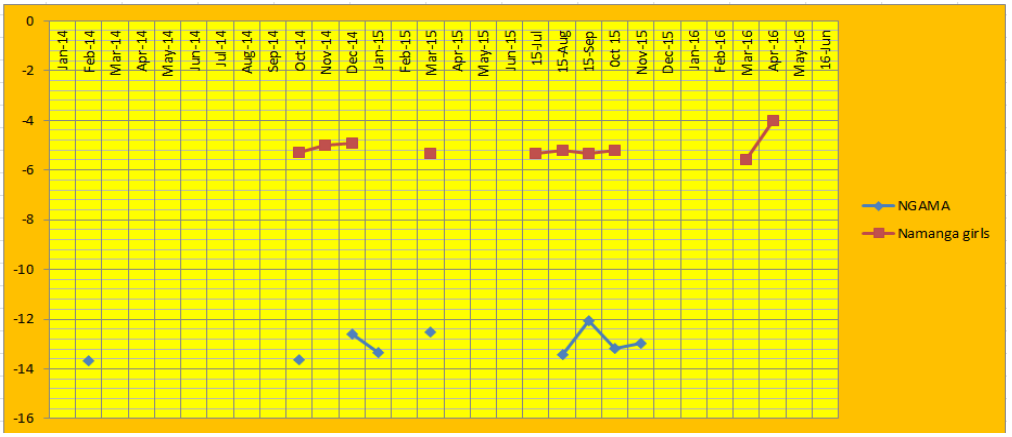
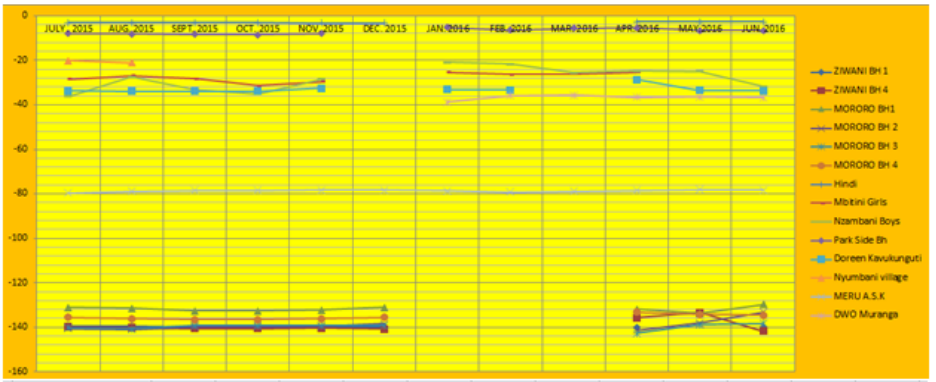


Figure 5.18: Comparison of Water Rest Level for Boreholes in Nolturesh Lumi

The general trend shows a relatively stable conditions indicating a relative balance between abstraction and recharge.

- **Chyulu Volcanics**: these are to be found within Tsavo west National Park extending to Emali Makindu and Kibwezi areas. There are no monitoring boreholes within this aquifer system however discharge from Mzima springs indicate stable conditions. It has been noted that springs around Makindu Town, Masimba Town and Mtito Andei areas are drying up. This could be attributed to increased abstraction as a result of rapid development of boreholes experienced in the recent past especially with the emergence of devolved governments.

Tana Catchment Area



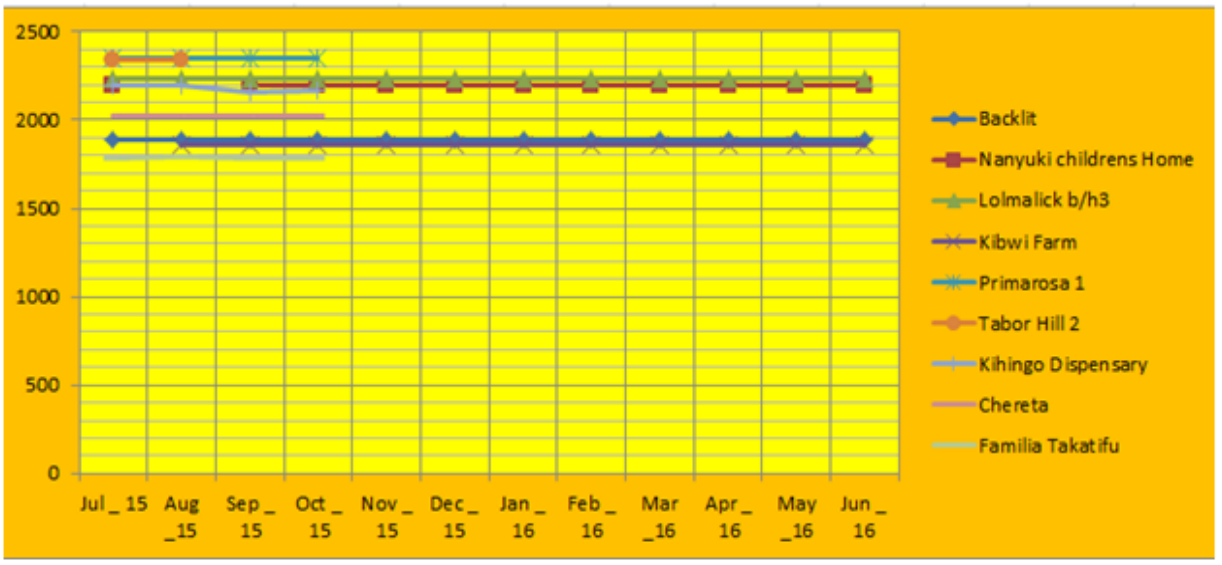
Bh Name	JULY. 2015	AUG. 2015	SEPT. 2015	OCT. 2015	NOV. 2015	DEC. 2015	JAN. 2016	FEB. 2016	MAR. 2016	APR. 2016	MAY. 2016	JUN. 2016
ZIWANI BH 1	-139.47	-139.51	-139.96	-139.96	-139.98	-139.8				-140.12		-140.11
ZIWANI BH 4	-139.8	-140.1	-140.52	-140.52	-140.41	-140.66				-135.68	-133.29	-141.8
MORORO BH1	-130.96	-131.46	-132.57	-132.57	-132.32	-131.1				-131.8	-133.82	-129.65
MORORO BH 2	-140.6	-141	-139.72	-139.72	-139.67	-138.35				-141.4	-137.96	-133.26
MORORO BH 3	-140.21	-140.81	-139.19	-139.19	-139.13	-139.11				-142.6	-138.83	-138.25
MORORO BH 4	-135.54	-136.04	-136.47	-136.47	-136.2	-135.45				-133.18	-134.26	-134.54
Hindi	-3	-3	-3	-3	-3.2	-3.2				-2.7	-2.7	-2.7
Mbitini Girls	-28.52	-26.86	-28.24	-31.42	-29.68		-25.4	-26.25	-26.06	-25.32		
Nzambani Boys	-36.3	-27.6	-33.35	-35	-28.46		-20.82	-21.7	-25.6	-24.8	-25	-31.73
Park Side Bh	-7.86	-8.2	-8.38	-8.56	-7.92		-5.26	-6.4	-5.6	-5.4	-6.55	-6.65
Doreen Kavukunguti	-33.8	-34	-34	-34	-32.64		-33.12	-33.28		-28.6	-33.5	-33.75
Nyumbani village	-20.13	-21.15										
MERU A.S.K	-79.6	-78.9	-78.6	-78.6	-78.4	-78.28	-78.8	-79.2	-78.9	-78.6	-78.2	-78.3
DWO Muranga							-38.8	-35.8	-35.75	-36.6	-36.5	-36.75

Figure 5.19: Comparison for Water Rest Level for Boreholes in Tana

- The water level trends show a relatively stable conditions for the year within the Catchment.Boreholes within the basement poor aquifers show seasonal fluctuations which are however not alarming

Ewaso Ngiro North Catchment Area

Water levels was the only parameter taken from the stations around the Upper Ewaso Ngiro Sub-Catchment



Name	Jul _ 15	Aug _15	Sep _ 15	Oct _ 15	Nov _ 15	Dec _ 15	Jan _ 16	Feb _ 16	Mar _16	Apr _ 16	May _16	Jun _ 16
Backlit	1892.29	1891.61	1892.34	1892.34	1893.24	1892.71	1892.53	1891.88	1892.37	1892.53	1892.47	1892.32
Nanyuki childrens Home	2194.62		2192.65	2193.56	2194.67	2193.43	2193.46	2194.29	2193.13	2193.34	2194.13	2194.08
Lolmalick b/h3	2234.65	2234.72	2234.57	2234.79	2234.44	2234.47	2234.76	2234.43	2234.37	2234.76	2234.43	2234.18
Kibwi Farm		1858.77	1858.86	1858.27	1858.87	1858.56	1858.27	1858.48	1858.26	1858.27	1858.48	1858.33
Primarosa 1	2348.6	2348.5	2348.5	2348.42								
Tabor Hill 2	2342.2	2342										
Kihingo Dispensary	2199.3	2192.5	2158.2	2165.7								
Chereta	2022	2022.5	2022.4	2023								
Familia Takatifu	1785.4	1788.4	1785.1	1786.3								

NB Water levels are in metres above mean sea level

Figure 5.20: Comparison of Water Rest Level for Boreholes in Ewaso Ng'iro

The trends in Upper Ewaso Ngiro North Sub-Catchment have been relatively stable during the year depicting a balance between abstraction and recharge

5.3.2 Groundwater Quality

Under the MTAP II project a total of 43 production boreholes were assessed for quality in Garissa County (Tana region) and in Wajir County. The water was found to have moderate to high salinity.

