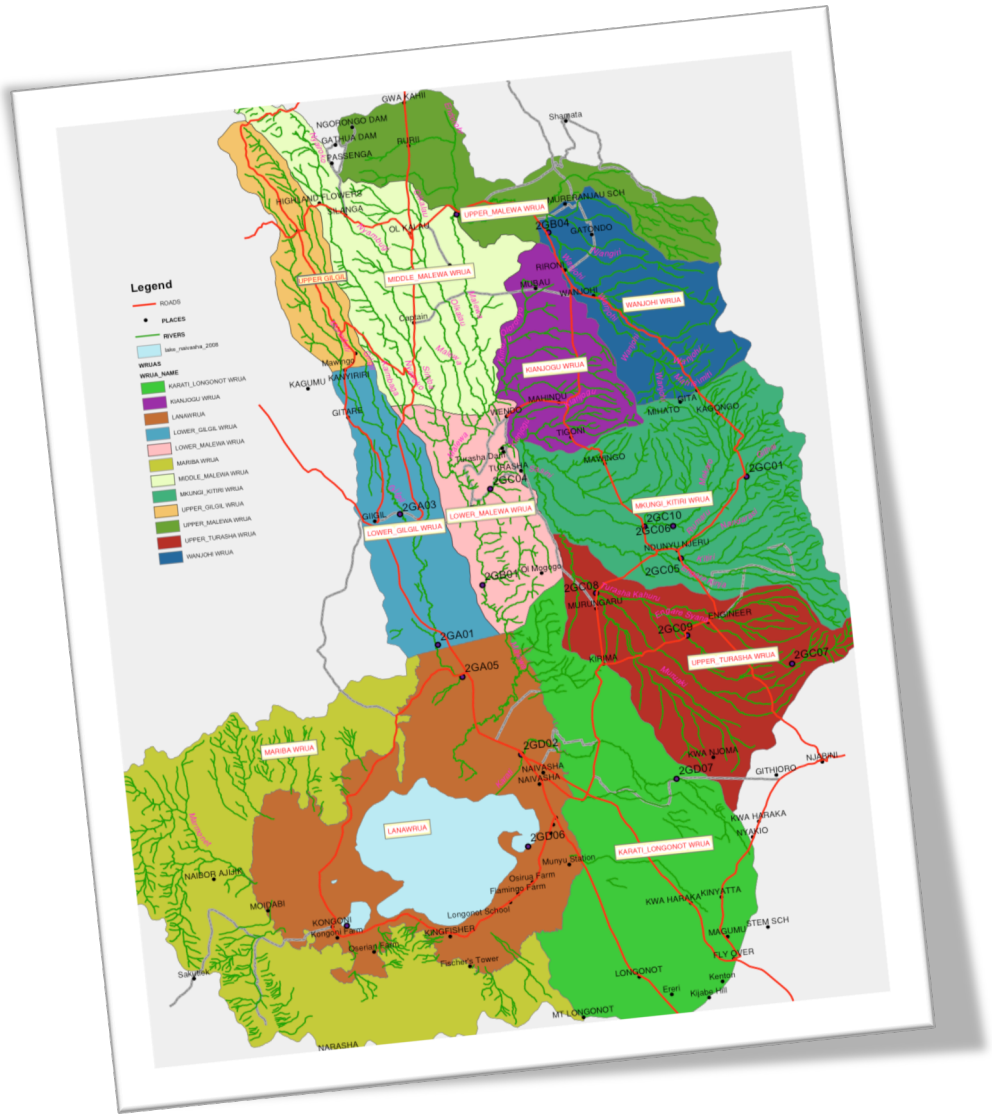
Internship Report
17-02-2011

Water Abstraction Survey in Lake Naivasha Basin, Kenya



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Preface

From April 2010 till the end of July 2010 I conducted an internship around Integrated Water Resource Management (IWRM) in the Lake Naivasha Basin, Kenya. SNV and the Water Resource Management Authority (WRMA) facilitated the internship. This document reports about the different internship objectives and related activities.

The internship activities included:

- Literature research
- Water abstraction and river discharge data collection through practical field work
- Data analysis and presentation
- Capacity building of Water Resource User Associations (WRUAs) in the Lake Naivasha Basin

The overall goal of the activities and research was to give support in refining the Water Allocation Plan (WAP), which will soon be implemented in the Lake Naivasha Basin. Next to the internship research presented in this report I'm about to do a bachelor thesis around IWRM in the Lake Naivasha basin. Wile the focus of the internship was on water abstraction and permit analysis; the bachelor thesis will focus on water availability in relation to the allocation rules as stipulated in the WAP.

All of the above activities were not done in a solo-act; therefore I would like to bring a word of thanks to several people.

Reint-Jan de Blois and Nancy Ndirangu thanks for making it possible for me to do an internship in Kenya, and thanks also to the clear supervising back up during the internship. Also thanks to all the other people at SNV, for their unrelenting support in facilitating the internship.

I would like to bring thanks to the people at WRMA Naivasha, where I was welcomed with great hospitality, and even if the office was small already; there was always some workspace for me. I want to thank the sub-regional manager Kimeu Musau, for his open minded and encouraging attitude towards my internship activities. Great thanks to Dominic Wambua who became a close workmate and friend that showed me the beauty of Kenya. Thanks also to the other people at WRMA for the great time in the office and in the field. Thanks to the other two internship students at WRMA; Kimnje Tito and Jackline Muturi, for the great experience of working together.

Thanks to all the twelve Water Resource Users Associations (WRUAs) in the Lake Naivasha basin for their hospitality and cooperation in the research. Special thanks to Eugene Reeksting, Richard Fox and Paul Roya, for their open and welcoming attitude towards me and my internship research. Thanks also to George Muchigia for the development of the GIS maps.

WWF Naivasha thanks for welcoming me in the process of the water abstraction survey.

Thanks to Gert Jan Veldwisch supervisor from Wageningen University for giving backup in the research process and in finishing of the internship report.

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Acronyms

CMS	Catchment Management Strategy
GIS	Geo Information System
KES	Kenyan Shilling (monetary unit)
LaNaWRUA	Lake Naivasha Water Resource Users Association
LANBUWRUA	Lake Naivasha Basin Umbrella Water Resource Users Association
MWI	Ministry of Water and Irrigation
RGS	Regular Gauging Station
SCMP	Sub-Catchment Management Plan
SNV	SNV Netherlands Development Organisation
SRO	Sub-Regional Office
WAP	Water Allocation Plan
WAS	Water Abstraction Survey
WRMA	Water Resource Management Authority
WRUA	Water Resource User Association
WSTF	Water Service Trust Fund
WWF	World Wide Fund for Nature

Summary

In the Lake Naivasha basin the water resources are under pressure due to a high water demand and changes in water availability. The Water Resource Management Authority (WRMA), that is the lead organisation in managing the water resources, developed together with stakeholders a Water Allocation Plan (WAP), to address the shortcomings of current management practices. A Water Abstraction Survey (WAS), which was finished in May 2010, has been done in the basin to gather information on abstraction and legal status of all water abstraction points. The results of this WAS are to be incorporated in the WAP, and to support WRMA and the basin Water Resource Users Associations (WRUAs) in enforcing the Water Act (2002) on field level.

The WAS can be seen as a success unless some of its shortcomings in the methodology, it has given better insights in the current status on abstraction amounts and on the legal status of the abstractions. Next to these factual numbers the whole process of the WAS has lead to a better understanding and cooperation between WRMA, the WRUAs and other organizations. Together it will be an impulse for better and new types of management of the water resources in the Naivasha basin.

Key findings derived during the WAS are that the water abstractions in the area around the lake are most dense and also account for ± $^2/_3$ of the total abstraction in the basin. In the catchment area the total river abstraction, according to the WAS results, is in the same order of magnitude as direct abstractions from the lake, which are both around 27 million m^3 $year^{-1}$. The out of the basin transfer at the Turasha dam accounts for 20% of the total river abstraction in the basin. Comparing the WAS with the WAP on abstraction amounts from rivers it can be concluded that abstraction derived by the WAS is higher than the indicated authorized abstraction in the WAP especially for the Malewa river.

The permit coverage of the abstraction points is poor, 50 % of the abstraction points do not have any form of legal status, the other 50% of the abstractions have or did have some kind of legal status (Application, Authorization or Permit), but only 8 % of all abstractions currently have a valid permit. The permit compliance in terms of allocated vs. abstracted quantities differs significant between abstractions around the lake and the catchment area. Wile in the area around the lake the allocated amount is almost double the actual abstracted amount, in the catchment area it is the other way around. Looking in detail to permit compliance it can be concluded that at some abstraction points there is huge over allocation and at others huge over abstraction.

Measurement compliance is low in the catchment area were measuring devices are often not installed, this is the opposite for the LaNaWRUA, but the provision of abstraction records to WRMA is also often lacking in the LaNaWRUA. Revenue collection from water use charges can be increased by ± 140% up to 66 million KES.

To bring all abstraction points into compliance with the water legislative framework a total of ± 1700 actions are required on legalizing abstractions, installing measuring devices and payment for water use. On average this is 1,85 action per abstraction point. The WRUAs have an important role to play in this, during the workshop about the WAS it became clear that the WRUAs need to be empowered before they can fully take up their mandate and support WRMA in enforcing the Water Act at field level. An information loop has to be created between WRMA and the WRUAs wherein the WAS data is updated and validated with new information from both parties. Efforts have to be put in increasing the community recognition of the WRUAs and the development and implementation of the SCMPs. Furthermore the WRUAs should be incorporated in the revenue collection from water use charges, a return cash flow from these revenues can be a successful strategy to encourage active involvement of the WRUA and to increase revenue. The ideal case is that WRMA is only doing the things that the WRUAs are not able to do. To get closer to this ideal situation it is necessary that WRMA together with WRUAs come up with a strategy to empower the WRUAs to bridge the currently existing enforcement gap.

1 Introduction

1.1 IWRM in the Lake Naivasha Basin

In the Lake Naivasha basin the ecosystem, livelihoods and commercial activities are all strongly relying on an adequate water supply. The Water Resource Management Authority (WRMA) is the leading organisation on water management issues and it is their mission to manage, regulate and conserve water resources judiciously, involving stakeholders for enhancement of equitable allocation and environmental sustainability.

The operations of WRMA are carried out through six regional offices set up at river basin level. The Lake Naivasha basin is part of the Rift valley river basin; a sub regional office is located in Naivasha falling under the regional office in Nakuru. At regional level a Catchments Area Advisory Committee (CAAC) supports WRMA, in advice on water resources issues in the river basin. At the user side WRMA facilitates the development of Water Resource User Associations (WRUAs) who are expected to assist in decision making on- and registration of water users, water allocation planning and management, water quantity and quality monitoring and conflict resolution.

In the Lake Naivasha Basin an umbrella WRUA is formed to represent all the twelve WRUAs in the basin (Annex III) including the 'Lake Naivasha WRUA' that represents water users on riparian land around the lake and upstream WRUAs along the tributaries and rivers feeding the lake. This 'Lake Naivasha Basin Umbrella WRUA (LaNBUWRUA)' is responsible for collaborating with WRMA in planning and enforcing ground and surface water allocation and abstraction in the entire basin.

Due to widespread concerns about siltation and over-abstraction of ground and surface water around the lake, stakeholders have made efforts to develop a Water Allocation Plan (WAP), which was completed in April 2010 (WRMA, 2009). The draft WAP concedes that one of the challenges was insufficient and up to date information on the availability and use of water in the basin as a whole. It proposes basin-wide abstraction surveys and hydrological, water use efficiency and demand management studies (WRMA, 2009).

With a Sub-Regional Office (SRO) in Naivasha town WRMA Naivasha covers the Lake Naivasha, Lake Elementeita and Lake Nakuru basins. Because of the high demand for adequate water management in the Lake Naivasha basin, WRMA is putting great effort in building a quality database both on water resource availability and water abstractions for the Lake Naivasha basin.

The water abstraction survey is conducted by WRMA in support of other stakeholders as the World Wildlife Fund (WWF), the LaNaWRUA and in-field support from the WRUAs. The survey in the area around the lake started in July 2009 and the survey in the Upper Catchment started in December 2009, the field-part of the survey was finalized in May 2010. The acquired data has been put into a database. After refining the database with additional information on permits from the office, the analysis and processing of the data started. A full list of objectives of the WAS can be found in Annex II.

A huge challenge in implementing the WAP is the capability of WRMA Naivasha and the 12 WRUAs in the Lake Naivasha Basin. The recently formed LaNBUWRUA has together with WRMA a major role to play in this. The current level of development and expertise of the WRUAs differs significantly. The LaNBUWRUA can be a platform for sharing thoughts and expertise between the different WRUAs and WRMA.

1.2 Internship Objectives

Preliminary of the internship period, objectives were set in cooperation with SNV and WRMA Naivasha to address the above stated challenges in IWRM in the Lake Naivasha Basin. The main objective was to support WRMA Naivasha and the 12 WRUAs in the Lake Naivasha Basin in refining the Lake Naivasha Basin Water Allocation Plan, including implementation of a Water Abstraction Survey for the Lake Naivasha Basin. The sub objective was to strengthen the capacity of the Lake Naivasha Umbrella WRUA (LaNBUWRUA) and its

constituent WRUAs in implementing SCMPs and the WAP. The initial internship activities and key deliverables are listed in Annex I.

1.3 Research Questions

To meet the internship objectives in a structured manner research questions have been developed. All research questions cover the whole Lake Naivasha Basin.

1. What are the locations and abstraction details of all water abstraction points from the lake, rivers and groundwater aquifers?
2. What is the status on compliance to the water legislative framework of these water abstraction points?
3. How can the outcome of the Water Abstraction Survey build capacity for the LaNaBUWRUA and the 12 WRUAs in the Lake Naivasha basin?

1.4 Background Information

1.4.1 Study Area

The Lake Naivasha basin or catchment is a sub-catchment within the Rift valley in Kenya (Figure 1). The Lake Naivasha basin covers an area of approximately 3400 km^2. With altitudes between 3080 m.a.s.l.in the upper catchment and ± 1887 m.a.s.l. at lake level.

Three types of landscapes can be identified in the Naivasha catchment: the Kinangop plateau, the Mau escarpment, and the Rift Valley floor (Annex III).

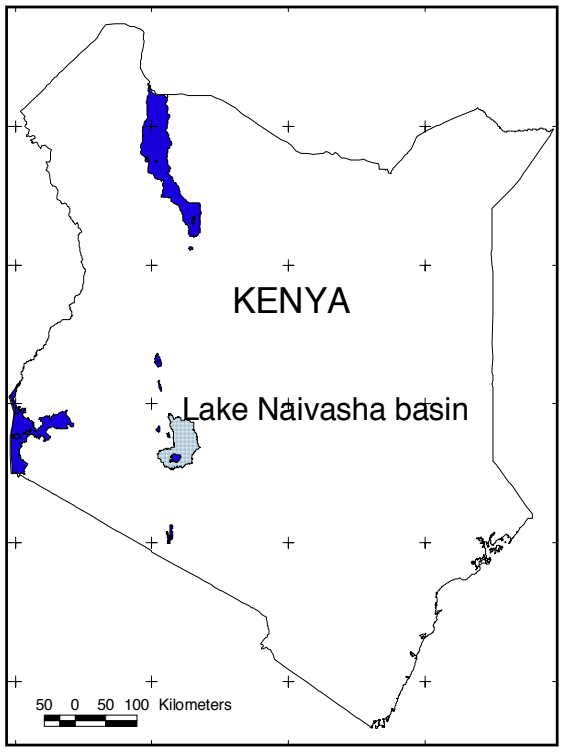


Figure 1: Lake Naivasha basin in Kenya *(source: WWF Naivasha)*

1.4.2 Climate

The climate is humid to sub-humid in the highlands and semi-arid in the Rift Valley. The mean monthly maximum temperature ranges between 24.6°C to 28.3°C. And mean monthly minimum temperature between 6.8°C and 8.0°C. The average monthly temperature ranges between 15.9°C and 17.8°C. The average annual rainfall ranges from about 1300mm in the upper catchment to about 600mm in the rift floor.

1.4.3 Hydrology

Lake Naivasha is a freshwater lake with a mean surface area of approximately 140 km^2. The two main rivers draining the catchment and entering the lake from the north are the Malewa (drainage area 1,700 km^2), which accounts for ±80% of the surface inflow and the Gilgil (drainage area 420 km^2) contributing almost 90% of the remaining surface inflow. A third river named Karati is seasonal and flows for about two months during the wet season. A schematic drainage pattern of the Lake Naivasha basin can be found in Annex VIII. Total river and precipitation inflow into the lake amount to 85%. Underground, subsurface recharge amounts to the remaining 15%.

1.4.4 Water use

The water use in the area is largely defined by the land use within the catchment. The main land use within the catchment is agriculture, which includes irrigated crop farming (horticulture, vegetables, fruits) around the lake (HQ image in Annex V) and mixed farming (wheat, maize, potatoes, beans and sunflowers) on the rain-fed slopes of the escarpment. Next to these irrigation purposes, water is also used for domestic purposes and geo-thermal activities. Major issues within the catchment include effects of climate change, degradation of catchment areas due to increased agricultural practices and declining river flows.

2 Methods

The Water Abstraction Survey was undertaken in two phases; first the area around the lake was covered in the period stretching from July to October 2009. In February 2010 the survey in the upper catchment started, this survey lasted to June 2010. The methodology used during both of these surveys is quite similar, only for the survey around the lake WRMA officers were supported to a large extent by LaNaWRUA members, which contributed a lot in expertise on the assessment of water use by large scale farmers.

The survey objectives were set by WRMA, LaNaWRUA and WWF, which can be found in Annex II. The WAS required financial, human a technical resources, in the preparation phase partners for WRMA, in coping with this high demand of resources, were found in the LaNaWRUA, WWF and SNV.

2.1 Data collection

Three teams were in place to undertake the survey and each team covered its own area. Together they covered the whole of the Lake Naivasha Basin. Each team consisted of 2 WRMA officers plus a driver and in the field they were most of the time supported by a WRUA official. Each team was equipped with a car, GPS device, current meter and attributes, bucket, stopwatch, and measurement tape.

A standard questionnaire, which can be found in Annex VI, for doing a water abstraction survey, guided the WRMA officers on which details to take from each abstraction point. On the questionnaire information regarding to the: “Owner, GPS coordinates, Permit, Authorized abstraction, Measuring device, Payments, Reasons of Non-Compliance to water rules, Abstraction Works, Surrounding activities, Storage facility, Actual abstraction assessment” were to be filled in.

The GPS coordinates were taken directly at the point of abstraction. The longitude and latitude were taken in decimal degrees and the altitude in m.a.s.l. using the Arc 1960 datum.

The water abstraction assessment was an important part of the survey, it was also the most difficult part of the survey. Because water is abstracted from different sources as lakes, rivers and groundwater aquifers, using different methods, such as piped- or open water systems. If a measuring device was installed in the abstraction works and a record of abstraction volumes was available the average daily abstraction could be calculated. Often no measuring device was installed; in such cases an abstraction assessment needed to be made. Basically there are two approaches to do this; supply and demand based.

The supply-based method was done using flow measurements in open streams, or volume metric measurements in piped systems. The volume metric method measures the outflow of pipe for a certain time period, using a bucket with a known volume. The time it takes to fill the bucket gives the capacity of the gravity pipe or pump in volume per time. This value multiplied by the total usage time per day gives the actual amount abstracted per day. The volume metric measurement was done at least 3 times in a row to minimize errors. The flow measurement in open water systems was done using a current meter or a v-notch. Using the current meter a measurement could be done in the intake channel it self, if that was not possible a measurement upstream and one downstream of the intake could be used to calculate the abstraction. This type of measurement proved not to be very accurate during the survey in the Lake Naivasha basin, mainly because the abstraction amount was small in most of the cases compared to the total flow in the river, secondly a flow measurement using a current meter contains already a significant error itself, especially when used under non-steady flow conditions.

The demand-based approach assesses the demand of water for irrigation, livestock or people. If an abstractor was irrigating, the area under irrigation can be multiplied with the standard water requirement of 60 m^3/day/ha. For more precise calculations irrigation method, crop type and soil type and weather conditions are needed. The water requirements for livestock were assessed using standard requirements. Every Livestock Unit (LU) requires 50 litres per day. One LU is equivalent to: “1 grade cow, 3 indigenous

cows, 15 sheep or goats or 5 donkeys". The water requirements for domestic use were assessed taking the amount of people and determining the consumption rate per person per day.

As I only went to the field for data collection in the last two weeks of the survey, with the actual purpose of getting a clear idea about how the survey was done, my involvement was not very extensive in the data collection part. On the contrary I was mainly executing the data processing, analysing, presentation and sharing parts as explained below.

2.2 Data Processing

All the data from the questionnaires needed to be processed into a digital database, to enable analysis, sharing, easy updating and exchange with GIS programs. Excel was the most convenient program to do this, because of it's easy to use interface and it's a commonly used database program. Details of each abstraction point were processed using a standardized naming system, to make the details suitable for analysis. Details on permit, like authorized abstraction and permit number were also refined using information from office files. By using this digital database it was also possible to easily assess gaps in the collected information.

Knowing the spatial locations of each abstraction point also enabled clustering of these points into specific WRUAs. The Lake Naivasha Basin contains a total of 12 WRUAs (Annex III). The boundaries of the WRUAs are based on drainage boundaries.

The main challenge during data processing was to find a good balance between suitability for analysis and specific information for each data attribute. It was impossible to analyse for example abstraction method without a simple indication, while in the field all kind of details were taken. When processing the data from the questionnaires each questionnaire was coded and this code was also linked to the sheet, so later on things could easily be checked. This ID-code was also used on the GIS maps, as with printed maps all information is not digital available anymore. The ID-code linked to a printed sheet or the excel file.

2.3 Data Analysis

After processing each point into a WRUA and refining the attribute data, the analysis was done in excel. In the analysis only the points in use were taken into account. The main part of the analysis corresponds with the WAS objectives 2 to 5 (Annex II). The output of the analysis gives: numbers, amounts and / or percentages of a certain feature.

During the analysis WRMA assisted to ensure that the analysis took place in a correct manner. What the actual analysis contained will become clear in the results. The constraints experienced during the survey will be discussed in chapter 0.

2.4 Data Presentation

As analysing of the data was a complex process the purpose of the data presentation was to overcome this complexity and present the analysis in a clear, understandable and complete manner. Therefore most of the analysis output is visually presented to enable quick interpreting of specific features and how they compare to each other. Next to this GIS maps have been developed with all abstraction points indicated on it. A presentation of and workshop on the whole process and results has been held on 9th July in Naivasha with WRMA and WWF as host. Several stakeholders were invited to this namely: Ministry of Water and Irrigation, WRMA Head Quarters, six regional WRMA offices, Water services Board (WSB), Water Service Trust Fund (WSTF), Catchment Area Advisory Committee (CAAC) region Nakuru, Lake Naivasha basin WRUAs, Several NGOs (SNV, WWF, Care Kenya, World Bank), the District Commissioner and Rural Focus (WAP consultant). A total of ± 70 people joined the presentation and workshop program.

In the actual presentation of the data especially some focus was put on the difference between the Lake Naivasha WRUA and the Upper Catchment. The activities related to water differ significant between these two areas. Therefore in the presentation of the results the Lake Naivasha WRUA is compared to the Upper Catchment in terms of abstraction amounts, and compliance to water legislative framework.

Next to presentation on this stakeholder meeting, the results have also been presented to each WRUA individually and in this internship report.

2.5 Data Sharing

Part of the objective of the internship was to build capacity to the WRUAs. In that light all the data of each specific WRUA has been made available to that specific WRUA in the form of a report, GIS map and data sheet (printed and digital when possible). Next to this data has been shared with Rural Focus to enable them in refining the WAP for the Lake Naivasha Basin.

3 Results

3.1 Basin Map

In Annex III a map of the Lake Naivasha Basin is shown, the map shows the basin boundary, WRUA boundaries within the basin (both based on hydrological boundaries), drainage pattern, regular gauging stations (2G..), places and some other information.

The maps show the Mariba WRUA on the bottom-left side, no rivers are draining into the lake from this side. Becht and Nyaoro (2006) argue that the lake is recharged with a groundwater inflow from this side.

The Upper Gilgil WRUA is located at the top-left side. The streams Morendat and Kiriundu/Gilgil drain into the Lower Gilgil WRUA were they confluence to the main Gilgil River. In the Lower Gilgil WRUA Little Gilgil stream flows into the Gilgil River. The Gilgil River passes through Lake Naivasha WRUA (LaNaWRUA) before it drains into the lake.

Wanjohi WRUA and Upper Malewa WRUA are located at the top-right side. The Wanjohi River flowing in the Wanjohi WRUA has it sources on the Aberdare Mountains. Just after the Wanjohi river discharges into Upper Malewa WRUA it confluences with the Malewa River. The Malewa River flows into the Middle Malewa WRUA, and further downstream into the Lower Malewa WRUA and LaNaWRUA before it discharges into the lake. On its way to the lake some other rivers / streams drain into the Malewa river. The biggest river draining into the Malewa River is the Turasha River.

The Turasha River has it sources in the Aberdare and Kipipiri mountains. From the Upper Turasha WRUA the Turasha River flows into the Mkungi Kitiri WRUA. The Mkungi River and Kitiri River drain into the Turasha. Just before the Turasha River discharges into the Lower Malewa WRUA and the Malewa River, Kianjogu River originating from Kianjogu WRUA drains into the Turasha River.

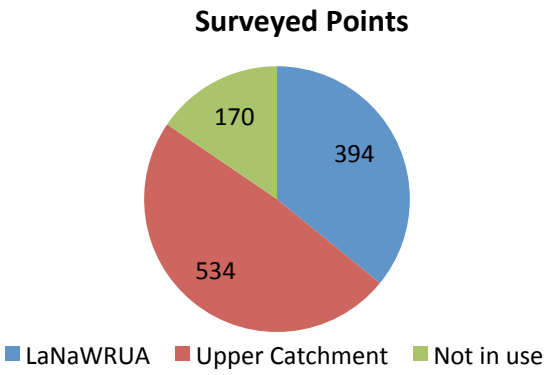
Karati-Longonot WRUA is located at the bottom-right side. Karati River, which is a seasonal river, drains from this area into the LaNaWRUA and into the lake.

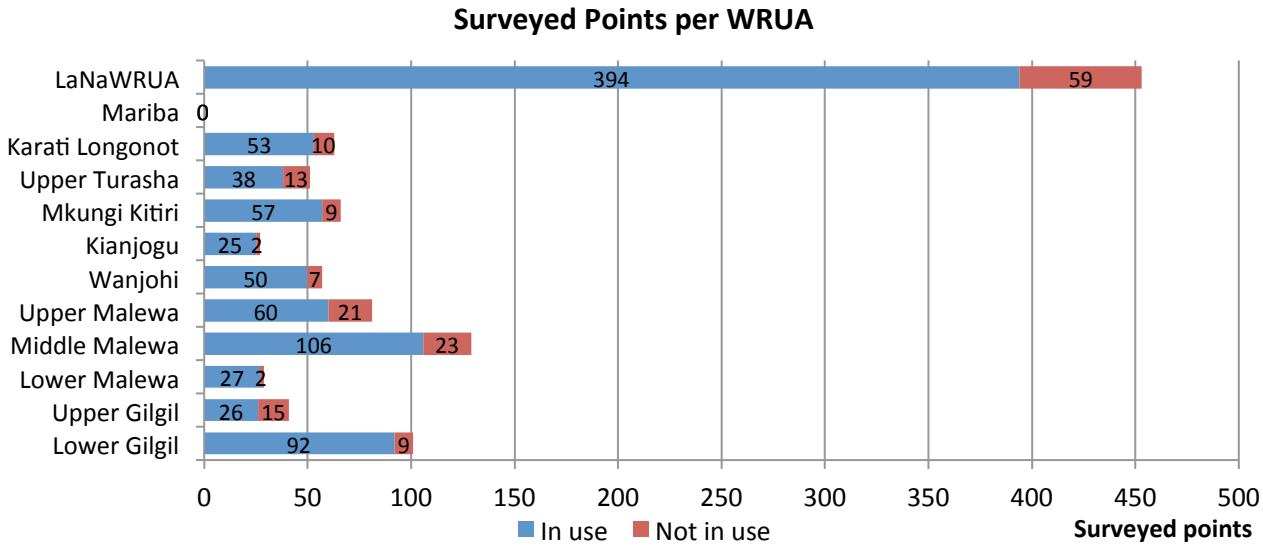
LaNaWRUA is located at the bottom-middle part of the basin. In contrary to the other WRUA boundaries the boundary of LaNaWRUA is not based solely on hydrological boundaries. The 2000 m.a.s.l. contour is taken as boundary with the surrounding WRUAs, this gives some implications in the Lower Gilgil and Lower Malewa WRUAs. Because the 2000 m.a.s.l. contour follows the Gilgil and Malewa rivers quit far into these WRUAs. The concerned WRUAs boards agreed that groundwater abstractions within the 2000 m.a.s.l. contour are within the managing jurisdiction of the LaNaWRUA, for the management of river water abstractions the cut-off boundary is taken as shown on the map. The reasoning behind this is that for groundwater abstractions within the 2000 m.a.s.l. contour different regulation apply than to those outside that boundary.