For Garissa County the borehole salinity increased with distance from the river Tana. Tests for arsenic showed that the concentrations were all within the permissible level (i.e less than 10 µg/l). Arsenic occurs naturally in some areas and may be toxic in high concentrations.

The routine groundwater monitoring was irregular in the reporting period. Less than 45% of the stations were monitored. Among those monitored none was done monthly as required. The main challenge was lack of funds to facilitate the data collection.

Groundwater generally exhibited high levels of fluoride in upper and middle Athi catchment, the Rift Valley and around the shores of Lake Victoria. The lower Athi including coastal areas showed moderate to high salinity.

Groundwater in the highlands in LVNCA and LVSCA generally showed low pH and salinity, and high Iron and Manganese concentrations were found at the lower catchment to the Lake in LVNCA and around the Winam Gulf. Iron and manganese are undesirable in water due to staining of laundry and plumbing fixtures.

Ground-Water Monitoring Boreholes

Ground water stations were monitored by sampling and in-situ measurements. Table 5.2 shows distribution of the boreholes monitored per region.

Name of Catchment	ACA	LVN	LVS	ENNCA	TCA	RVCA	Total
No of Stations	32	12	20	16	19	41	140

Table 5.2: Groundwater Monitoring Stations

Groundwater Assessment in ENNCA

Matabithi Borehole

This borehole is located in Isiolo County which is characterized by moderate salinity content.

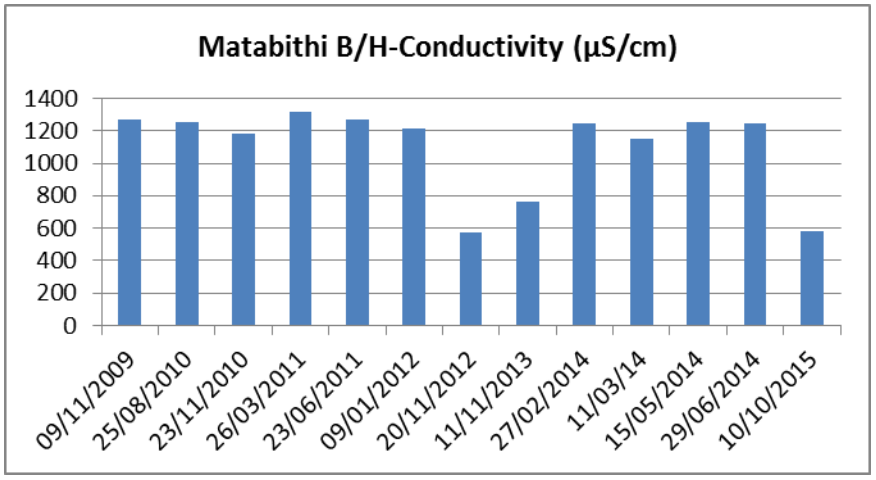


Figure 5.21: Electrical Conductivity (µS/cm) in the Matabithi Borehole, Isiolo

Logologo Borehole

Logologo borehole in Marsabit County was not monitored in 2015/2016 FY However, the general characteristic of groundwater in the area is moderate to high mineral content with conductivity as high as 6000 µS/cm.

Ruiri Borehole

The borehole is in Meru County has fresh water with low conductivity. The conductivity has remained relatively constant, except for the year 2012.

Ruiri Borehole Electrical Conductivity Trend

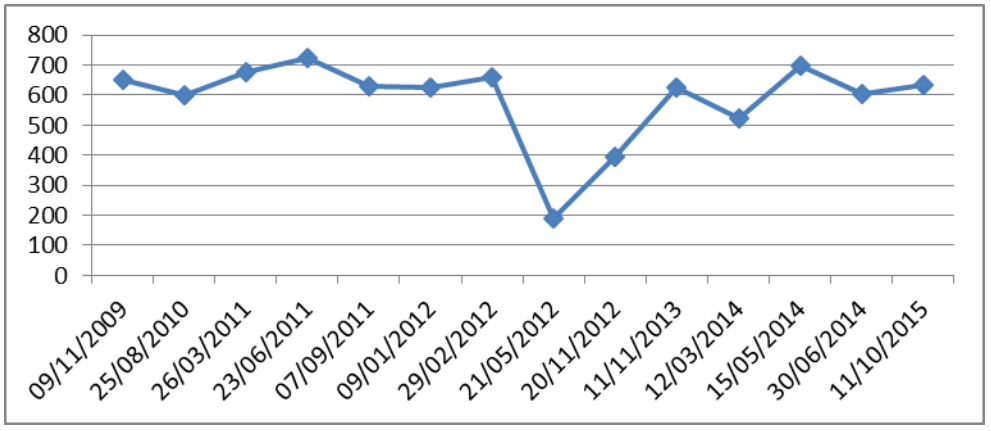


Figure 5.22 Electrical conductivity (µS/cm) - Ruiri Borehole, Meru

Groundwater Assessment - TCA

Baraza Borehole, Garissa Water & Sanitation Company (GAWASCO).

Figure 5.23 shows the trend in turbidity for Baraza Borehole. The range of the turbidity (0.48 -4.8 NTU) in the last two years was within the permissible limits for drinking (5 NTU).

Baraza Borehole Turbidity Trend

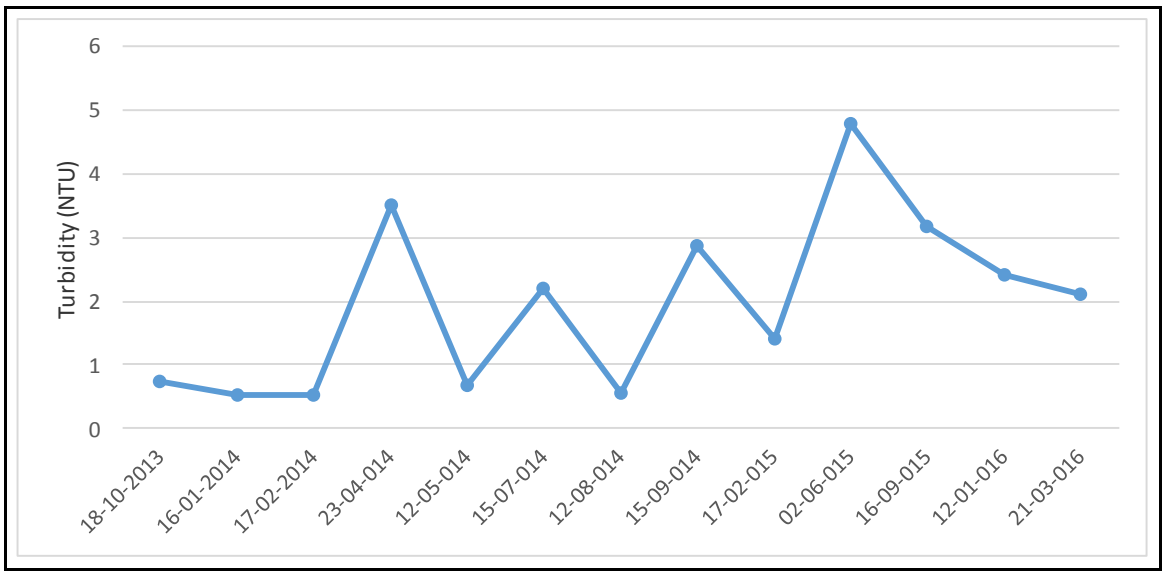


Figure 5.23. Turbidity (NTU) in GAWASCO Baraza Borehole.

Electrical conductivity ranged from 123.6- 329 µS/cm in the last two years with an average of 264.9 µS/cm. The conductivity changes with water levels in the Tana River. During low flow the conductivity in the borehole increases.

Baraza borehole Electrical conductivity Trend

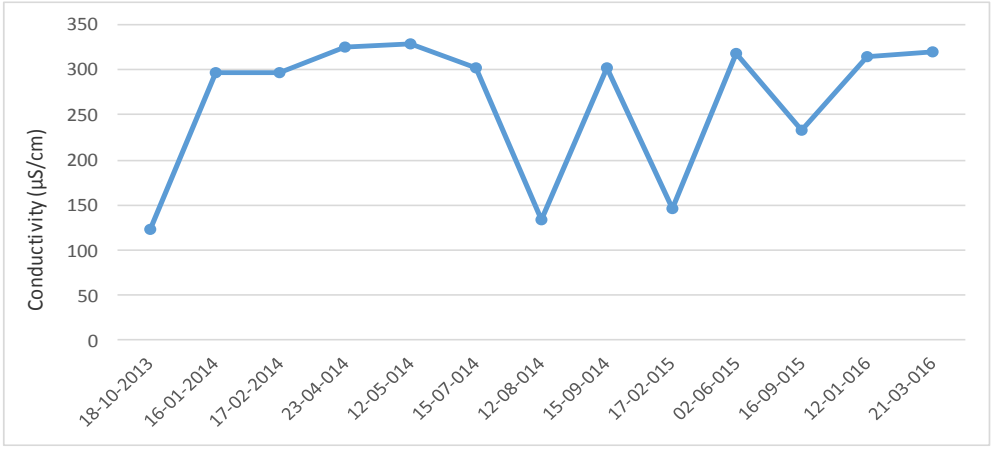


Figure 5.24: Electrical Conductivity trend of GAWASCO Baraza Borehole

Groundwater Assessment - RVCA

The Marula and Sopa boreholes were monitored for fluoride. The fluoride levels were high.

Groundwater Assessment in ACA

GTI Mombasa Borehole Electrical Conductivity

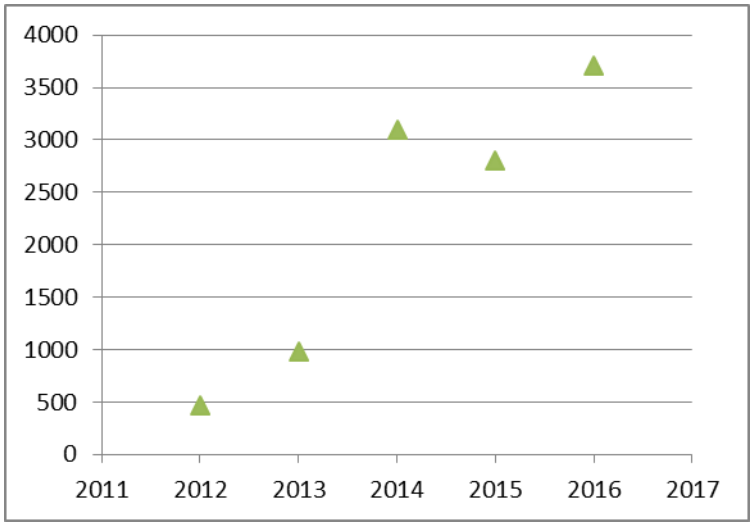


Figure 5.25 Electrical Conductivity (µS/cm) Trend - GTI Borehole, Mombasa

The conductivity has been increasing, indicating that the borehole is getting salinized probably due to unsustainable abstraction.

5.4. Groundwater Recharge

Based on studies conducted in past years, stakeholders consultation have been going on during the year in Tana and Athi Region in order to have the Lamu Sand Dunes and Nairobi Aquifer Suite Recharge areas gazetted and declared groundwater Conservation areas. These exercises are still in progress.

5.5. Special Events

No special events were recorded or reported during the year under review

5.6. Special Studies

Likoni Boreholes Resistivity Logging

The exercise was conducted on May 2016 in Mtongwe area.

- The two boreholes logged were drilled by Mombasa Water Sewerage and Sanitation Company as exploratory wells under the sponsorship of World Bank.

UpGro Project in Kwale County

The groundwater Risk Management for Growth and Development project is a DiFD supported research study which aims to improve the understanding of groundwater risks and institutional responses by studying the tradeoffs between groundwater utilization and socio-economic

development within the coastal aquifers of Kwale County where irrigated agriculture, mining and tourism enterprises share resources with domestic water supplies.

The research aims to provide evidence of new approaches to promote water security, growth and development.

Geophysics

The first phase of geophysics field data collection was undertaken in December 2015 and January 2016.

The field work was conducted by WRMA staff in collaboration with the University of Nairobi and RFL geologists.

A second phase of the geophysical studies was done on May-June 2016 totaling to 20km on E-W orientation to characterize the western boundary of the study area.

Hydrochemistry

The project team conducted a detailed hydrochemistry field survey in the study area. The first groundwater sampling campaign for water quality was conducted during September-October 2015 where 81 sites were identified out of which 77 sites were sampled.

Regular monitoring of water quality is also being carried out at 36 sites within the study area on a fortnight basis. Measured parameters include PH, Conductivity, Temperature, TDS and Turbidity.

These studies are still on going.

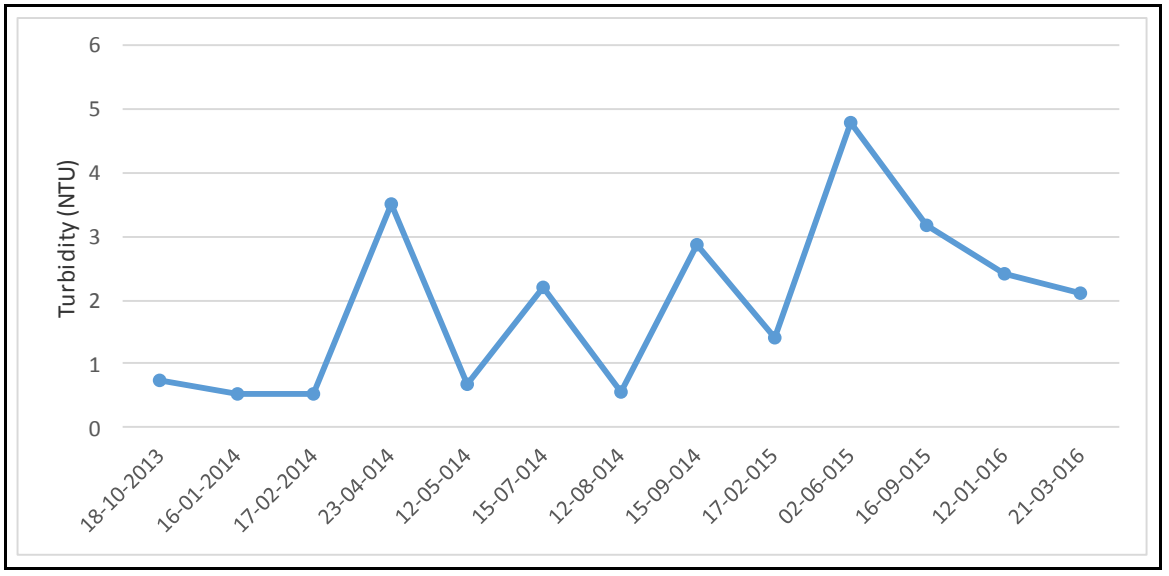


Figure 5.3. Turbidity (NTU) in GAWASCO Baraza Borehole.

Electrical conductivity ranged from 123.6- 329 µS/cm in the last two years with an average of 264.9 µS/cm. The conductivity changes with wter levels in the Tana River. During low flow the conductivity in the borehole increases.

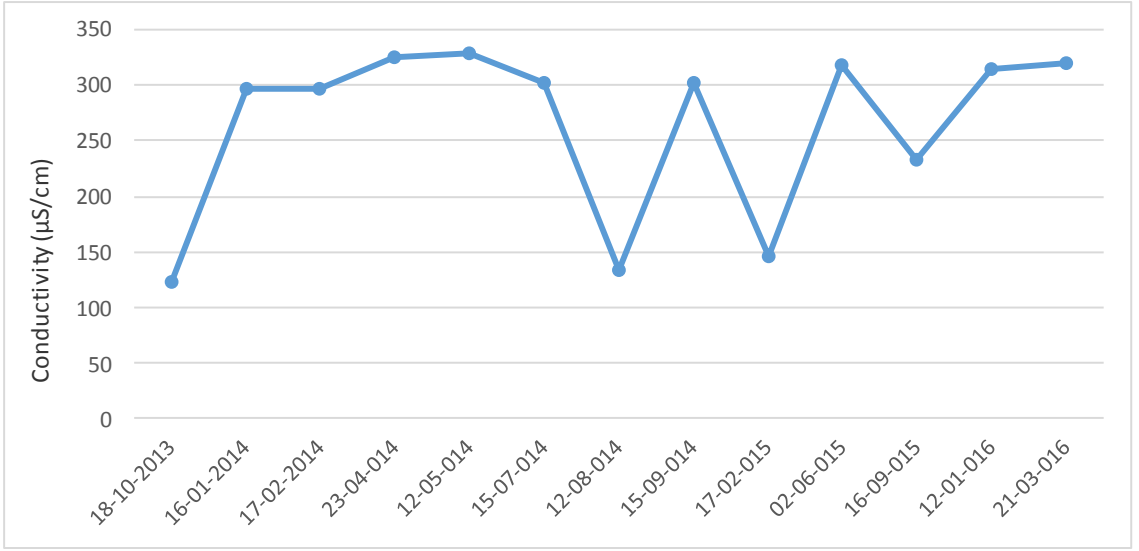


Figure 5.4: Electrical Conductivity trend of GAWASCO Baraza Borehole

5.3.3 Groundwater Assessment – RVCA

The Marula and Sopa boreholes were monitored for fluoride. The fluoride levels were high.

5.3.4 Groundwater Assessment in ACA

GTI Borehole, Mombasa

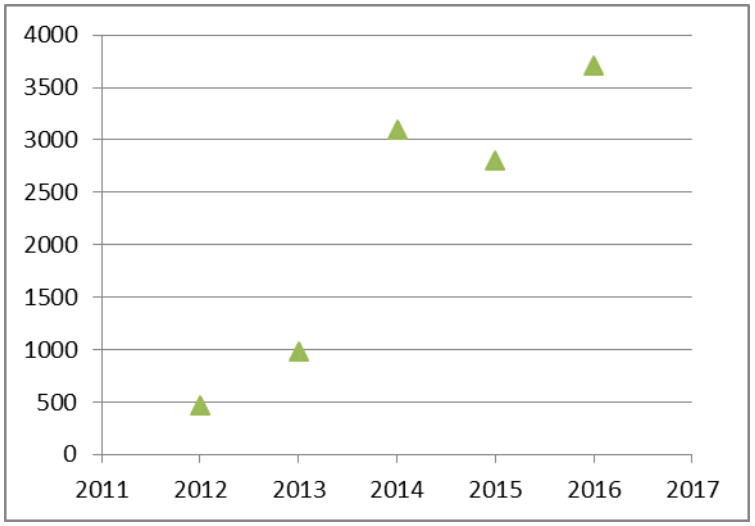


Figure 5.4 Electrical Conductivity (µS/cm) Trend - GTI Borehole, Mombasa

The conductivity has been increasing, indicating that the borehole is getting salinized probably due to unsustainable abstraction.