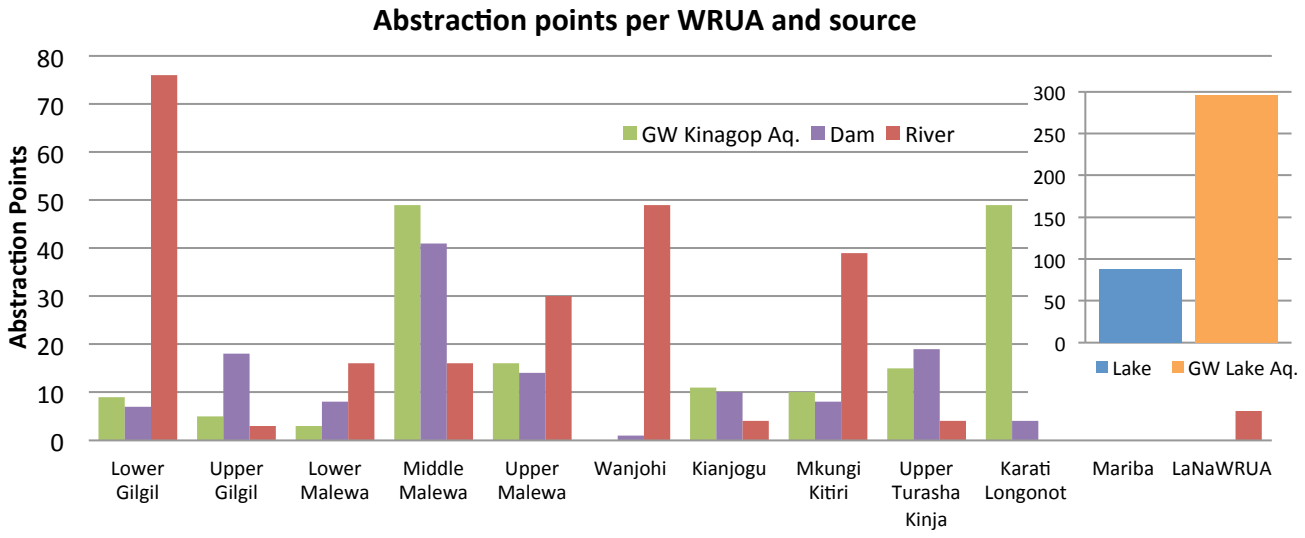
In the analysis LaNaWRUA is often compared to the other 11 WRUAs in the basin the cluster name used for this 11 WRUAs is the Upper Catchment.

3.2 Abstraction points

During the WAS 1098 water abstraction points have been identified of which 534 are in use in the Upper Catchment, 394 are in use in LaNaWRUA and in the whole basin 170 are not in use. The points not in use can be capped boreholes, closed or abandoned abstraction works. In the graph below the points in use and not in use are shown per WRUA. Within Mariba WRUA no points are surveyed. Opinions about this differ, because of a boundary issue between Mariba WRUA and LaNaWRUA. Also the survey was more focused on the upper part of the catchment than on the Mariba WRUA, therefore some abstraction points might not be included in the survey.





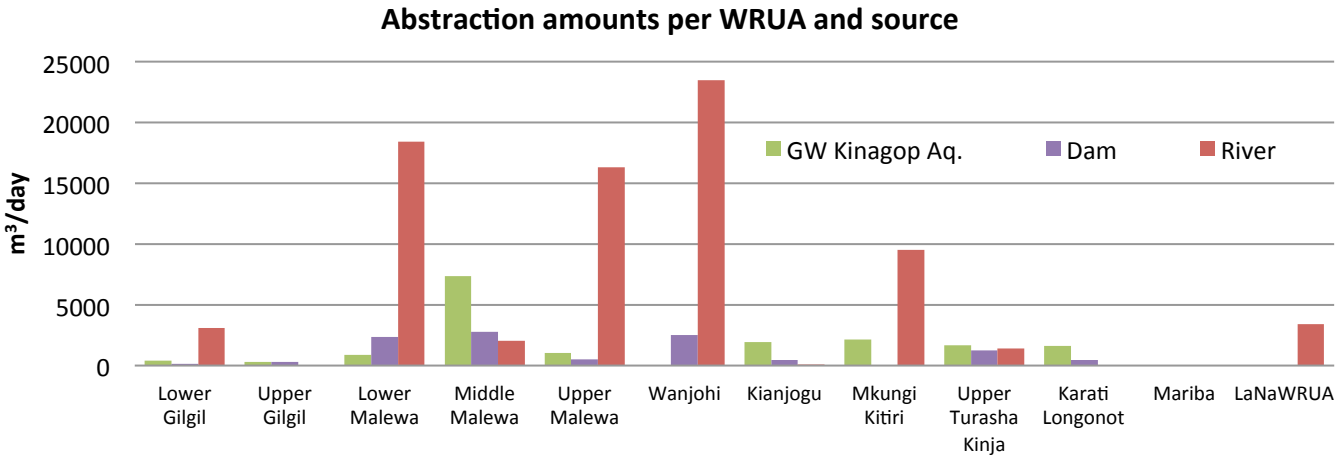


In the graph above, where groundwater and lake abstractions in LaNaWRUA are pasted in as an extra graph because of a scale issue. It can be seen that most of the river abstraction points are in the Lower Gilgil, Wanjohi, Mkungi Kitiri and Upper Malewa WRUAs. Abstractions from dams can be summed up together with river abstractions, because the dams are mostly situated in small streams that drain into the rivers. In that

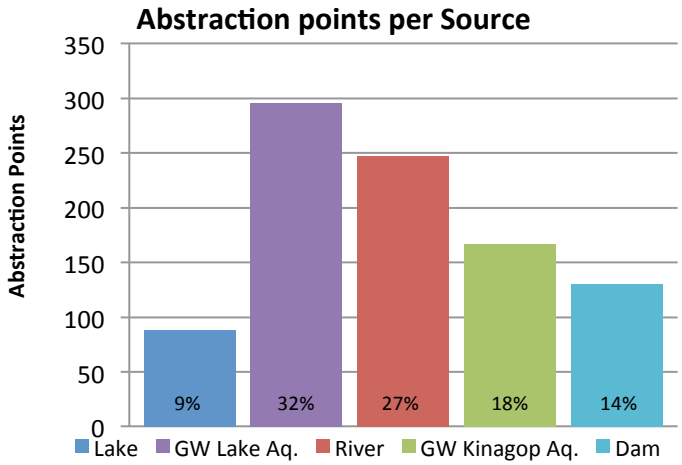
case the number of river abstractions is also relative large in Middle Malewa WRUA. The relative high number of river abstractions in Lower Gilgil WRUA is remarkable, because it is a small WRUA and the Gilgil River is not a very big river that can even fall almost dry in some years. During the survey a lot of small-scale farmers with portable pumps have been identified in this area. Numbers of abstraction points might therefore be relative large, but the abstraction amount doesn't have to be large. This will be dealt with in the next paragraph

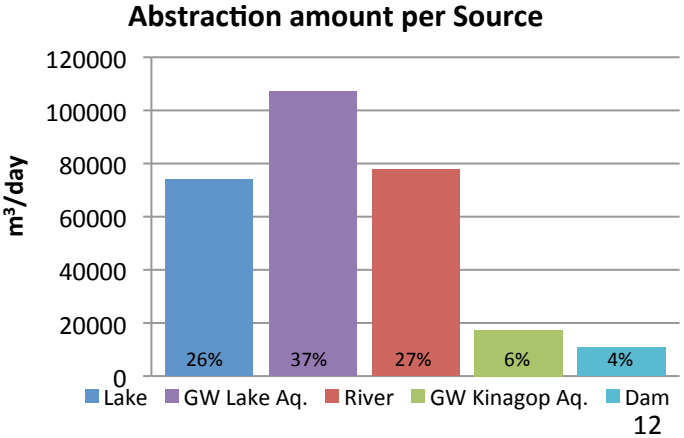
Groundwater abstractions in the Upper Catchment are from the Kinagop aquifer, which is a collective noun for the aquifers in the Upper Catchment. High number of groundwater abstractions can be found in LaNaWRUA and in Middle Malewa and Karati-Longonot WRUA. Compared to the size of the WRUA abstractions are most densely in the LaNaWRUA. This is not very remarkable because most economic activities related to water are also situated in this area.

3.3 Abstraction amounts



It is very clear from the graph above that in the Upper Catchment most water is abstracted from the rivers. The main reason behind this is that a lot of gravity systems are in place in the mountainous regions. Such systems consist of a weir in a stream with a pipe in it, that transports the water by gravity to villages and farmers downhill, sometimes on a continuous basis. The reason for the high river abstraction in Lower Malewa WRUA is different. Just before the confluence of the Turasha River with the Malewa River the so-called Turasha dam is in place, which delivers drinking water to Nakuru, which is outside the Lake Naivasha basin, and to some other cities. It is estimated that this single abstraction accounts for 16.000 m^3/day, which is 20% of the total river abstraction in the basin.

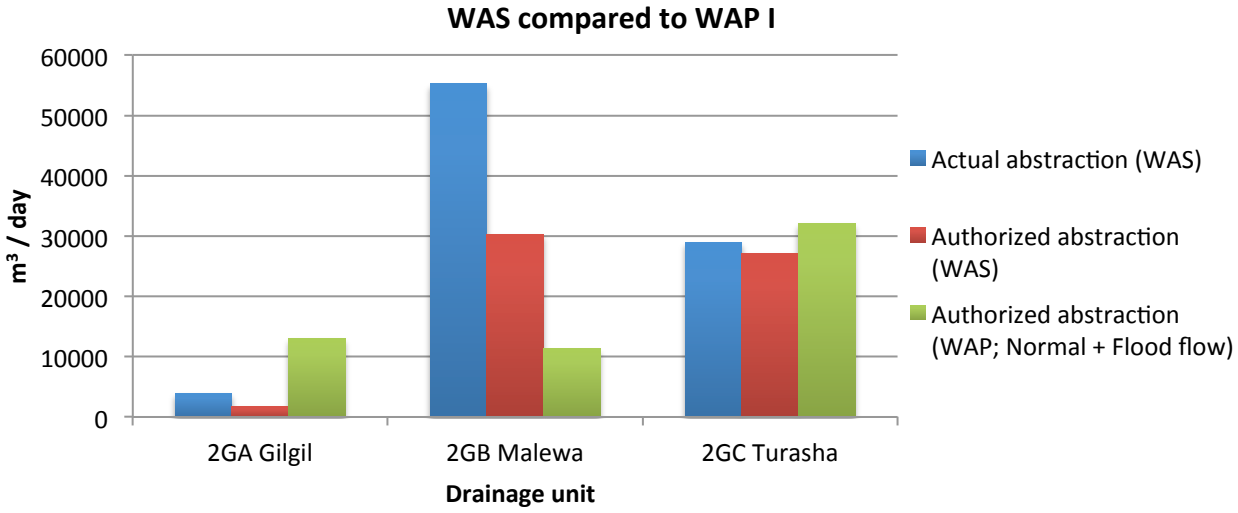




Abstraction in the LaNaWRUA including abstraction from rivers, the lake and the lake groundwater aquifer accounts for 64 % of the total abstraction in the whole basin. Groundwater abstraction on the north side of the lake is

contributing the most to this number. Analysing the lake abstractions with this graphs shows that compared to other sources a relative small amount of abstraction points accounts for a relative large abstraction. This can be explained because around the lake there are mainly large scale farmers that abstract water in large quantities (see Annex V). Groundwater abstraction in the Upper Catchment and abstraction from dams is relatively small compared to abstraction from the Lake, groundwater within LaNaWRUA (GW Lake Aq.) and rivers.

In the WAP (WRMA, 2009) the water balance indicates the allocation of resources from the different river units or the so-called drainage units, which are 2GA Gilgil, 2GB Malewa and 2GC Turasha. A schematic picture of these drainage units can be found in Annex VIII. The authorized or allocated abstraction from these drainage units in the WAP is based on old permit records from MWI. The WAP makes a distinction in allocation from normal and flood flow, abstraction from normal flow may only be used for domestic purposes while abstraction from flood flow can be used to irrigate. The normal flow is indicated as flow between the Q80 and Q95 thresholds and flood flow between Q50 and Q80 thresholds, the flow below the Q95 threshold is the reserve below this threshold domestic abstraction is limited to 50% of the normal abstraction. The Q95 threshold is the amount of water that on average will at least flow 95% of the time in a year through a specific place in the river, this value is derived from a flow duration curve. The same applies to the Q80 and Q50 thresholds. The graph below shows the total actual abstraction and authorized abstraction in each drainage unit as derived by the WAS. This is compared to the sum of normal and flood flow indicated in the WAP. While for the drainage unit 2GC figures are quite in line with each other. For 2GA the WAP indicates a significant larger amount of authorized abstraction than the authorized and actual abstraction derived by the WAS. For 2GB it is the other way around, the WAP has indicated a significant smaller amount of authorized abstraction than the authorized and actual abstraction derived by the WAS.