6 WATER USE

6.1 Permits

6.1.1Number of Permits issued

790No. permits issued during the 2015/16 Financial Year. Out of the 790 permits, 629 were new permits while the rest were renewals of old permits.
The total permits processed through Permit Database as at 30th June 2016 are 4,609.

6.1.2 Type of permits issued

The new permits issued in the financial year were as follows;

- Groundwater 424No.
- Surface Water 201No.
- Effluent Discharge 4No.

6.2 Water Use

6.2.1 PDB Reports

Figure 6.1: No. of applications, Authorizations, Permits as at 30.06.2016 Report

Region	Hydro. Units	No. of New Applications	Current Authorization Status			Current Permit Status		
			Valid	Expired	Cancelled	Valid	Expired	Cancelled
LVN	36	173	76	696	0	172	10	0
LVS	29	267	120	547	0	138	31	0
RVC	33	542	380	1170	0	437	71	0
ATHI	32	684	1723	6917	0	2224	120	0
TANA	45	407	61	1090	0	779	162	0
ENNCA	29	212	127	650	8	361	114	8
TOTAL	**204**	**2285**	**2487**	**11070**	**8**	**4111**	**508**	**8**

-There were 2,283 new applications as at 30.6.2016.
-Athi region had the highest no. of applications yet to be processed followed by Rift valley and Tana respectively.
-LVN had the lowest no. of new applications
-There were 2,487 valid authorizations against 11,070 expired ones as at 30.6.2016.
-Athi had the highest no. of valid authorizations followed by Rift Valley and ENNCA respectively.

-The highest no. of expired Authorizations were also from Athi, followed by Rift and Tana respectively.
-LVS had the least no. of expired authorizations followed by ENNCA and LVN
-Only ENNCA region had the cancelled authorizations
-There were 4,111 valid permits against 508 expired ones.
-Athi had the highest no. of valid permits, followed by Tana and Rift Valley.
-Tana had the highest no. of expired permits followed by Athi and ENNCA
-LVN had the lowest no. of expired permits followed by LVS and Rift Valley respectively.

Final Transactions Status by Month between July-2015 and June-2016 Report

Month /Year	App Rcvd	Auth. Issued	Auth. Ext.	Permits Transfer	Permits Variation	App. deferred	Applications rejected	Permits issued	Permits Renewal	Permits Cancellation	Total
July-2015	12	346	20	0	0	30	5	50	6	0	469
August-2015	24	315	18	0	1	16	10	26	11	0	421
September-2015	26	232	13	2	2	3	3	45	8	0	334
October-2015	27	176	19	0	1	6	2	77	7	0	315
November-2015	14	264	15	7	0	5	8	78	6	0	397
December-2015	9	163	19	4	0	14	3	43	16	0	271
January-2016	25	142	8	1	1	2	0	23	2	0	204
February-2016	43	222	12	0	3	2	5	58	19	0	364
March-2016	65	163	29	1	2	0	1	69	22	0	352
April-2016	131	222	32	0	0	4	2	22	11	0	424
May-2016	95	216	14	0	6	1	0	32	24	0	388
June-2016	42	156	8	0	1	7	1	104	31	0	350
TOTAL	**513**	**2617**	**207**	**15**	**17**	**90**	**40**	**627**	**163**	**0**	**4289**

Table 6.2 Final Transactions Status by Month between July-2015 and June-2016 Report

During the year under review, a total of 4,289 applications were handled at various offices in different levels as follows;

-513 new applications received within the financial year, awaiting issuance
-2,617 authorizations were processed within the Financial Year
-207 authorizations extended
-new permits issued
-163 old permits renewed
-15 Permits transferred
-17 permits varied
-applications deferred
40 applications rejected
No permit was cancelled during the year under review.

LIST OF METERS AS AT 30.6.2016				
REGION	SRO	SW	GW	TOTAL
LVNCA	ELD	2	1	3
	KTL	0	1	1
	SYA	0	4	4
LVSCA	KCO	4	3	7
	KSI	0	0	0
	KSM	7	4	11
RVCA	KAB	0	17	17
	KAP	0	1	1
	LOD	0	3	3
	NSA	20	107	127
	NAR	0	0	0
ATHI	KBU	9	49	58
	KBZ	17	42	59
	LTK	1	3	4
	MSA	0	99	99
	NRB	1	265	266
TANA	GSA	0	0	0
	KRG	9	7	16
	KTI	2	9	11
	MRG	2	13	15
	MRU	2	0	2
ENNCA	ISL	3	2	5
	MAE	0	0	0
	MIT	1	46	47
	NUK	13	17	30

	RUM	0	2	2
TOTAL		93	695	788

Table 6.3: Meters list as at 30-Jun-2016 Report

- 22 Sub regions had installed 788 meters in the permit database.
  - 93 are for surface water abstractions
  - 695 are for groundwater abstractions
  - Kisii, Narok, Garissa and Mandera have not installed any meter in the system.
  - All the sub regions in Rift Valley and Athi have installed meters and entered them in the PDB.
  - Athi has the highest no. of meters installed followed by Rift valley and ENNCA respectively.
  - LVN has installed the least no. of meters

Permit processing performance (Ageing Analysis)

REGION	Category of Permit	No. processed within Service Charter Timelines	No. Not processed within Service Charter Timelines	processed within regulation Timeline (180 days)	Total No. authorized	Average Permit Processing Time(days)	Service Charter Timeline (days)
	Cat A	8	8	Yes	16	**80**	60
	Cat B	120	49	Yes	169	**93**	90
	Cat C	1	1	Yes	2	**135**	150
	Cat D	0	0	n/a	0	n/a	180
LVN	**TOTAL**	**129**	**58**		**187**		
	Cat A	1	0	Yes	1	**22**	60
	Cat B	94	20	yes	114	**78**	90
	Cat C	4	0	Yes	4	**41**	150
	Cat D	0	0	n/a	0	n/a	180
LVS	**TOTAL**	**99**	**20**		**119**		
	Cat A	8	8	Yes	16	**74**	60
	Cat B	265	62	Yes	327	**75**	90
	Cat C	28	3	No	31	**185**	150
	Cat D	0	3	No	3	**664**	180
RVC	**TOTAL**	**301**	**76**		**377**		
	Cat A	1	0	Yes	1	**15**	60
	Cat B	1251	316	Yes	1567	**96**	90
	Cat C	16	8	No	24	**262**	150
	Cat D	0	6	No	6	**641**	180
ATHI	**TOTAL**	**1268**	**330**		1598		
	Cat A	2	8	Yes	10	**178**	60
	Cat B	100	90	No	190	**221**	90
TANA	Cat C	1	4	No	5	**562**	150

	Cat D	0	3	No	3	**663**	180
	TOTAL	**103**	**105**		**208**		
	Cat A	1	7	No	8	**443**	60
	Cat B	63	45	Yes	108	**106**	90
	Cat C	0	1	No	1	**976**	150
	Cat D	0	1	No	1	**744**	180
ENNCA	**TOTAL**	**64**	**54**		118		

Table 6.4: Permit processing performance (Ageing Analysis

- Category A
  - LVN processed 50% of the applications within the Service Charter (SC) times and all within regulation (R)
  - LVS had one application processed within SC and (R) timelines
  - RVC processed 50% of the applications within the Service Charter (SC) times and all within regulation (R)
  - Athi processed one application within SC and (R) timelines
  - Tana processed 20% of the applications within SC timelines and all within regulation (R)
  - ENNCA processed one applications within SC timelines but the average processing time of the remaining 6 applications were processed after 180 days provided for in the Water Act.