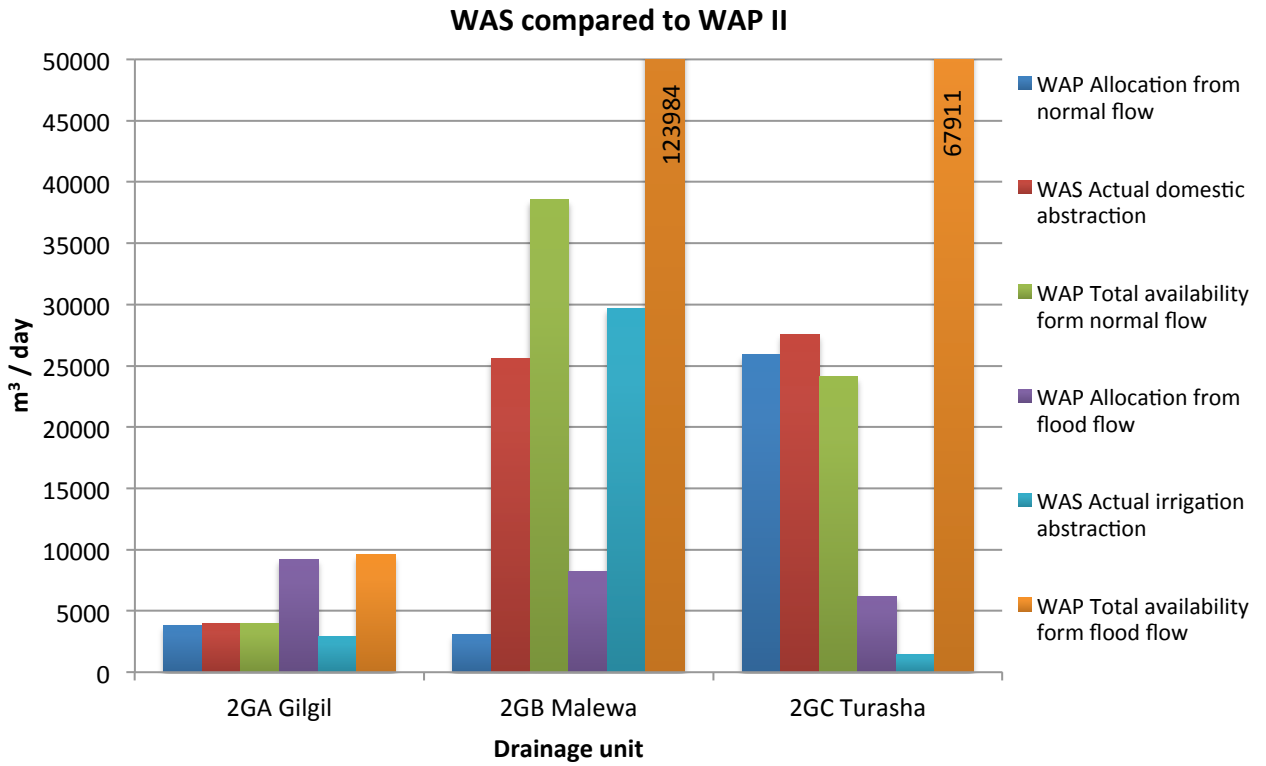


The graph "WAS compared to WAP II" is more detailed on the distinction between normal and flood flow. For each drainage unit the in the WAP indicated allocation and availability from normal and flood flow values have been compared with the WAS results wherein the actual abstraction is split up in abstraction for domestic and irrigation purposes. In this manner the allocation and availability from normal flow as indicated in the WAP can be compared to actual abstraction for domestic purposes, the same applies to allocation and availability from flood flow and actual abstraction for irrigation.

For drainage unit 2GA Gilgil the actual domestic abstraction is at the same level as the resource availability from normal flow. According to this there is no water available anymore for allocation from normal flow. Abstraction for irrigation has not yet reached the flood flow threshold, the difficulty is that abstractions for domestic and irrigation purposes are not clearly separated in the WAS and on top of that abstractors are not always complying to rules of when and how much water they can abstract. It is logical that exactly during dry periods farmers will abstract water for irrigation, but this will most probably also be the period without flood flow.

The same argument as explained here above is applicable to drainage unit 2GB Malewa. The normal flow threshold is not yet exceeded by domestic abstraction, but adding abstraction for irrigation on top of this it can be exceeded. With the fact in mind that almost no farmers have sufficient storage facility (chapter 3.7) it can be assumed that abstraction for irrigation will take place during normal flow periods. In the WAP it is also stated that the Gilgil and Malewa river experience periods of very low flow, in which the reserve is not being respected.

In drainage unit 2GC the situation is slightly different, actual abstraction for domestic use is already exceeding the normal flow availability. The other difference with the other two drainage units is that there is hardly any abstraction for irrigation. It is argued that the land in drainage unit 2GC is less suitable for cultivation and irrigation than the land in the other areas, which can be an explanation of the low abstractions for irrigation.



A comment that needs to be made about the above stated analysis is that for the establishment of the reserve, normal and flood flow thresholds old data has been used. It can be assumed that especially because of land use changes these thresholds have shifted. A proposed thesis research by the author of this document is going into more detail on this topic.

As the purpose of the water balance in the WAP with the indicated allocation amounts is that it supports in decision making for new permits. It is very important that the indicated flow thresholds are correct. Otherwise decisions will be made based on possible wrong theoretical assessments of resource availability.

In the WAP no water balance for Lake Naivasha or groundwater aquifers is indicated therefore it wasn't possible to compare lake water and ground water abstractions as derived from the WAS with the resource availability.

3.4 Legal status

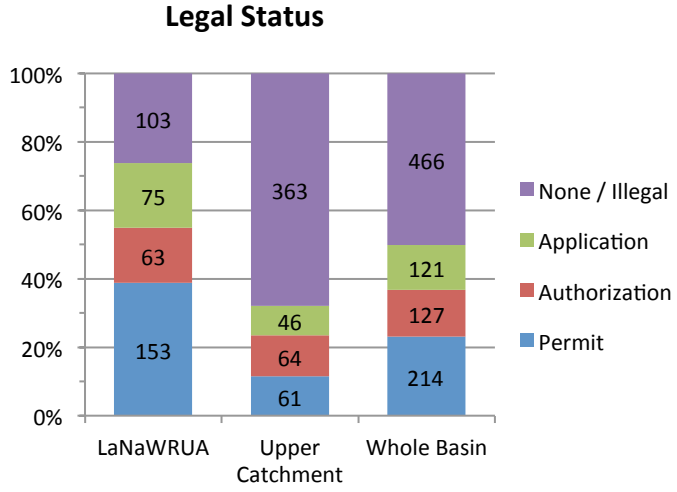
One of the main objectives of the water abstraction survey was to get a clear view on the compliance status of all water abstractors / abstraction points to the water legislative framework? At each point it is indicated if the abstractor has a permit to abstract water. There are two different types of permits: an authorization allows an abstractor to build abstraction works, after inspection by WRMA and/or the WRUA if the

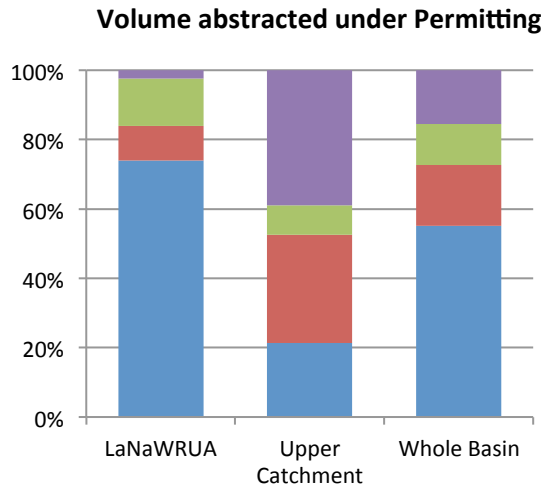
abstractor complied with the construction details. A permit can be issued that allows the abstractor to really abstract the water. Such a permit is valid for a 5-year period after which renewal is required. This paragraph will show the results on permit coverage and on the status of these permits.

3.4.1 Permit Coverage

Out of the 928 points in the whole basin 214 points (23%) have a permit to abstract water, 127 points (14%) have an authorization to construct abstraction works and 121 points (13%) have a pending application. Which can be both an application for authorization to construct works or an application for a permit to abstract water. Conclusion from this is that 50% of the abstraction points in the Lake Navaisha basin have a legal status. But out of these 50% only 8% is valid while other 42% out of this 50% are expired permits, expired authorizations or pending applications. Valid means that the abstractor has a permit to abstract water, which is not expired. The remaining 466 (50%) abstraction points in the basin don't have any form of legal status and are illegal. The bar graph on the left shows how the legal status of the LaNaWRUA, the Upper Catchment and the Whole Basin compare to each other.

Comparing LaNaWRUA with the Upper Catchment substantial differences can be derived. In the LaNaWRUA 74% of the points have some kind of legal status (permit, authorization or application), compared to a value of 32% in the Upper Catchment. The percentage of valid permits in relation to all abstraction points is 14% in LaNaWRUA compared to 3% in the Upper Catchment. Conclusion that in both areas the valid permit coverage is remarkable low. This is one way of analysing the legal status another way is to look at abstraction amounts under permitting instead of abstraction points.





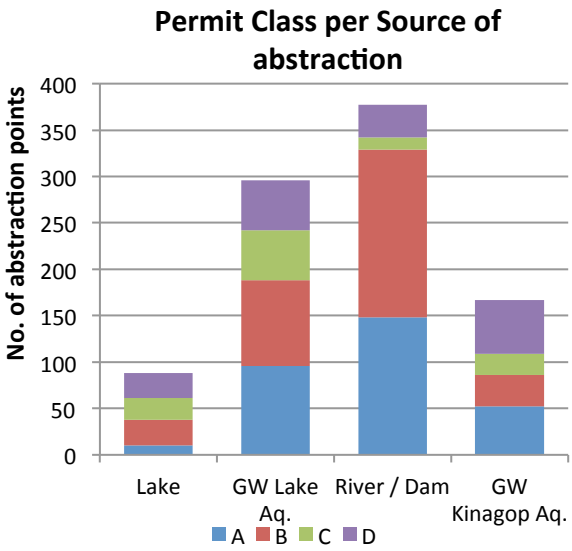
To avoid confusion, the bar-graph showing "volume abstracted under permitting" shows the volume abstracted within each type of legal status. It is not about permitted volumes, that information will be given further one in this report. A first conclusion that can be drawn from this bar graph is that 55% of the volume in the whole basin is abstracted under permission. If you include authorizations and application this figure rises to 85%. Volume abstracted under valid permits is 21%. Again if you compare the LaNaWRUA with the Upper Catchment it can be concluded that within LaNaWRUA more water is abstracted on a legal basis.

The Performance Contract (2009-2010) of WRMA states in paragraph D3 the target: *"Regulate and control water use (Deadline June 2010)." This will be achieved by; "Increasing the level of compliance on issuance of permits for regulation of water use to 80% by volume of water abstracted."*

Comparing this to the 21% value of volume abstracted under valid permits that rises from the water abstraction survey, it can be concluded that there is still a long way to go before the 80% target is reached.

3.4.2 Permit Classification

When looking to permit classification there are 4 classifications: "A, B, C and D". The classification is based on source of abstraction and after that on the amount abstracted. Annex VII shows the permit thresholds in detail for the different abstraction sources. During the survey the WRMA officers indicated a permit class, which is based on source and authorized amount abstracted, because this information was not available for all points. The permit class is also calculated for each point based on source and actual abstraction.

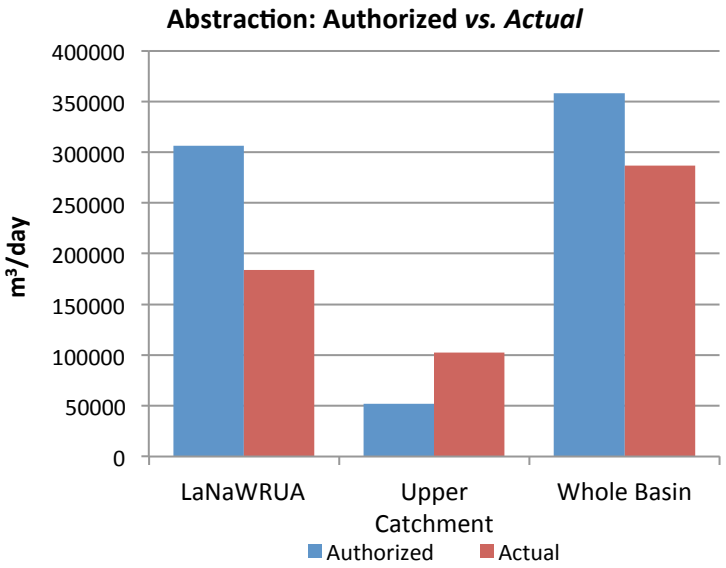


The indicated and calculated permit classifications are combined using the calculated as none was indicated otherwise the indicated is used unless the calculated class was higher than the indicated class. The bar graph on the right shows this combined classification for each source of abstraction.

Going back to permit coverage, with this information on permit classification, it can be concluded that only 21% of the big abstractors in terms of quantity, which are the permit class D and C abstractors from the rivers, lake and groundwater aquifer around the lake, have a valid permit.

3.5 Permit Compliance

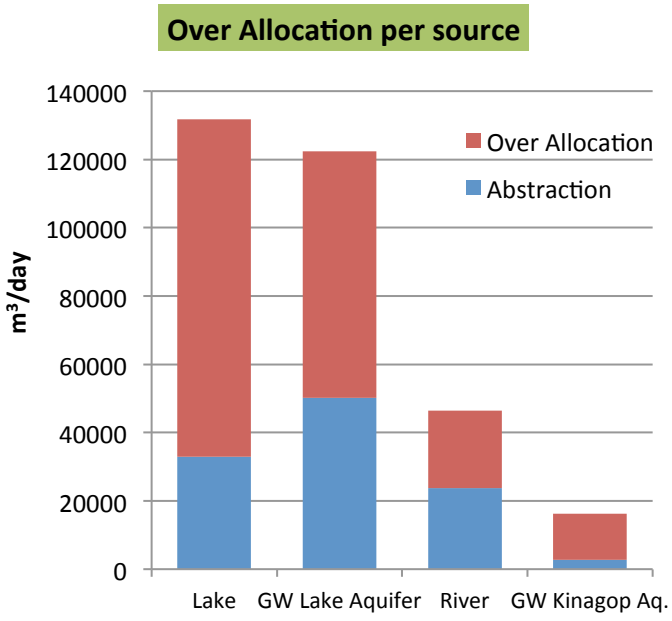
Each abstraction point with a permit is allocated or authorized a certain amount of water that it can abstract per day. The bar graph on the right compares this authorized amount with the actual abstraction. In the authorized amount expired permits and authorizations are included. Points with a permit or authorization that are not in use are not included. The bar graph shows that within the whole basin 80% of what is authorized is abstracted. This percentage indicates that there is over allocation at some points. The authorized amount for points not in use, which is $34 \cdot 10^3$ m^3/day, is not included in the graph and above percentage.



The difference between LaNaWRUA and the Upper Catchment is clear in this figure as in the LaNaWRUA 60% of what is authorized is actually abstracted in the Upper Catchment it's more or less the other way around, 50% of what is actually abstracted is authorized.

To give better and more detailed insight in allocated amounts versus the actual abstraction. A distinction is made between points that abstract less than the allocated amount and points that abstract more than the allocated amount. In this analysis not all abstraction points are included because not for all points an allocated amount is indicated. This can be because they don't have a permit or some permit details were missing during the analysis.