- Category B
  - All regions apart from Tana processed category D applications within regulation.
  - Approximately 80% of the applications were processed within the SC timelines

- Category C
  - LVN and LVS processed their applications within SC and R timelines
  - However, the remaining regions processed their applications after the expiry of the 180 days provided by regulation
  - This was as a result of;
  - CAACs which were not in place
  - Submission of NEMA License

- Category D
  - The Lake regions did not process any application under this category
  - However, the remaining regions all processed beyond the time allowed by regulation
  - This was as a result of;
  - CAACs which were not in place
  - Submission of NEMA License
  - Collection of assessment fees for Effluent Discharge assessment

6.2.2 Monthly water use

Monthly Water Abstracted Between July-2015 and June2016

Month	**SW**	**GW**	**Total**
July-2015	0	0	0
August-2015	0	22983	22983
September-2015	0	0	0

October-2015	0	0	0
November-2015	0	0	0
December-2015	0	0	0
January-2016	0	0	0
February-2016	0	0	0
March-2016	0	0	0
April-2016	0	0	0
May-2016	0	0	0
June-2016	0	0	0
Average	**0.00**	**1,915.25**	**1,915.25**

Table 6.5: Monthly Water Abstracted Between July-2015 and June2016

ENNCA is the only region which entered the monthly abstraction data in August 2015

6.2.3 Water use by permit category

AUTHORIZED WATER USE (m3/d)					
	CATEGORY				**TOTAL**
REGION	A	B	C	D	
LVN	1,176.21	25,182.37	878,382.36	5,509,968	6,414,708.94
LVS	954.79	17,839.94	41,642.26	2,779,120.43	2,839,557.42
RVC	490.22	42,312.29	64,861.21	2,040,319.17	2,147,982.89
ATHI	156	222,356.60	222,050.45	5,492,564.60	5,937,127.65
TANA	751.61	542,764.23	428,301.35	84,713,696.29	85,685,513.48
ENNCA	1,229.10	61,776.56	105,902.70	67,649.55	236,557.91
TOTAL	**4,757.93**	**912,231.99**	**1,741,140.33**	**100,603,318.04**	**103,261,448.29**

Table 6.6Water use by permit category

- ENNCA has authorized the highest volumes in category A, and Athi the least volumes
- Tana has authorized category B volumes followed by Athi. LVS authorized the least volumes
- LVN has authorized highest volumes in category C, followed by Tana. LVS authorized the least
- Tana has authorized the highest volumes in category D followed by Athi. ENNCA has the least volumes
- In summary the highest volumes of water have been authorized by Tana, followed by LVN and Athi.
- Authorized volumes include all application statuses from authorization to permit level

6.3 Special Studies

Abstraction data was collected during the Wajir County water resources assessment study where by 444 abstraction points were captured and this data will inform on the level of water abstraction in this county.

7 EMERGING ISSUES

CHALLENGES

- Lack of Equipment for surface Water highflow monitoring and adequate facilitation to officers to collect data
- Late payment of gauge readers and slow input of data in the data base
- Financial constraints. Inadequate and untimely funding has led to inconsistency in monitoring of surface and groundwater resources and inadequate data for appraising water quality. Important events like El Nino, low flows and high flows are not captured. The water quality situation cannot be accurately established in the country.

- Human resources. There is inadequate technical staff in some regions and sub-regions to handle water quality activities. At the head office adequate and competent staff are needed for effective coordination of activities.
- Inadequate equipment and laboratory supplies.
- Most of the monitoring boreholes are also water supply boreholes for individuals and institutions this has presented the groundwater monitoring with a big challenge since for good and reliable data water pumping from the monitoring borehole needs to be stopped for at least 24 hours before the water levels are taken. This has not been achieved, also the time laps between the pumping stoppage and the level measurement is not consistent hence leading to inconsistent and unreliable data for decision making.

- There is lack of long term data for comparison purposes and therefore analysis may not be very accurate.

- Groundwater monitoring has faced logistical support and limited resources problems and has not been consistent leaving a lot of gaps. Some sub-regions have virtually stopped monitoring due to this reason.

- The automated stations which would give real-time data have faced installation and downloading related problems and are not functioning they need to be reinstalled but resources availability has hindered the exercise.

I. OPPORTUNITIES

- The African Wildlife Foundation has started a monitoring programme for Chyulu Hills Watershed and WRMA will be partnering with the Organisation in monitoring data collection and this will improve data availability.

- Unlocking the Potential of Groundwater for the poor (Upgro) for Groundwater Risk Management for Growth and Development (Gro for GooD) Project in partnership with Oxford University, University of Nairobi, WRMA, Kwale County Government, JKUAT,UPC (Spain),Rural Focus Ltd, Base Titanium Ltd and KISCOL are supporting co-development and future use of groundwater risk management tool by key stakeholders.

- KEMRI Kisumu has installed data loggers in boreholes within Nyando Sub-Catchment and has signed an MOU with WRMA to share the data so collected.
- Engineers without Borders, an America Firm has donated five transducers (data loggers) to Kisumu Sub-Regional Office and installation of the same in strategic wells is under way.
- Some substantial data has been collected on groundwater during MTAP I and MTAPII Projects the relevant sub-regions involved in these Projects should consolidate these data to be in cooperated in their data bases and also the National Data Base to be created.
- These opportunities we hope will widen the groundwater data collection base.

8 CONCLUSIONS

1. Water resources monitoring data is very important for planning and proper regulation of water resources in the country. It provides a critical input into the water resources management function, hence should be given adequate funds for the operations and maintenance of the networks. Special attention needs to be given to the automation of the network for real time data capture.

2. The challenge, under the WRM Rules 2007, is to have all water resources, both surface and groundwater, in good quality status. This can be achieved successfully through concerted efforts by all stakeholders and policy makers. WRMA has embraced IWRM principles and concept in managing and regulating water use and protecting water catchment areas and is implementing the new constitution with special effort being made in collaborating with county governments.

3. Increased pollution occurring in the water resources, chiefly nutrient enrichment, siltation, organic and chemical requires special effort through enhanced enforcement and compliance with the effluent discharge permit conditions.

4. In addition awareness creation and sensitization of good practices in water pollution management need to be continued with special emphasis to river clean-up campaign which was launched during the year and will continue in coming years.

9 RECOMMENDATIONS

Water has now been elevated to a human rights issue. Article 43 (1) d; every person has a right to clean water in adequate quantity. WRMA, as the manager of the resource must position itself strategically to deliver this right to Kenyans. This will take finances which the government will be required to provide for extensive water resource assessment and planning.

The definition of land now includes water resources. Article 62 (1) I, j, k, & l defines water bodies as public land which is vested in and held by the National in trust for the people of Kenya, and shall be administered by the National Land Commission.

A working relationship must be then worked out between the resources manager; WRMA and the NLC.

Water allocation planning should be done for all sub-catchments involving stakeholder for sustainable water regulation and management.

10 ANNEXES

Annex 1 Categories of Monitoring Stations under the Regional Catchment Management Strategies

i. Monitoring Stations of National Importance

These are monitoring stations established at the lower river reaches before a river discharges into a transboundary lake/ocean, the river flows into a neighboring country, a station established on a shared lake or stations on major lakes in Kenya. These stations are also important regionally as they are at the downstream divide of management units; hence they monitor the outflows from the management units. The only exception to this definition is Station 4G01 on Tana River at

Garissa. This station monitors the flow contributions from the Upper Tana Sub-catchment. From

Garissa, flow decreases towards the Indian Ocean.

ii. Monitoring Stations of Regional Importance (Management Unit (MU) Stations)

These are monitoring stations established at the outfall of a management unit to monitor the flows from a specific management unit. Under the existing network of river gauging stations, there might be need to utilize a gauging station in a downstream management unit (with appropriate adjustments) as the control station for an upstream management unit.

iii. Stations of Sub-regional Importance (Stations within Management Units)

These are monitoring stations within a management unit (Intra-Management Unit (IMU) stations and measure flow contributions of specific streams within the management unit.

It was foreseen that the operational level of monitoring stations within the management units could be constrained by the availability of personnel to run the stations and the logistics on supervision. It was, therefore, envisaged that a manageable number of stations within this category were to be selected at the initial stages and build on the network as the resources to operate were enhanced.

iv. Special Purpose Stations

These are monitoring stations established in a management unit for a specific purpose, e.g. for an ongoing project to establish flow and volume conditions at a proposed dam site; to develop discharge relations with a new station. However, stations in the different categories could also be considered as special purpose stations as long as their long-term operation is not violated.

Based on the above definitions, the following is a breakdown on the categories of monitoring network in the six WRMA catchment areas and the identified management units:

Annex 2: CMS SURFACE WATER MONITORING STATIONS

Summary: CMS stations

Station Category	Number
National	22
Management Unit (MU)	48
Intra Management Unit	
Special	31
Total	223

CMS Station details

S/N	Region	Stn ID	Name	Long/Eastings	Lat/Northings	Station
1	LVN	1AA01	Malaba	34.2708	0.6417	National
2	LVN	1AD02	Malakisi	34.3419	0.6250	National
3	LVN	1AH01	Sio	34.1417	0.3875	National
4	LVN	1EF01	Nzoia at	34.0903	0.1236	National
5	LVN	1FG02	Yala	34.2653	0.0431	National
6	LVS	1GD03	Nyando	34.9597	-0.1250	National
7	LVS	1HB04	Lake Victoria	34.7403	-0.0875	National
8	LVS	1JG04	Sondu Miriu	34.8019	-0.3358	National
9	LVS	1KB05	Gucha Migori	34.2069	-0.9472	National
10	LVS	1LA04	Mara	35.0361	-1.2333	National
11	RVCA	2B13	Lake Turkana	35.9170	3.5520	National
12	RVCA	2EB10	Lake Bogoria	36.0610	0.2780	National
13	RVCA	2EH1	Lake Baringo	36.0270	0.6160	National
14	RVCA	2FA9	Lake	36.2400	-0.4080	National
15	RVCA	2FC4	Lake Nakuru	36.0920	-0.3210	National
16	RVCA	2GD6	Lake Naivasha	36.4170	-0.7690	National
17	RVCA	2K04	Ewaso Ng’iro	35.8450	-1.1010	National
18	ATHI	3HA13	Sabaki	39.7670	-3.1170	National
19	ATHI	3J02	Lake Jipe	37.7580	-3.5420	National
20	ATHI	3J12	Lake Challa	37.7130	-3.3136	National
21	TANA	4G01	Tana at Garrisa	39.7000	-0.4500	National