Abstractions from the lake, from groundwater aquifers around the lake, from rivers and from groundwater aquifers in the Upper Catchment are analysed separately. Abstractions from dams are not included in this analysis because the problem of over- allocation and abstraction is not occurring in significant proportions with dams. This analysis is not 100% correct because for some abstraction points of one abstractor the total abstraction is taken together instead of the exact amount per abstraction point. This gives some inconvenience because a permit, with an authorized abstraction amount, is linked to a single abstraction point. But still it gives a good indication on the current status of over allocation / abstraction from the different sources in the basin.



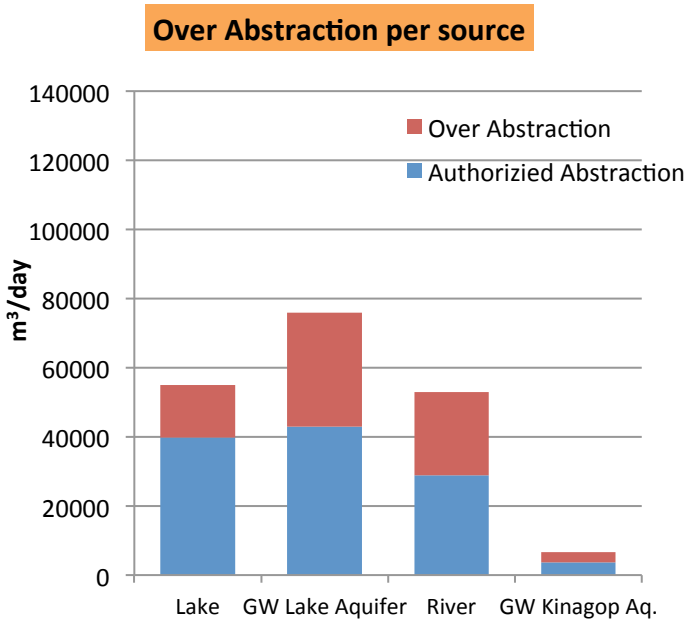


Table 1: Over- allocation and abstraction

		Lake	GW Lake aq.	Rivers	GW Kinagop aq.	Total
	Total abstraction points	88	296	247	167	798
	Total abstraction ($\cdot 10^3$)(m^3/day)	74	107	78	17	276
Over Allocation	Points were: Actual abstraction ≤ Allocated abstraction	58	118	42	40	258
	Abstraction ($\cdot 10^3$)(m^3/day)	33	50	24	3	110
	Allocation ($\cdot 10^3$)(m^3/day)	132	122	47	16	317
	Over Allocation ($\cdot 10^3$)(m^3/day)	99	72	23	13	207
	Over Allocation (%) (Over Allocation / Abstraction x 100%)	300 %	144 %	96 %	433 %	188 %
Over Abstraction	Points were: Actual abstraction > Allocated abstraction	19	44	51	10	124
	Abstracted ($\cdot 10^3$)(m^3/day)	40	43	29	4	116
	Allocated ($\cdot 10^3$)(m^3/day)	25	10	5	1	41
	Over Abstracted ($\cdot 10^3$)(m^3/day)	15	33	24	3	75
	Over Abstraction (%) (Over abstraction / Allocation x 100%)	60 %	330 %	480 %	300 %	183 %
	Points not applicable	11	134	154	117	416

The bar graphs and Table 1 about over- allocation and abstraction indicates at quit a number of abstraction points some huge differences between allocated and abstracted amounts. It is true that in practice it's difficult for WRMA to allocate a right amount to an abstraction point, a bit of over allocation is therefore not

rare. But the numbers shown here are somewhat out of range, for example: 99 · 10^3 m^3/day is over allocated to abstraction points around the lake this is more (133 %) than the total actual abstraction from the lake. The same can be concluded in relation to groundwater abstractions around the lake and to a lesses extent about river abstractions. Over allocation is not a problem as long as the abstractors are not increasing their abstraction compared to their current actual abstraction, it can become a problem if abstractors are expanding their activities and therefore will increase their water use.

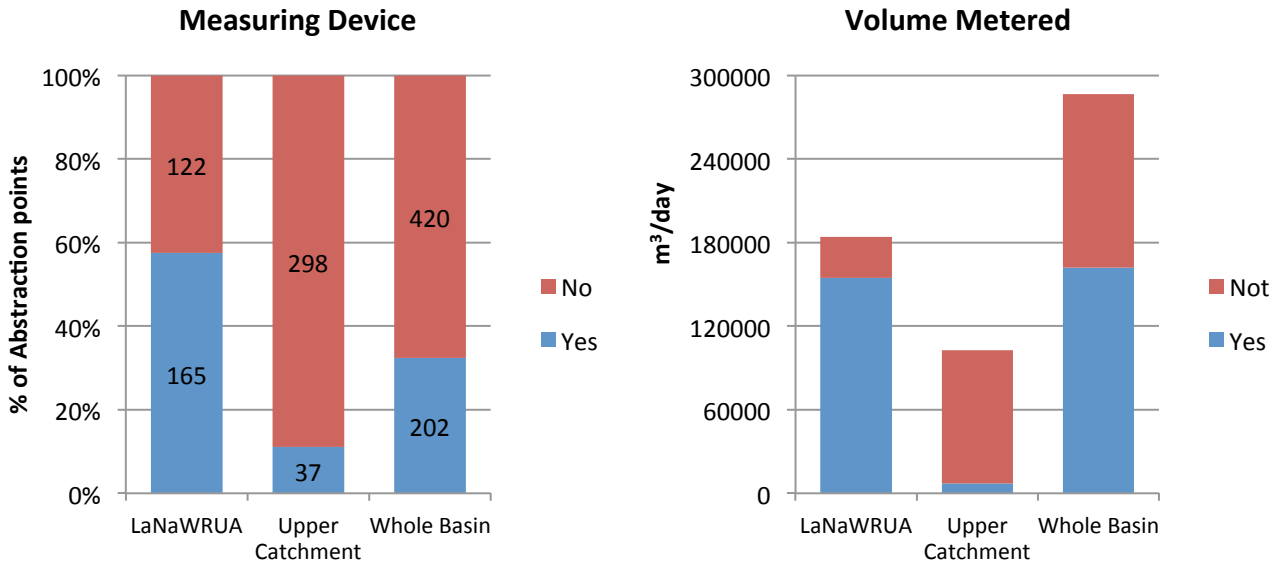
Over abstraction is at less abstraction points occurring than over allocation and also total over abstracted quantity is smaller than the over allocated quantity. Still the over abstraction percentages indicates large over abstraction compared to what's permitted for the groundwater aquifer around the lake, the rivers and groundwater aquifers in the Upper Catchment.

As one of the main concerns in the basin is that the water resources are over exploited. WRMA and the WRUAs have to take steps in bringing the abstraction points into compliance with their permits. By either amending the permitted amount to the actual abstraction or by decreasing the actual abstraction in cases of over abstraction. Especially in the LaNaWRUA, where the quantities related to this problem are relatively high, actions are required.

3.6 Measurement compliance

Each abstraction points that falls in permit class "B", "C" or "D", must have a measuring device at the point of abstraction according to the Water Resource Management Rules (2007) (WRM-Rules 2007) of WRMA. Abstraction points that fall in class "A" don't need a measuring device unless WRMA finds it necessary. The bar graph on the left shows the percentages of the points with and without a measuring device (only points that fall within permit class "B", "C" or "D" are included). The bar graph on the right shows the abstracted volume that is metered.

Respectively 57%, 11% and 32% of the points within the LaNaWRUA, the Upper Catchment and the Basin as a whole are metered. The percentage of volume metered is respectively 84%, 7% and 56% for the LaNaWRUA, the Upper Catchment and the Basin as a whole.



Measurement compliance consists of two main parts namely; having a measuring device in place and keeping records of abstraction amounts and sharing of these records with WRMA. This second part enables to monitor the actual abstraction per time period. This is important in relation to permit compliance and revenue collection. Also it will give better insight in abstraction fluctuations throughout the year, which are important parameters in water resource management.

The Performance Contract (2009-2010) of WRMA states in paragraph D3 the target: *"Regulate and control water use (Deadline June 2010)." This will be achieved by; "Increasing the level of compliance on installation of measuring devices for control of water use to 80% by volume of water abstracted."*

Comparing this to the 56% value of volume abstracted with a measuring device in the basin that rises from the water abstraction survey, it can be concluded that the 80% target is not reached. The figure for the LaNaWRUA only indicates that the target is reached. Still having a measuring device in place is only part of the goal, control and regulation of water use is another thing. Also regular monitoring is yet not happening, meter readings are not collected or submitted regularly and if so not analysed. With the WAS a first start is made on monitoring of water abstractions, continuation of this monitoring on a regular basis is required to get better insights in the total abstractions from each source and in fluctuations of this abstractions throughout the year.

3.7 Storage

Storage facility and enough storage capacity are very important for river water abstractors. This to enable irrigation water users to bridge the period during normal flow, when they are not allowed to abstract water from rivers. The WRM-rules (2007) prescribe that water for irrigation purposes can only be abstracted during flood flow.

But even river abstracters that use the water for domestic purposes should have storage facility. They are allowed to abstract during normal flow, but below that level abstraction is also restricted. The chance is 5% that the flow drops below the normal flow threshold.

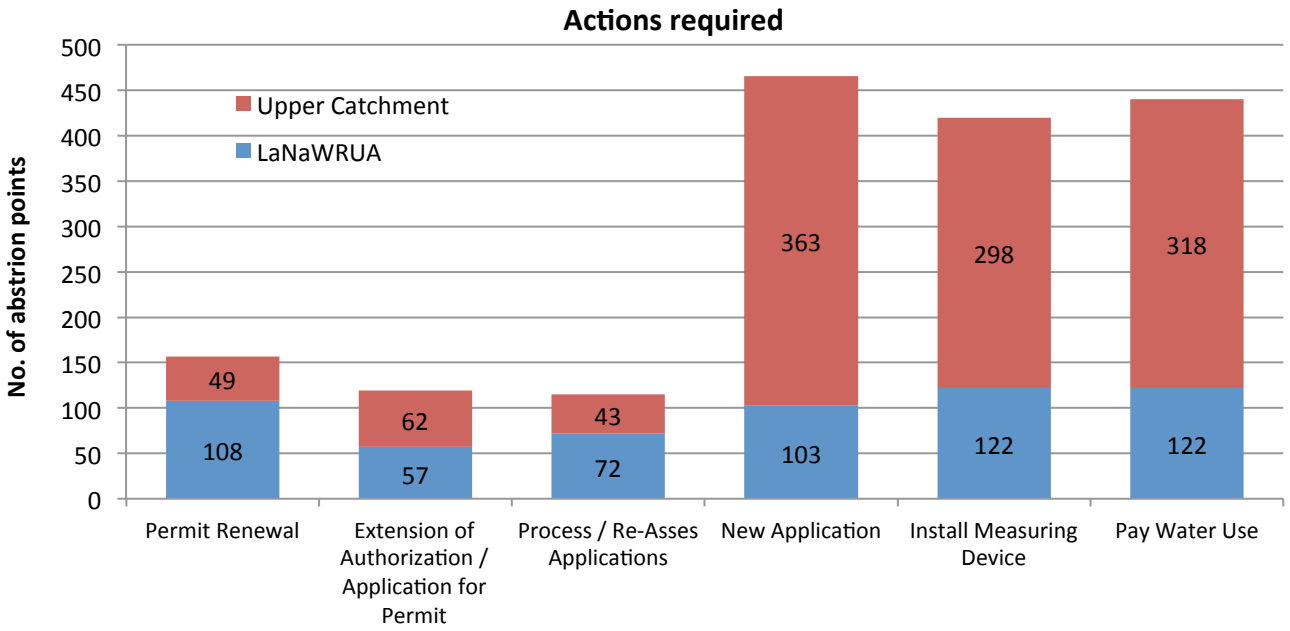
Current figures give no clear indication in exact numbers, because not enough data was collected to do a reliable analysis. What can be concluded from the survey is that storage facilities and related capacities are both more or less abundant in the catchment. It is highly recommended that river water users should look for themselves what action they need to take according to this topic, because if the WRM-rules as prescribed in the WAP are going to be enforced it will have huge consequences in terms of legal water availability for river water abstractors.

3.8 Water use purposes

Accurate indication for each purpose was difficult because at many abstraction points the water is used for multiply purposes. And it is not clearly indicated how much water is used for each specific purpose. For 483 points the purpose is mainly domestic (rural water projects and drinking water companies included), for 369 points mainly irrigation and for 76 points mainly commercial. The points with mainly domestic purposes (rural water projects and drinking water companies included), abstract 73 $\cdot 10^3$ m^3/day, that with mainly irrigation purposes 198 $\cdot 10^3$ m^3/day and that with commercial purposes 16 $\cdot 10^3$ m^3/day.

3.9 Actions required

The bar graph below shows the actions required based on the current status of the abstraction points on legalization, measurement and payment compliance.



Permit Renewal: *Abstraction points with expired permits.*
These water users have to apply for permit renewal.

Extension of Authorization / Application for Permit: *Abstraction points with expired authorizations.*
If the construction is still going on, the abstractor has to apply for extension of authorization. If the works are finished and water abstraction already started the abstractor has to apply for a permit.

Process / Re-Asses Application: *Abstraction points with a pending application.*
WRMA should process the recent applications or re-asses the application if it is an out-dated application.

New Application: *Abstraction points without any form of legalisation.*
These water users have to apply for permit. WRMA should process these new applications, taking into account how much water is available for allocation.

Install Measuring Device: *Abstraction points within permit class "B", "C" and "D" without a measuring device.*
These water users have to install a measuring device at the point of abstraction and keep records of the amount of water abstracted.

Pay Water Use: Abstraction points within permit class "B", "C" and "D" were no water use charges are paid.
These water users have to start paying water use according to the metered amount or an assessed amount if no meter is installed.

Continuing on the findings on legal status in chapter 3.4 it is clear that at many abstraction points an action is required to bring the abstractor into compliance with the water legislative framework. In order for WRMA and the WRUAs to be able to control and regulate water abstraction, according to the allocation rules laid out in the WAP, it is important as a first step to have abstractions legalized. Just as important is it that all water users install a water meter and submit water use data to the WRUAs and WRMA. Otherwise WRMA and the WRUAs don't have enough insights in total water usages from the different sources, which is in relation to over exploitation required before new permits can be issued.

The WRUA has great responsibility in enforcement on the above stated actions. WRUA officials should sensitize and monitor compliance of the water users in their WRUA. At the same time WRMA and WRUA already have to make difficult decisions because many abstraction points do and didn't have any form of

legal status. If it is assessed that within specific water sources the maximum allocation amount is already reached points without legalization cannot be legalized without difficulties.