22	ENNCA	5E03 (Renamed 5ED01)	Ewaso Ng'iro at	37.6780	0.6420	National
23	LVN	1CE01	Kipkarren	34.9653	0.6083	MU
24	LVN	1DA02	Nzoia	34.8069	0.5889	MU
25	LVN	1DD01	Nzoia (Mumias)	34.4875	0.3722	MU
26	LVN	1ED01	Lusumu	34.4806	0.3092	MU
27	LVN	1EG02	Wuroya	34.2431	0.1500	MU
28	LVN	1FG01	Yala	34.5451	0.8080	MU
29	LVS	1GB03	Ainamutua	35.0556	-0.0722	MU
30	LVS	1GD07	Nyando	35.1639	-0.1639	MU
31	LVS	1HA11	Nyamasaria	34.9994	-0.0722	MU
32	LVS	1HB05	Awach Seme	34.4736	-0.0889	MU
33	LVS	1HD09	Awach Kibuon	34.7833	-0.0250	MU
34	LVS	1HE01	Awach Tende	34.5486	-0.4667	MU
35	LVS	1JD03	Yurith	35.0792	-0.4764	MU
36	LVS	1JF08	Kipsonoi	35.0783	-0.5103	MU
37	LVS	1JG05	Sondu	35.0133	-0.3917	MU
38	LVS	1KB01A	Gucha	34.2750	-0.9542	MU
39	LVS	1KC03	Migori	34.4708	-1.0639	MU
40	LVS	1LA03	Nyangores	35.3472	-0.7861	MU
41	LVS	1LB02	Amala	35.4375	-0.8972	MU
42	RVCA	2B21	Turkwell	35.6000	3.1110	MU
43	RVCA	2B33	Suam	35.0167	1.4667	MU
44	RVCA	2C7	NDO	35.6470	0.4510	MU
45	RVCA	2D1	Suguta	36.1060	1.1820	MU
46	RVCA	2EB8	Waseges	36.0744	0.3445	MU
47	RVCA	2EE7B	Perkera	35.9660	0.4580	MU
48	RVCA	2EG3*	Molo	36.0110	0.4440	MU
49	RVCA	2FA8	Mereroni	36.2200	-0.3930	MU
50	RVCA	2FC16	Njoro	36.0820	-0.3190	MU
51	RVCA	2GA1	Gilgil	36.3630	-0.5990	MU
52	RVCA	2GB01	Malewa	36.4030	-0.5560	MU
53	RVCA	2K01	Ewaso Ng'iro	35.7580	-1.1510	MU
54	ATHI	3BA32	Nairobi	37.1190	-1.1940	MU
55	ATHI	3BC08	Ruiru	36.8780	-1.0890	MU
56	ATHI	3CB05	Ndarugu	37.1610	-1.1310	MU
57	ATHI	3F09	Athi Kibwezi	38.0577	-2.2015	MU
58	TANA	4BC02	Tana Sagana	37.2070	-0.6720	MU
59	TANA	4BE01	Maragua	37.1530	-0.7500	MU
60	TANA	4CC07	Thika	37.3820	-1.1040	MU
61	TANA	4DD02	Thiba	37.5060	-0.7320	MU

62	TANA	4EA07	Mutonga	37.8960	-0.3760	MU
63	TANA	4F19	Kazita	38.0060	-0.2390	MU
64	ENNCA	5AC08	Ewaso Narok	36.8630	0.5080	MU
65	ENNCA	5BC04	Ewaso Ngiro	36.9050	0.0900	MU

66	ENNCA	5BE20	Nanyuki	37.0300	0.1470	MU
67	ENNCA	5DC01 (former	Ewaso Ngiro	36.8670	0.5290	MU
68	ENNCA	5DA07 (former	Isiolo	37.5670	0.3330	MU
69	LVN	1BB01	Nzoia (Moi's	35.1333	0.9208	IMU
70	LVN	1BB02	Losura	35.2375	0.9542	IMU
71	LVN	1BD02	Large Nzoia	35.0611	0.7611	IMU
72	LVN	1BE06	Kwoitobus	35.0903	0.9653	IMU
73	LVN	1BH01	Kamukuywa	34.8028	0.7847	IMU
74	LVN	1DB01	Kuywa	34.7000	0.6236	IMU
75	LVN	1EE01	Nzoia	34.2250	0.1778	IMU
76	LVN	1FD02	Mokong	35.1244	0.1378	IMU
77	LVN	1FF03	Edzawa	34.5583	0.0944	IMU
78	LVN	1BG07	Rongai	34.9250	0.7740	IMU
79	LVS	1GB06A	Mbogo	34.7078	-0.3820	IMU
80	LVS	1GC03	Kipchorian	35.4583	-0.2042	IMU
81	LVS	1GC04	Tugunon	35.4139	-0.2528	IMU
82	LVS	1GG01	Namuting	35.3472	-0.2028	IMU
83	LVS	1HA01	Great Oroba	35.0000	-0.0194	IMU
84	LVS	1HA02	Little Oroba	34.9708	-0.0278	IMU
85	LVS	1HA14	Awach Kajulu	34.8042	-0.0472	IMU
86	LVS	1HD03	Awach Kabondo	34.8833	-0.4486	IMU
87	LVS	1HD05	Awach Kasipul	34.8403	-0.5014	IMU
88	LVS	1HD06	Eaka Kioge	34.9500	-0.5083	IMU
89	LVS	1HE02	Mogusii	34.7631	-0.6192	IMU
90	LVS	1HE03	Isanda	34.7367	-0.5744	IMU
91	LVS	1JA02	Kiptiget	35.2569	-0.5514	IMU
92	LVS	1JC19	Kimugu	34.1754	-0.4767	IMU
93	LVS	1JD04	Ainapkoi	35.5847	-0.4042	IMU
94	LVS	1KA09	Riana	34.5167	-0.7139	IMU
95	LVS	1KB03	Gucha	34.5708	-0.8083	IMU
96	LVS	1KB11	Oyani	34.5333	-0.9033	IMU
97	LVS	1KB12	Kenyamware	34.9214	-0.6667	IMU
98	RVCA	2B08	Wei Wei	35.4650	1.3930	IMU
99	RVCA	2B24	Morun	35.4290	1.5310	IMU
100	RVCA	2C06	Kessup	35.4980	0.6280	IMU
101	RVCA	2C14	Kimwarer	35.6330	0.3170	IMU
102	RVCA	2EA01	Maji Matamu	36.1060	0.0000	IMU
103	RVCA	2EB03	Waseges	36.2110	0.1860	IMU
104	RVCA	2EC02	Rongai	35.9310	0.1060	IMU
105	RVCA	2EE09	Narosura	35.8740	0.2420	IMU
106	RVCA	2EG01	Molo	35.9130	0.0860	IMU
107	RVCA	2FC05	Njoro	35.9250	-0.3720	IMU
108	RVCA	2GA03	Gilgil	36.3440	-0.4920	IMU

109	RVCA	2GB05	Malewa	36.4010	-0.4930	IMU
110	RVCA	2GC04	Turasha	36.4170	-0.4790	IMU
111	RVCA	2GC05	Nandarasi	36.5590	-0.5510	IMU
112	RVCA	2GD02	Karati	36.4190	-0.6940	IMU

113	RVCA	2H01	Tongi Tongi	36.5930	-0.9200	IMU
114	RVCA	2H03	Little Kendong	36.5890	-1.0610	IMU
115	RVCA	2K03	Narok	35.8450	-1.1010	IMU
116	RVCA	2K10	Ewaso Ng'iro	36.0680	-1.4602	IMU
117	RVCA	2K16	Ewaso Ng'iro	36.1160	-2.0490	IMU
118	ATHI	3AA04	Mbagathi	36.6910	-1.3230	IMU
119	ATHI	3AA06	Mbagathi	36.9820	-1.4400	IMU
120	ATHI	3BA10	Ruiruaka	36.8230	-1.2270	IMU
121	ATHI	3BA29	Nairobi	36.8100	-1.2740	IMU
122	ATHI	3BB11	Kiu	36.9310	-1.1820	IMU
123	ATHI	3BB12	Kamiti	36.9710	-1.1970	IMU
124	ATHI	3BD05	Thiririka	37.0410	-1.1540	IMU
125	ATHI	3DB01	Athi	37.6455	-1.4107	IMU
126	ATHI	3DA02	Athi at Munyu	37.1959	-1.0893	IMU
127	ATHI	3EA02	Maruba	37.2460	-1.5190	IMU
128	ATHI	3F02	Athi	37.8460	-1.7900	IMU
129	ATHI	3F06	Kibwezi Springs	38.0760	-2.3760	IMU
130	ATHI	3F07	Kiboko	37.0950	-2.2080	IMU
131	ATHI	3F11	Little Kiboko	37.7080	-2.2080	IMU
132	ATHI	3G02	Tsavo	38.4740	-2.9960	IMU
133	ATHI	3J 16	Lumi Kivarua	37.6952	-3.4329	IMU
134	ATHI	3J15C	Lumi	37.7030	-3.3920	IMU
135	ATHI	3KB01	Ramisi	39.3730	-4.4500	IMU
136	ATHI	3KG01	Umba	39.1110	-4.5690	IMU
137	ATHI	3LA05	Voi	38.5930	-3.3930	IMU
138	ATHI	3MH26	Marere	39.4080	-4.2000	IMU
139	TANA	4AC03	Sagana	37.0430	-0.4490	IMU
140	TANA	4AC04	Chania	36.9580	-0.4210	IMU
141	TANA	4AD01	Gura	37.0760	-0.5170	IMU
142	TANA	4BB01	Ragati	37.1930	-0.6370	IMU
143	TANA	4BC05	Rwamuthambi	37.2420	-0.5850	IMU
144	TANA	4BD01	Mathioya	37.1780	-0.7140	IMU
145	TANA	4BE10	Tana Rukanga	37.2580	-0.7250	IMU
146	TANA	4BF01	Saba Saba	37.2640	-0.8640	IMU
147	TANA	4CA02	Chania	37.0630	-1.0260	IMU
148	TANA	4CB04	Thika	37.0660	-1.0210	IMU
149	TANA	4DA10	Thiba	37.3170	-0.6210	IMU
150	TANA	4DB04	Nyamindi	37.3690	-0.6150	IMU
151	TANA	4DC03	Rupingazi	37.4380	-0.5330	IMU
152	TANA	4EA06	Mutonga	37.8560	-0.2790	IMU
153	TANA	4EB06	Ruguti	37.8580	-0.3510	IMU
154	TANA	4EB07	Thuchi	37.8710	-0.3620	IMU
155	TANA	4EB11	Mara	37.8710	-0.3420	IMU

156	TANA	4EC New	Ena	37.4333	-0.29463	IMU
157	TANA	4F09	Ura	37.9790	0.0650	IMU
158	TANA	4F10	Kazita	37.9780	-0.0960	IMU
159	TANA	4F17	Thingithu	37.9600	-0.1690	IMU

160	TANA	4F20	Thanandu	38.0092	-0.09925	IMU
						IMU
162	ENNCA	5AA05	Equator	36.3630	0.0200	IMU
163	ENNCA	5AA13	Lake Ol	36.4028	0.0111	IMU
164	ENNCA	5AB02	Pesi	36.5170	0.2000	IMU
165	ENNCA	5AB04	Pesi	36.5270	0.0630	IMU
166	ENNCA	5AC10	Ewaso Narok	36.7240	0.4380	IMU
167	ENNCA	5AC15	Ewaso Narok	36.5370	0.2570	IMU
168	ENNCA	5AD01	Mutara	36.5530	0.0670	IMU
169	ENNCA	5AD04	Mutara	36.6630	0.0800	IMU
170	ENNCA	5BA03	Moyok	36.8710	0.2630	IMU
171	ENNCA	5BB02	Ewaso Ng'iro	36.8670	0.1330	IMU
172	ENNCA	5BC02	Naro Moru	37.0250	0.1650	IMU
173	ENNCA	5BC05	Rongai	37.0670	0.0420	IMU
174	ENNCA	5BC06	Burguret	37.0380	0.1090	IMU
175	ENNCA	5BC08	Engare Ngobit	36.7830	0.0500	IMU
176	ENNCA	5BD02	Surugoi	36.6030	0.0760	IMU
177	ENNCA	5BE01	Nanyuki	37.0770	0.0210	IMU
178	ENNCA	5BE02	Ontulili	37.1390	0.0400	IMU
179	ENNCA	5BE05	Teleswani	37.2300	0.0830	IMU
180	ENNCA	5BE06	Timau	37.2420	0.0880	IMU
181	ENNCA	5BE07	Likii	37.0870	0.0210	IMU
182	ENNCA	5BE19	Ngusishi	37.2610	0.1000	IMU
183	ENNCA	5BE21	Nanyuki	37.0280	0.1320	IMU
184	ENNCA	5BE22	Sirimon	37.2000	0.0610	IMU
185	ENNCA	5D02 (5DA01)	Ngare Nything	37.4228	0.1814	IMU
186	ENNCA	5D04 (5DA02)	Ngare Ndare	37.3440	0.1860	IMU
187	ENNCA	5D10 (5DA03)	Rugusu	37.4744	0.1933	IMU
188	ENNCA	5D11 (5DA04)	Kithima	37.4908	0.2006	IMU
189	ENNCA	5D14 (5DA05)	Likiundu	37.8040	0.2330	IMU
190	ENNCA	5D-NEW (5DA06)	Ewaso Ngiro	37.5310	0.5666	IMU
191	LVN	1CA02	Sergoit	35.0667	0.6333	Special
192	LVN	1AD03	Malakisi	34.3389	0.6236	Special
193	LVN	1CB05	Sosiani	35.0903	0.6264	Special

194	LVN	1EB02	Isiukhu	34.7500	0.2542	Special
195	LVN	1FC01	Kimondi	35.0486	0.2000	Special
196	LVN	1FE02	Yala	34.9361	0.1833	Special
197	LVN	1FG03	Yala	34.1427	0.0060	Special

198	LVS	1GD02	Nyando	35.1569	-0.1694	Special
199	RVCA	2FC13B	Sewage Effluent	36.1310	-0.3790	Special
200	ATHI	3ED01	Thwake	37.8280	-1.7850	Special
201	ATHI	3G03	Mzima springs	38.0280	-3.0140	Special
202	ATHI	3G06	Nor Turesh	37.5680	-2.9580	Special
203	TANA	4AA05	Sagana	37.0390	-0.4430	Special
204	TANA	4AB01	Muringato	36.9430	-0.4000	Special
205	TANA	4AB06	Amboni	36.9920	-0.4070	Special
206	TANA	4CC03	Yatta Furrow	37.3610	-1.0940	Special
207	TANA	4DA New	Thiba	37.46479	-0.7176	Special
208	TANA	4DC06 II	Kapingazi	37.4500	-0.4830	Special
209	TANA	4EA03	Kithino	37.6810	-0.1020	Special
210	TANA	4EB09	Tungu	37.6600	-0.3040	Special
211	TANA	4F08	Thangatha	37.9740	0.0480	Special
212	TANA	4F13	Tana Grand	38.0180	-0.2850	Special
213	TANA	4F16	Tana	38.0092	-0.0766	Special
214	TANA	4F28	Rujirweru	38.0608	-0.2159	Special
215	TANA	4G02	Tana Garsen	40.1170	-2.2750	Special
216	ENNCA	5D-	Ewaso Ngiro	36.8707	0.5992	Special
217	ENNCA	5E06 (5EC01)	Bakuli Springs	37.9900	2.3325	Special
218	ENNCA	5E-NEW	Ngurunit	37.2757	1.7205	Special
219	ENNCA	5H01 (5HA01)	Daua River	41.8756	3.9694	Special

ANNEX 3 Instrumentation of Monitoring Boreholes

Table 5.4: Borehole instrumentation

S/No.	Borehole Name	Remarks
1	Kakamega General Hospital C 7006	Airline
2	Tande	Airline
3	Shamiloli	Airline
4	Shillom	Airline
5	Siaya DH	Airline
6	Mwikalikha	Airline
7	Kapsabet Girls Sec C11403	Airline
8	TMC	Observation borehole
9	Kapsabet Boys Sec Sch.	Airline
10	Bethesda C-7053	Airline
11	Kitinda	Observation borehole
12	Bungoma Bible Children's	Airline
13	Moi's Bridge C-10604	Airline
14	Bungoma Ded	Automated
15	Busia Prison C-9590	Observation borehole
16	Kitale Club	Airline
17	Kitale Seed	Observation borehole
18	Kabatini(DB)	Automatic
19	Kabatini	Airline
20	St. Mary's	Airline
21	Baharini	Airline
22	Naivasha MW&I	Airline
23	Panda	Airline
24	Kinyanjui/Naivasha	Airline
25	Mayflower/Naivasha	Airline
26	Ayub suleiman	Airline
27	M.O.W.D.	Airline
28	Katakala	Airline
29	carzam	Airline
30	Marula	Automatic
31	Subati	Airline
32	Rongai (DB)	Automatic
33	Kacheliba Hospital	Airline
34	Cherombai Pri. sch	Airline

35	St Cecilia Girls	Airline
36	Kacheliba mixed	Airline
37	Chepkobe comm bh	Airline
38	Cheptianga comm bh	Airline
39	BCFC	Airline
40	Ngoswani comm.bh	Airline
41	Rift Valley academy	Airline

42	RVA	Airline
43	TD Jakes	Airline
44	EOR Ekule	Airline
45	Nkairimiran	Airline
46	Lodwar BH 1.C	Automatic
47	Nariokotome BH	Automatic
48	Narengewoi BH 2	Automatic
49	Lopwarin	Automatic
50	Lemotit	Airline
51	James Finlay	Airline
52	Mercy Girls School	Airline
53	Taita Towett	Airline not in place
54	KPA	Airline
55	KEMRI 1	Observation well, no airline
56	KEMRI 2	Airline
57	Trinity Maseno	Airline
58	Ndori B/H	Airline not in place
59	Kinyose spring	Discharge measurements taken by manual means
60	Ngandalel Dispensary borehole	Airline
61	Withur Community Borehole	Airline
62	Ainamoi Borehole	Airline
63	Kiambu District Hospital	Airline
64	Limuru DO's Offic	Airline
65	Gnt, Juja	Airline
66	Eastern flour mills	Airline
67	Machakos school for Handicapped	Airline
68	Bishop Kioko Hosp.	Airline
69	Kabete NCC	Airline
70	Riverside Park	Airline

71	St. Lawrence University	Airline
72	Kenya High School	Automated- equipped with data
73	Jorgen Ladaforgd	Airline
74	Hotel Boulevard	Airline
75	Unilever	Airline
76	Kenya Polytechnic	Automated- equipped with data
77	Karen Country Club	Airline
78	Anthony Ngotho	Airline
79	Hillcrest Karen	Airline
80	Tiwi BH 1	Automated-Has a data logger
81	Tiwi BH C	Airline