3.10 Revenue collection

WRMA collects revenue from: water use charges, assessment fees for new applications or renewals, permit fees for issuing of new or renewed permits and from fees for water quality analysis.

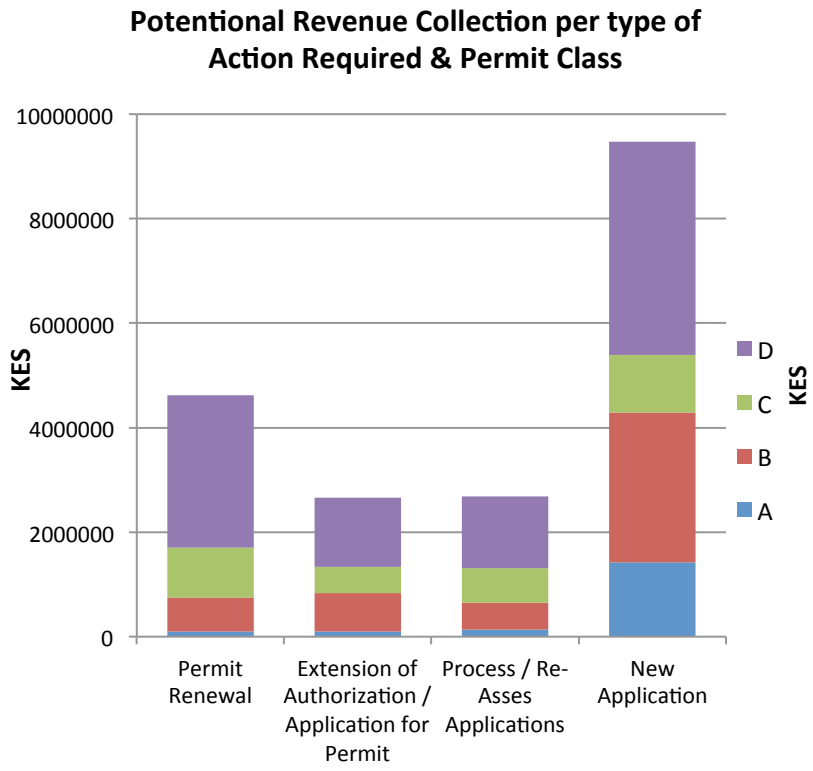
3.10.1 Assessment and permit fees

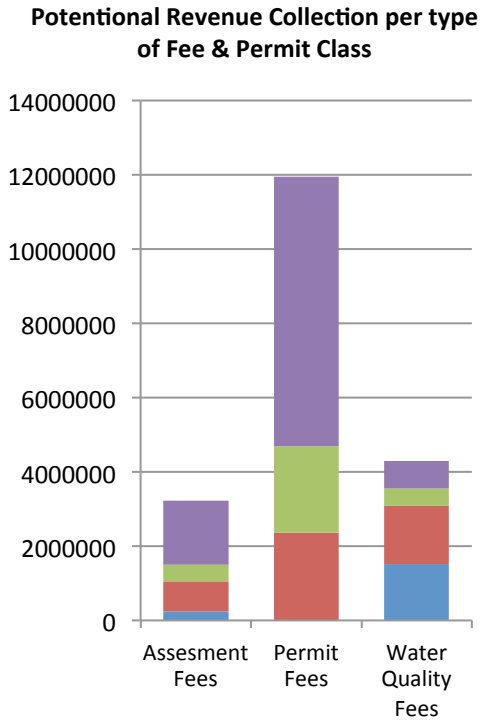
The amount of fee depends on the permit class in which the application or permit falls as shown in Table 2, except for water quality analysis fees, which are always 5000 KES. (100 KES = 1.23 US$ or € 0.90 *(17-2-2010)*)

Table 2: Assessment and permit fees

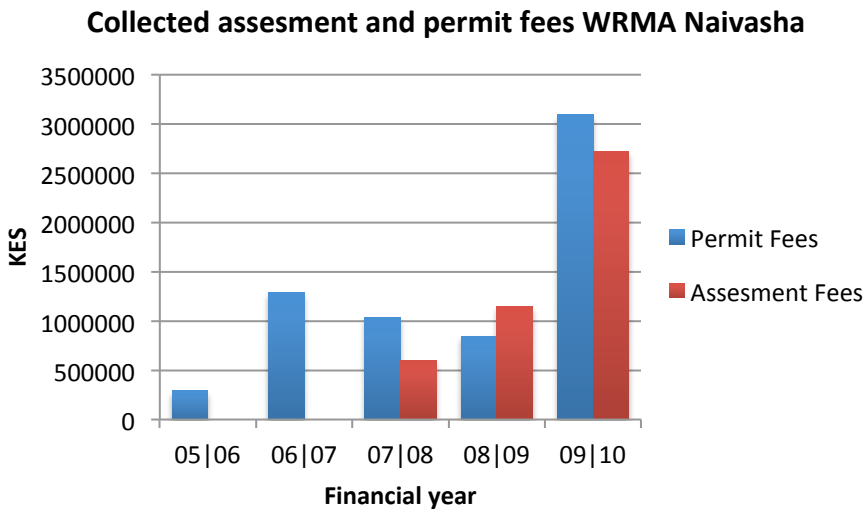
	Permit Class			
	A	B	C	D
Assessment fees (KES)	1.000	5.000	20.000	40.000
Permit fees (KES)	0	7.500	25.000	50.000

To derive the potential revenue on assessment and permit fees. The actions required on legal status from chapter 3.9 can be used as a starting point, out of combining this with the assessment and permit fees the following bar graph on the left is made.





From the graph on the right can be concluded that KES 3.2 million of revenue can be obtained through assessment fees, KES 12 million of revenue can be obtained though permit fees and an additional KES 4.3 million can be obtained though water quality analysis. It should be noted that these are not revenues that return on a yearly basis, a permit is valid for 5 years after that period a permit needs to be renewed whereby permit fees can be obtained. Of the financial years 2005 till 2010 revenue levels in the Lake Naivasha basin from assessment and permit fees are indicated in the graph below. From this graph it can be concluded that in past years already an increase in revenue collection from assessment and permit fees has taken place.

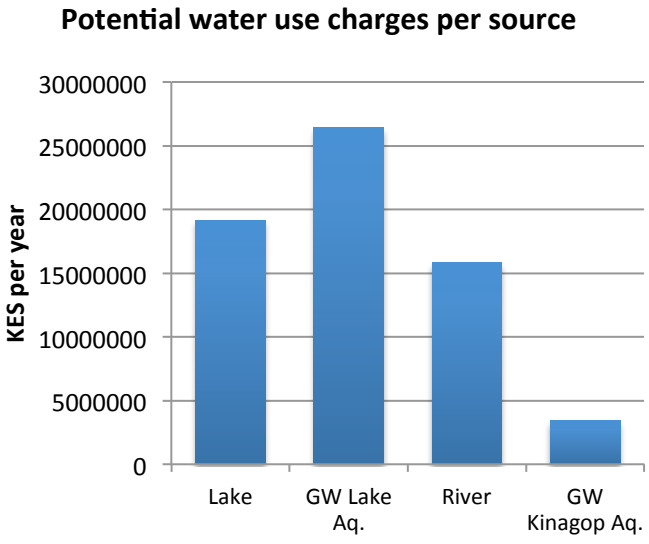


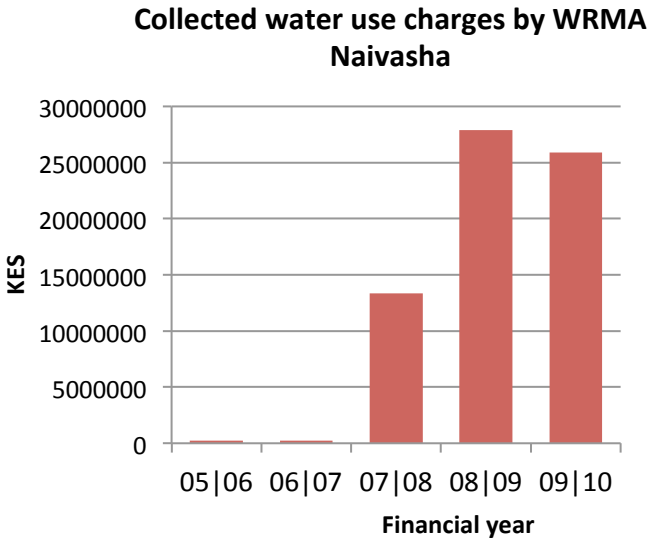
3.10.2 Water use charges

Water use charges have to be paid for the amount of water abstracted. Prices per cubic meter differ according to the purpose of the abstracted water (see Table 3) Water abstractors within permit class A don't have to pay water use charges. A calculation has been made to assess the potential revenue from water use charges in the Lake Naivasha basin. This has been done through combining the actual abstractions with purpose of use and price thresholds as shown in Table 3. Total potential revenue from water use charges is estimated at KES 66 million per year. With respectively KES 46 and 20 million coming from abstractions within LaNaWRUA and the Upper Catchment. The potential revenue for each separate water resource is shown in the bar graph below. The actual revenue from the past years as shown in the graph below, which is around KES 27 million in the last two financial years. Is less than half of the potential revenue estimated for the whole basin. A huge leap can be made here in increasing the revenue collection. Comparing the water use charges with assessment and permit fees it can be concluded that water use charges have more potential to contribute to the revenue collection of WRMA Naivasha.

Table 3: Water use charges per m^3 (KES)

Purpose	Thresholds	
	≤ 300 m^3/d	> 300 m^3/d
Domestic	0.5	0.5
Irrigation	0.5	0.75
Commercial / Industrial	0.5	0.75





3.11 WAS Workshop

On 9th July 2010 a workshop on the Water Abstraction Survey was held. During this workshop, which was organized by WRMA and WWF with support from SNV, the objectives, methodology, results and challenges were presented on fact sheets and by presentation to all invited stakeholders. During the second part of the workshop the results from the water abstraction survey were discussed, group discussions took place and three topics have been discussed, namely: "Gaps in the methodology of the water abstraction survey", "Challenges in enforcement and implementation of water act" and "Role of WRUAs: Challenges and their mandates". At the end of the workshop each group presented the outcome of the discussions and finally the WRMA CEO Eng. Philip Olum emphasized the importance of certain issues and closed the workshop.

3.11.1 Exchange and updating of information

First action that should be taken was sharing the water abstraction survey data with the WRUAs in a usable format. This has been done some few weeks after the workshop, a WRUA specific WAS report with map was presented to each WRUA. WRUA officials should also be trained on data collection necessary for updating and validating the current WAS information. This to enable the WRUAs to provide up to date information to WRMA like: monitoring results of water use and compliance to the water legislative framework.

WRMA should monitor changes in permit coverage and other parameters for each specific WRUA, and communicate this with the WRUAs so that they know which improvements have been made over a certain time period. Ultimately a loop is created between WRMA and the WRUAs, WRMA has to update the current database with the data that the WRUAs deliver, with new information on the legal status and payment status. This loop should be continuous in kind and WRMA should deliver an updated data sheet and map with all the abstraction points and an analysis of the data at least once a year.

A shortfall of the WAS is that it didn't cover data collection on the social aspects of water users. Therefore it was, for example, not possible to give a valid level of community awareness on and understanding of the water legislative framework. In future exercises it is important that this kind of research is also done to get better insights in the social mechanisms behind issues on legal status and compliance.

The WRUAs can also contribute in water resource monitoring; they should be continuously involved in reading gauge heights at the regular gauging stations and in communicating the state of the river flows to WRMA.

The WAS results were also to be incorporated in the WAP as soon as possible according to the WAP consultant, WRMA and the WRUAs.

3.11.2 Enforcement of water rules

The WRUAs play or should play a great role in enforcement of the water rules on ground level. They have roles to play in conflict resolution, advice on permit allocations, dissemination of water resources abstraction rules, sensitizing on the unavoidable need for water users to have a permit, have a measuring device and pay for water use. The main issue that arose was that the WRUAs don't have the capacity and don't get the incentives to undertake all these activities. Next to this awareness and recognition of the WRUAs by the community was seen as a bottleneck.

A clear enforcement plan should be made that the WRUAs can work with, it must be understandable and within the (future) capacities of the WRUA. It is the responsibility of WRMA, in cooperation with the WRUAs, to develop this enforcement plan and to set targets on the actions identified. The WRUAs should also be taught on how they can educate the community on direct benefits off good water- and natural resource-management practises. Furthermore the WRUAs need to get more incentives to put energy in enforcing the water rules, for example by creating a return flow of a fixed part of revenue collected from water use charges and application/permit fees. WRMA has to develop an empowerment plan and strategy for this type of self-regulation for the WRUAs. To increase recognition of the WRUAs by the community they should all have an office and WRMA has to do awareness campaigns and official launchings of the WRUAs.

The WRUAs should also try to understand why people are not complying with the water legislative framework and communicate their findings with WRMA. At the same time they can sensitize and create awareness on the water legislative framework. A great tool for doing that would be a simplified version of the Water Act and the WRM-rules, WRMA should supply in this.

3.11.3 Required resources

To undertake the above stated activities on information exchange and enforcement of water rules, the WRUAs need resources (funds, human and equipment). The SCMP funding by the WSTF is the medium through which financial resources can be acquired. The main bottleneck is that most WRUAs don't have an developed SCMP in place and therefore don't get funding, due to low quality of the SCMP, complicated WDC and long process of approval by WRMA and WSTF. Secondly also the human resources are not sufficient; WRUAs need capacity building on social, technical and accounting skills. The WRUAs also need the facilitation and equipment like office space, computers, GPS readers etc.

To increase the processing off the SCMP a strong team should be brought together to draft a SCMP, also a quick feedback mechanism between the WRUAs and the WSTF/WRMA should be created so that required changes to the draft SCMP can be made within a short time. Too increase resources for operational activities; WRMA should support the WRUAs by creating a return flow of the revenue collected from water use charges and permit/application fees. In the process of revenue collection the WRUAs should also be incorporated when possible. The Naivasha basin has been appointed as a pilot for Water Act implementation and thus the need on empowerment for the WRUAs as explained in this paragraph is essential, if the WRUAs want to take up their roles formally and strong. It is important not to look at this required empowerment for the WRUAs as a one-sided supportive relationship between WRMA and the WRUAs. The ideal case is that WRMA should only be doing what the WRUAs cannot be able to do. In such a way the WRUAs are decreasing the workload of WRMA that currently isn't completely fulfilled by WRMA. For example the cost of the WAS were expensive and WRMA officers didn't have time left to stay on track with their normal activities, empowered WRUAs can collect data by themselves and in this manner costs can also be decreased in future exercises.