82	KICC	Airline
83	Hindu Temple	Airline
84	Trufoods	Airline
85	Uchumi Supermarket (Ngong Rd)	Airline
86	Kabansora millers	Airline
87	GTI Mombasa	Airline
88	Lake Kenyatta Well No.5	Airline
89	Witu Well Field Piezometer well No.3	Airline
90	Hindi Well Field Monitoring	Airline
91	Meru Show Ground	Airline
92	Mbirikine	Airline
93	Materini Community Borehole	Airline
94	Ndoleli Methodist Church	Airline
95	Ngondi	Airline
96	Ciakariga	Airline
97	St. Francis Assisi- Mitunguu	Airline
98	Rubate Teachers College	Airline
99	Karaba Mission	Airline
100	Don Bosco	Airline
101	Ruturi Monitoring Borehole	Airline
102	Siakago Secondary School	Airline
103	Kids Alive	Airline
104	Kamuhuria	Airline
105	Makuyu Police Station	Airline
106	Ichaki Catholic Parish	Airline
107	Maragua Muslim Mosque	Airline

108	Muthithi Secondarys School	Airline
109	Thika Muslim College	Airline
110	DWO Muranga	Airline
111	Mwangu Secondary School	Airline
112	Kiganjo Community Borehole	Airline
113	Catholic Mission Carmelite	Airline
114	Nyeri Technical Institute	Airline
115	Nyumbani Village	Airline
116	Kanyongonyo	Airline
117	Atongoi Primary School	Airline
118	Itumba	Airline
119	Kyatune	Airline
120	Kaluva Secondary School	Airline
121	Nzambini Secondary School	Airline

122	Tyaa Kamuthale	Airline
123	Aikman	Airline
124	Backlit	Airline
125	Nanyuki childrens Home	Airline
126	Lolmalick b/h3	Airline
127	Kibwi Farm	Airline
129	Primarosa 1	Airline
130	Tabor Hill 2	Airline
131	Kihingo Dispensary	Airline
132	Chereta	Airline
133	Familia Takatifu	Airline
134	RUIRI	Airline
135	MATABITHI	Airline
136	KARGI	Airline

Annex 4: LVSCA WQ Data

Station	Years of Data	Mean for the Quarter for certain parameter	Long Term Mean	Maximum recorded value	Minimum Recorded Value
Gucha /Migori (1KB05)	2000 to June 2016	Ec 120 uS TSS 210 mg/l pH- 7.7 TP 0.9 mg/l TN Turbidity - 517 NTU	Ec 145 TSS- 255 mg/l pH- 7.22 TP- 0.4 mg/l TN – 2.0 mg/l Turb- 356 NTU	Ec 800 TSS- 1000 mg/l pH- 8.2 TP – 1.6 mg/l TN – 6.0 Turb- 1020 NTU	Ec 74 TSS- 10 mg/l pH- 6.4 TP- 0.11mg/l TN-0.6 mg/l Turb-40 NTU
R. Mara (1LA04)	2000 to June 2016	Ec 152 uS TSS 99 mg/l pH- 7.72 TP 0.17 mg/l Turbidity - 56 NTU	Ec 194 TSS- 219 mg/l pH- 7.5 TP- 0.26 mg/l TN – 2.4 mg/l Turb- 197 NTU	Ec 528 TSS- 600 mg/l pH- 8.6 TP – 0.59 mg/l TN – 6.5 mg/l Turb- 660 NTU	Ec 67.6 TSS- 10 mg/l pH- 6.8 TP- 0.04mg/l TN-0.72 mg/l Turb-40 NTU

Annex 5: ENNCA WQ Data

Station	Data sets	Turbidity monitored	Long Term Mean	Maximum Recorded Value	Minimum Recorded Value
5ED01(Achers Post)	18	642	711	6180	5.8
5DA07 (Isiolo)	12	3.79	109.3	786	0.81
5BC04(Ewaso ng'iro)	15	50.4	145	526	13.51
5BE20(Nanyuki)	12	5.64	47	307	5.31
5DC01(Ewaso ng'iro)	2	48.3	26.5	48.3	4.78

Annex 6: TCA Long term WQ Data

Station	Years of Data	Mean for Year XX for certain parameter	Long Term Mean	Maximum Recorded Value	Minimum Recorded Value
River Tana-Garissa (RGS 4G01)	December 2013 to February 2015	pH	pH=7.6	pH =7.8	pH=7.11
		2013* -7.48			
		2014 -7.74	Turbidity (NTU) =2031.4	Turbidity (NTU) =9442.5	Turbidity (NTU) =205
		2015 -7.23			
		2016* -7.7			
		Turbidity (NTU)	Electrical conductivity (µS/cm)= 162.3	Electrical conductivity (µS/cm)= 196.2	Electrical conductivity (µS/cm)=138 .2
		2013* -875			
		2014 -4253.8			
		2015 -547.6			
		2016* -230.7			
		Electrical conductivity			
		2013*-145.9			
		2014 -177.4			
		2015 -158.2			
		2016* -138.7			
		Dissolved oxygen 2015*-1.79 mg/l			

Annex 7: Turbidity, RVCA

Station	Years of Data	Mean for TSS for Year 2015	Long Term Mean	Maximum Recorded Value	Minimum Recorded Value
2EH1 L. Baringo	9	14	40.83	146	2
2EB10 L. Bogoria	8	208.5	88.13	394	17
2FA9 L. Elementaita	8	97	176.5	364	97
2GD6 L. Naivasha	10	40	22.5	67	7

2FC4 L. Nakuru	8	46	164.28	377	45
2EE7 Perkerra R.	5	223	322.7	1800	5
2C7 Kerio	7	75.6	487.5	3200	7

Annex 8: WQ Data for Stations in ACA

Station	Station ID	Altitude	GPS	Date	Temp.	pH	E.C	TDS	D.Oxygen	Turbidity	Salinity
Mbagathi River At Rongai Bridge	3AA04		X 0273911, Y 9840191	15/2/2016	22.5	7.05	548.1	350.8	4.75	37.1	
Nairobi River At Museum Hill	3BA29		X 0256574, Y 9859024	15/2/2016	23.4	7.01	534.4	342.0	7.33	19.2	
Ruirwaka River At Runda Bridge	3BA10		X 0256780, Y 9864780	15/2/2016	20.4	5.93	119.6	76.5	7.45	56.7	
Mbagathi River At Rongai Bridge	3AA04		X 0273911, Y 9840191	15/3/2016	20.3	-	502	321.3	-	>10	0.2
Nairobi River At Museum Hill	3BA29		X 0256574, Y 9859024	16/3/2016	20.6	-	666	426.2	-	>10	0.3
Ruiruaka River At Runda Bridge	3BA10		X 0256780, Y 9864780	16/3/2016	19.4	-	168.6	107.9	-	>10	0
Mbagathi River At Rongai	3AA04		X 0286822, Y 9858057	18/3/2016	27.6	-	537	343.7	-	>10	0.2
Nairobi River At Museum Hill	3BA29		X 0273911, Y 9840191	15/3/2016							
Ruirwaka River At Runda	3BA10		X 0256574, Y 9859024	16/3/2016							
Athi River At Kamulu	3AB02		X 0256780, Y 9864780	16/3/2016							
Mbagathi River At Rongai	3AA04		X 0286822, Y	18/3/2016							

Bridge			9858057								
Nairobi River At Museum Hill	3BA29		X 0273911, Y 9840191	15/3/2016							
Ruiruaka River At Runda Bridge	3BA10		X 0256574, Y 9859024	16/3/2016							
Ruiruaka River At Runda			X 0256780, Y 9864780	4/26/2016	20	6.98	141.8	90.8	1.81	424	
Nairobi River At Museum Hill			X 0256574, Y 9859024	4/26/2016	25.1	6.8	463.1	296.4	2.76	224	

Annex 9: Sediment Loads, LVNCA

1	Station	Years of data 2014/2016	Mean for the year 2015/2016 for sediment tons/day	Long term mean	Maximum recorded values	Minimum recorded values
2	Malakisi (1AD02, N)			137	614	1.35
3	Malaba (1AA02, N)			228	3,688.2	1.09
4	Sio (1AH01, N)			245	608	20
5	Nzoia at Ruambwa (1EF01,N)			3,363	3638.5	26.38
6	Yala at Bondo (1FG02, N)			242	550	21
7	Koitobos (1BE02, MU)			168	3110	3.2
8	Nzoia at Mumias (1DD01, MU)			1,661	5,146	44
9	Isiukhu (1EB02, MU)			158	1,376	2.82
10	Nzoia at Brigadier (1BD02, MU)			70	93	4.2
11	Lusumu (1ED01, MU)			571	4,321	2.63
12	Wuroya (1EG02, MU)			74	210	0.7
13	Kipkaren (1CE01,			73	349	4

	MU)					
14	Nzoia at Webuye (1DA02, MU)			860	3,894	34
15	Kuywa at Matisi (1DB01, MU)			286	393	60
16	Malakisi (1AD02, N)			137	614	9
17	Malaba (1AA02, N)			228	3642.75	28.15
18	Sio (1AH01, N)			245	608	48
19	Nzoia at Ruambwa (1EF01,N)			3,363	5,362.30	88.61
20	Yala at Bondo (1FG02, N)			242	550	21