The public-private partnership was an essential part in the success of the WAS, this should be recognized and continued in developing the capacities of the WRUAs in the basin

3.11.4 WRUA boundary

There is a boundary issue for the Mariba WRUA and LaNaWRUA, it is very important that both parties agree on a final boundary so that it is clear in which WRUA the abstraction points are. Both parties should seek contact with each other and WRMA to discuss the issue and find a good solution.

Also the new format of the boundary between LaNaWRUA, Lower Gilgil and Lower Malewa WRUA, that separates groundwater management from surface water management, should be worked out practically by both parties. So that the roles and responsibilities of each WRUA are clear.

4 Discussion

As the outcome of the WAS is to be used for support in decision-making in water management issues in the Lake Naivasha basin, it is important that the results of the WAS are reliable. At the same time it should be recognized that a close to 100% reliability is not reached. Fieldwork, data processing and analysis were all constrained by several issues. The results should therefore not be taken as absolute values, but as (close) estimates. This chapter will discuss the constraints experienced during the WAS and to what extent these constraints influence the reliability of the WAS results. The WAS results will also be compared to related research done in the Lake Naivasha basin. Finally the way forward on how to use and update the WAS results will be discussed.

4.1 Fieldwork constraints

The field survey took place in two parts; the first part around the lake was done during a dry period wherein the lake level has dropped and consequently the lake water edge has receded substantially. Because of this some abstraction points didn't have access to the lake water anymore. In many cases this was pre-empted by digging canals towards the lakeshore. While in other cases less or no water was abstracted or water users shifted to groundwater abstraction. The conclusion that can be drawn from this in relation to the WAS results, is that the number of abstraction points and the total abstraction amount indicated during the WAS, might be lower than in a period wherein the lake level is higher. And for the same reasoning groundwater abstraction might be indicated higher. During the second part of the survey in the catchment area a big constraint was that the wet season started already when the survey wasn't finished yet. Normally farmers only irrigate during dry periods when rainfall is not sufficient. Many abstraction from rivers and streams are done with portable pumps that are difficult to locate in wet periods when they are not in use. The implication for the WAS results is that the number of abstraction points and total abstraction amount in the catchment area is probably indicated lower than it will be during a normal situation. The extent of this is probably not very big because the abstractions with portable pumps are small compared to the abstractions with gravity systems in the Upper Catchment.

An abstraction survey is an exercise that needs the right resources (funds, technical know how & equipment) to be able to the fieldwork properly. The methods used in the field shouldn't be named "state of the art", in many cases estimates have been used instead of calculations. Also flow measurements with the bucket and stopwatch or with a current flow meter are not very reliable. The estimates are based on interpretations and because three teams were doing the survey and briefing plus communication between teams wasn't always very good, it can be assumed that the estimates which in itself are not completely accurate might also be different between the three teams. In terms of quantity it is difficult to say to what extent this has effect on the WAS results. What can be the case is that the results differ per region or WRUA, because the teams were surveying different regions and so interpretations errors can be made consequently in a particular region.

When visiting an abstraction point it also happened some times that the owner of the abstraction works was not available. Because of this there was often no access in these cases to the permit files. These files could be shared at another time, but this was not always done. Conclusion in this is that more abstraction points than indicated in the WAS results might have some form of legal status. Another issue was that the institutional framework to operationalize the WAS, in cases when water users were not willing to cooperate, was inadequate.

4.2 Data processing and analysis constraints

The questionnaires were not always filled in completely, different units and GPS notations were used, permit details were lacking and no WRUA was indicated on the questionnaire form. This made the data processing a challenging activity. Interpretation was required when things were not clearly indicated, standardization was required to enable analysis, and some gaps needed to be filled with guessing. Because no WRUA was indicated and GPS coordinates were not always correct, the locations of some points is dubious. Also boundary issues between LaNaWRUA and the Mariba, Lower Gilgil and Lower Malewa WRUA and the lately discovered issue between Upper Turasha Kinja WRUA and Mkungi Kitiri wherein a part of the Upper Turasha

Kinja WRUA was indicated as part of the Mkungi Kitiri WRUA made it difficult to process all abstraction points into the correct WRUA area. Due to this a correct analysis per WRUA was difficult.

Permit details were often missing and including office files in the database was a difficult and long-during process that wasn't completely done. Also specific details on authorized amounts per type of use were not indicated. Also the purpose of the actual abstracted water and area under irrigation was not clearly indicated in many cases. The above issues were a big constraint in the comparison with the WAP figures on abstractions from the different drainage units and in the comparison with other related research. Also a good indication of potential revenue collection was constrained by this, which is partly derived by the purpose of the used water.

The processing and analysis of groundwater abstraction points was constrained by the fact that there is no clear indication on boundaries between groundwater aquifers. In the processing and analysis two types of aquifers have been taken into account namely; Kinagop aquifer that represent all the groundwater aquifers in the whole basin except the LaNaWRUA. The actual case is that there are several aquifers in the catchment area. Currently there is one single permit classification for these aquifers as shown in Annex VIII. The other type of aquifer is the Lake aquifer, this shallow aquifer has a strong linkage with the lake due to its high transmissivity, the gradients between the lake and groundwater level are low. When the lake level is higher than the groundwater level in this aquifer it will recharge the lake aquifer and vice versa (Becht & Nyaoro, 2006). It is not clear to what point this aquifer extents from the lake, in the processing and analysis it is assumed that all abstractions within the LaNaWRUA are from the Lake aquifer, in reality this will not be completely true. Still the results can be used, because the large groundwater abstractions in the LaNaWRUA are taking place at the north side of the lake. The linkage with the aquifer north of the lake and the lake is well studied and proven (Becht & Nyaoro, 2006).

A missed opportunity in the analysis is that while all abstraction points are processed into a GIS database no analysis has been done using GIS software. Such an analysis could give better insights into the spatial distribution of the WAS results and the emerging issues.

4.3 Related research

The water resources in the Lake Naivasha basin have been topic of research for many times. In previous research no exact numbers and details of abstraction points are given, but there are abstraction quantities indicated for the lake and the groundwater abstraction around the lake. Becht and Harper (2002) estimated a total human/irrigation abstraction from the lake (for 1990) of 60 million m^3 $year^{-1}$. The WAS indicates a significant lower abstraction rate from the lake of 27 million m^3 $year^{-1}$.

Different recent estimates for groundwater abstraction tend to confirm each other. A rough estimate made during the groundwater study by Rural Focus (2006) using a combination of methods (area under irrigation, current estimated public water supply; and borehole yields and number) came to 59,95 million m^3 $year^{-1}$ ±20%. The results of the WAS indicate an abstraction of almost 40 million m^3 $year^{-1}$, this value is significantly lower than estimates through earlier research. Becht and Harper (2002) estimated the same value as Rural Focus namely 60 million m^3 $year^{-1}$, and even suggested and acknowledge the likelihood that current abstraction is probably higher than this value.

According to this related research the abstraction quantities derived by the WAS are questionable. And should be re-examined before it can give a reliable background for taking management decisions. Details derived by the WAS on other topics such as the legal status are more likely to be reliable, despite there is no earlier research to which it can be compared.

4.4 Way forward

The results of the WAS are acquired and processed with great efforts, both in human and financial terms. Now it should be put into use for managing the water resources in the Lake Naivasha basin in a better way. In managing the water resources WRMA and the WRUAs are strongly relying on each other. WRMA can't

enforce the Water Act (2002) on it's own when looking to the actions required in paragraph 3.9 that sum up to a total of ± 1700 actions on legalizing abstractions, installation of measuring devices and payment of water use. The WRUAs have to play an essential role in this by sensitizing the abstractors on the water legislative framework and the purpose of it. WRUA members should analyse and validate the outputs of the WAS by themselves and draw and communicate their own conclusions. The information can also give a great contribution in the development of or either refining the WRUA specific SCMPs. Furthermore the presented information is not 100% correct and will become less accurate when time moves on and situations change, therefore it is important that the database is updated with information from the WRUAs and WRMA. By doing this changes should be monitored so after each period conclusions can be drawn on the status of water abstraction in each WRUA. It is important that each WRUA starts to work with the presented information to create ownership of the data and to get familiar with all the water users, which are potential members of the WRUA and partners in implementing the SCMP.

Looking to the current capabilities of the WRUAs in the Naivasha basin that range from strong to insufficient. It is required that WRMA comes up with a strategy on how to really get the WRUAs working on what they are supposed to do. A good option can be to gradually increase responsibilities by the WRUAs. This is advisable to generate more water use charges. At the same time it should be recognized that decentralizing such activities could make it less transparent. Also water use differ significant between WRUAs, the idea of a return cash flow as a fixed part of revenue collection is therefore winsome for particular WRUAs will in other WRUAs this would stand for an increase in work without an significant increase in a return cash flow. The issue that most abstractions are downstream wile the conservation measures are needed mostly upstream is another point of attention. Take for example the huge abstraction at the Turasha dam in the Lower Malewa WRUA and the large abstractions around the lake. To increase equitability between WRUAs and to fore come imbalances between the WRUAs it is important that when a certain return cash flow comes into practise it should also be taken into account where the water comes from. Currently a project that deals with this type of issues is the Payment for Environmental Services (PES) program, which is mainly driven by WWF Naivasha and Care Kenya (Gathenya, 2007).

5 Conclusion

The WAS can be seen as a success despite some shortcomings in the methodology, it has given better insights in the current status on abstraction amounts and on the legal status of the abstractions. Next to these factual numbers the whole process of the WAS has lead to a better understanding and cooperation between WRMA, the WRUAs and other organizations. Together it will be an impulse for better and new types of management of the water resources in the Naivasha basin.

Key findings derived during the WAS are that the water abstractions in the LaNaWRUA are most dense and also account for ± $^2/_3$ of the total abstraction in the basin. In the catchment area the total river abstraction is in the same order of magnitude as direct abstractions from the lake, which are both around 27 million m^3 $year^{-1}$. The out of the basin transfer at the Turasha dam accounts for 20% of the total river abstraction in the basin. Comparing the WAS with the WAP on abstraction amounts from rivers it can be concluded that abstraction derived by the WAS is higher than the indicated authorized abstraction in the WAP especially for the Malewa river. Allocation thresholds for domestic supply as indicated in the WAP are also almost reached according to the WAS results.

The permit coverage of the abstraction points is poor, 50 % of the abstraction points do not have any form of legal status, the other 50% of the abstractions have or did have some kind of legal status (Application, Authorization or Permit), but only 8 % of all abstractions currently have a valid permit. This figure is not only low because of many small illegal abstractions. Also out of the big abstractions, which are the permit class D and C abstractions from the rivers, lake and groundwater aquifer around the lake, only 21% have a valid permit. The permit compliance in terms of allocated vs. abstracted quantities differs significant between the LaNaWRUA and the catchment area. While in the LaNaWRUA the allocated amount is almost double the actual abstracted amount, in the catchment area it is the other way around. Looking into detail to permit compliance it can be concluded that at some abstraction points there is huge over allocation and at others huge over abstraction.

Measurement compliance is low in the catchment area were measuring devices are often not installed, this is the opposite for the LaNaWRUA, but the provision of abstraction records to WRMA is also often lacking in the LaNaWRUA. Revenue collection from water use charges can be increased by ± 140% up to 66 million KES.

To bring all abstraction points into compliance with the water legislative framework a total of ± 1700 actions are required on legalizing abstractions, installing measuring devices and payment for water use. On average this is 1,85 action per abstraction point. The WRUAs have an important role to play in this, during the workshop about the WAS it came clear that the WRUAs need to be empowered before they can fully take up their mandate and support WRMA in enforcing the Water Act at field level. An information loop has to be created between WRMA and the WRUAs wherein the WAS data is updated and validated with new information from both parties. Efforts have to be put in increasing the community recognition of the WRUAs and the development and implementation of the SCMPs. Furthermore the WRUAs should be incorporated in the revenue collection from water use charges, a return cash flow from these revenues can be a successful strategy to encourage active involvement of the WRUA and to increase revenue. The ideal case is that WRMA is only doing the things that the WRUAs are not able to do. To get closer to this ideal situation it is necessary that WRMA together with WRUAs come up with a strategy to empower the WRUAs to bridge the currently existing enforcement gap.

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Annexes

Annex I. Internship Activities and Key Deliverables

The total duration of the assignment will be 3 months between the 6th of April and the 6th of July. Specific activities will include the following:

In relation to Objective 1:

i) In collaboration with WMRA Nakuru/Naivasha staff, review the status of the current GIS (rivers, gauging stations, meteorological stations, abstraction points) and Mike Basin (water balance) model as it relates to the recently developed Lake Naivasha Basin Water Allocation Plans[1]

ii) Assist WRMA Naivasha staff in implementing a **Water Abstraction Survey for Lake Naivasha basin** by mapping water abstraction points with a GPS, reading if a meter exists- or estimating (discharge formulae, barrel and stopwatch) the dry-season abstraction volumes/discharge.

iii) Compare and analyze permit coverage/compliance and revenue potential/collection:
- non-permitted vs. permitted abstractions (permit coverage),
- permitted vs. actual abstraction volumes/discharge (permit compliance), and
- the actual vs. potential revenue collection from water use charges in the river basin and the sub-region as a whole - taking WRMA Performance Contract (09/10) requirements into consideration:
  - Increasing the level of compliance on issuance of permits for regulation of water use to 80% by volume of water abstracted.
  - Increasing the level of compliance on installation of measuring devices for control of water use to 80% by volume water abstracted.

iv) Study the recently developed **Lake Naivasha Basin Water Abstraction Plan** (WAP) with a view to:
- Strengthen the academic validity of the WAP in relation to the proposed abstraction limitations - through a literature review of past and ongoing research in the Lake Naivasha basin by ITC-The Netherlands and other Kenya based research institutions.
- Translate academic theories into feasible and practical recommendations for the WAP.

v) In collaboration with WRMA Naivasha staff undertake river discharge measurements and look up previous river discharge data. To update the current water balance model laid out in the WAP.

vi) Support WRMA and the umbrella WRUA in adjusting the WAP into a practical WRMA-compliant document based on the assessed water demands, abstraction and minimum (environmental) and downstream flows.

In relation to Objective 2:

i) Support WRMA in strengthening the relationship between the 12 WRUAs in the Lake Naivasha Basin to encourage and facilitate the adoption of sustainable practices for the use of water resources in the Lake Naivasha Basin through effective implementation of WRUA-level SCMPs and the basin-wide WAP

ii) Support WRMA in strengthening the capacity of the newly formed Lake Naivasha Umbrella Water Resources Users Association in providing oversight and coordination functions to the member WRUAs implementing the WAP and other conservation initiatives in Lake Naivasha basin.

Key deliverables

1. Literature (research) Review Report summarizing relevant findings of past and ongoing research in the Lake Naivasha basin by ITC-The Netherlands and other Kenya based research institutions.
2. Water Abstraction Survey Report
3. Permit Coverage, Compliance and Revenue Analysis Report
   Note: since deliverable 1 provides the theoretical background for the two other (closely related) deliverables, the three should be combined e.g. as chapters in a single report.

[1] Which forms an integral part of the Sub Catchment Management Plans that WRMA is assisting Water Resource User Associations in developing.

Annex II. WAS objectives

To better understand water use in the basin, stakeholders have come together to undertake a basin-wide water abstraction survey. The overall aim of the survey was to provide information necessary, in supporting decision on water allocation and to improve the (local) management of the water resource.

In advance of the survey, WRMA and its cooperating partners on the survey have set objectives that are listed and briefly explained below.

1. The first objective was to capture all water abstraction points in the Lake Naivasha Basin. This includes abstraction from rivers, boreholes, lake abstraction and abstraction from storage dams.

2. The second objective was to understand the level of permit coverage. This includes determining how many abstraction points have a permit, authorization or application. And to determine how many of these permits, authorizations or application are still valid. This objective can be viewed from two sides it determines the legal abstraction points, but more important also the illegal abstraction points and abstraction points with expired permits / authorizations or pending applications.

3. The third objective was to understand the level of compliance on permits, measurement of water abstraction, and paying for water use.

   In relation to permits compliance; an abstraction point is compliant if the actual abstraction amount is not exceeding the authorized abstraction amount. And that the abstraction point only uses works to abstract water that it is authorized to do.

   Measurement compliance is about, if the abstraction point has a measuring device installed at the point of abstraction. According to the Water Act (2002) each abstraction point that falls within Permit Class “B”, “C” or “D” is obliged to have a measuring device installed and to provide abstraction data to WRMA. Abstraction points within Permit Class “A” do not have to pay for water use.

   Again the same abstraction points in Permit Classes B”, “C” or “D” are obliged to pay for water use. The objective at this point is to measure the level of revenue collection on water use charges.

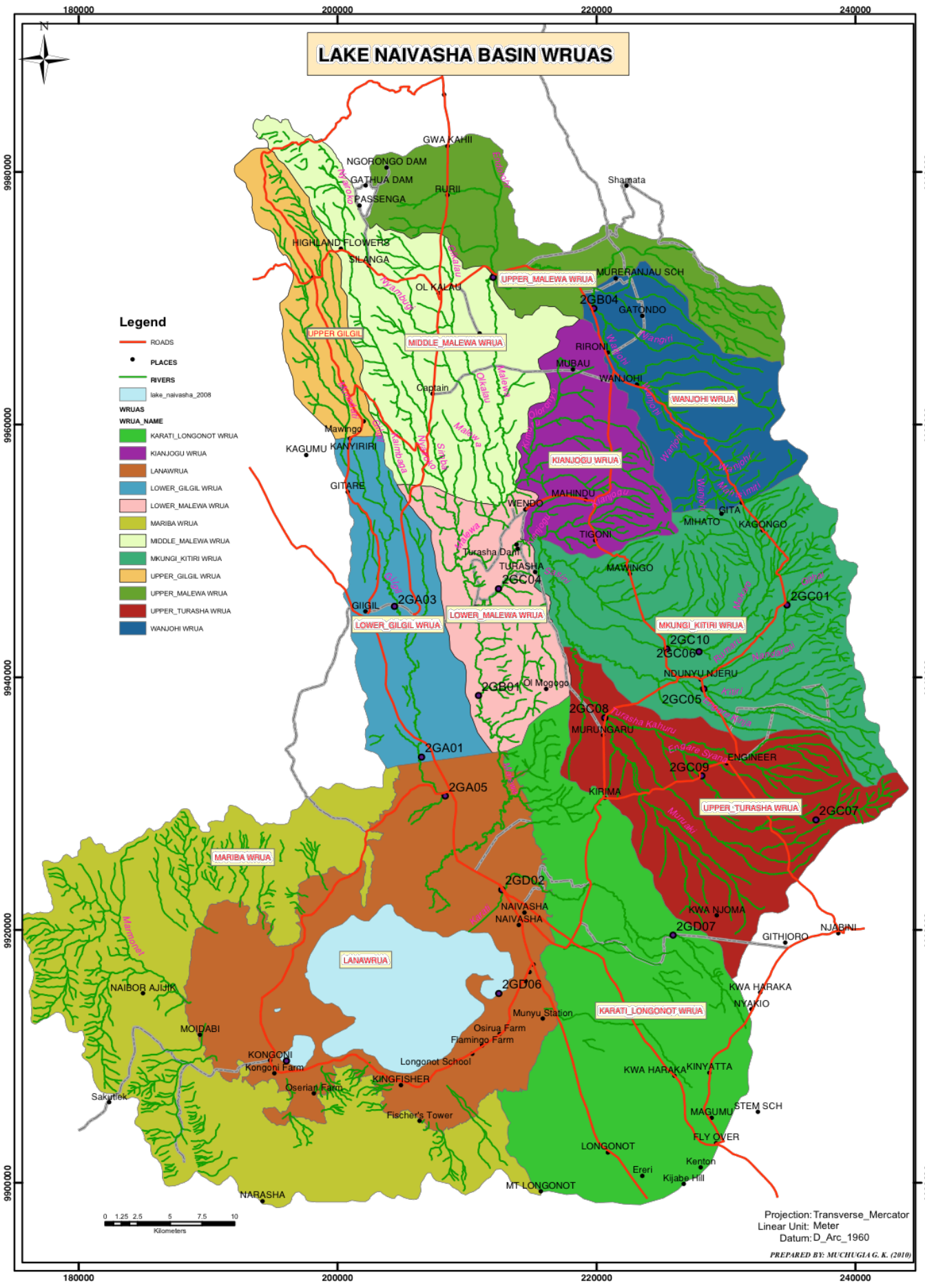
4. The fourth objective was to capture the actual abstraction amount per day at each abstraction point. This objective was also set to obtain information on water balance to improve the Water Allocation Plan for the Lake Naivasha basin.

5. The fifth objective was to cluster all the surveyed abstractors into specific WRUAs. This to enable WRUA officials to know who is within their area. And to give direction to water users on where they can go if they have issues regarding the water use.

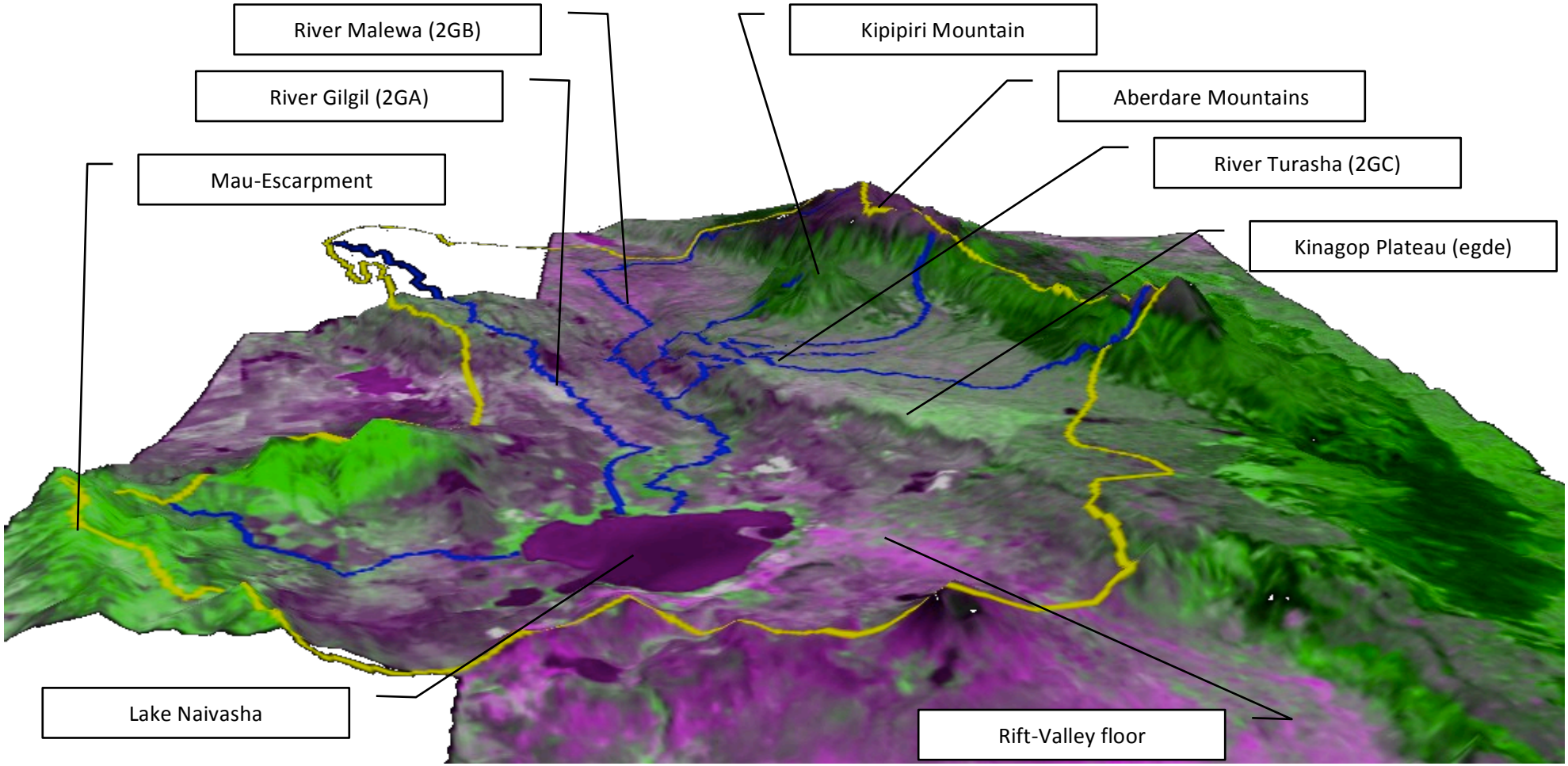
6. The sixth objective was to measure the level of community understanding of the water legislative framework; Water Act (2002) and WRM Rules (2007).

7. The seventh objective was to develop a GIS database containing the spatial location and other details of all the surveyed abstraction points.

Annex III. Basin map with WRUAs indicated

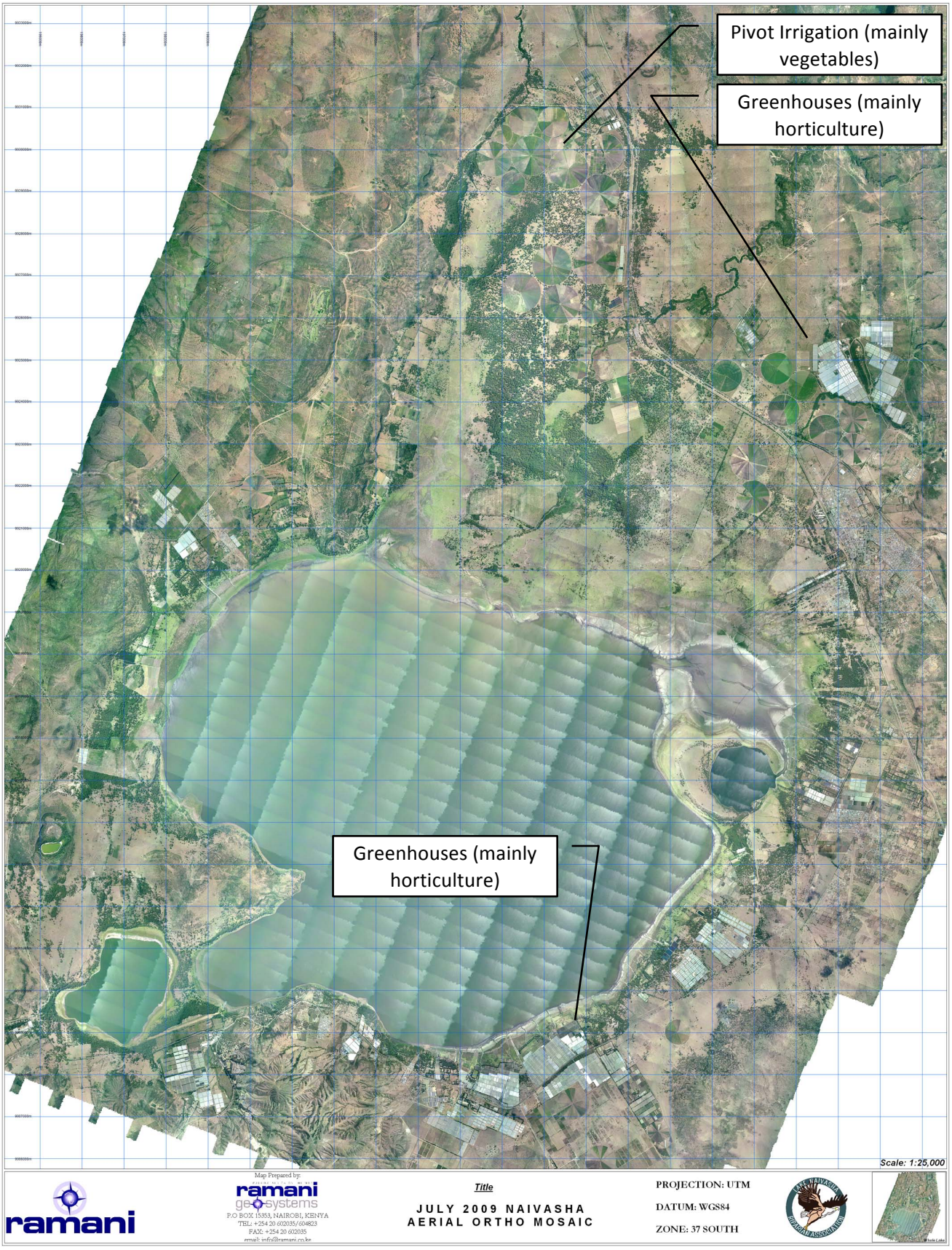


Annex IV. 2D image of the basin



Source: WWF Naivasha

Annex V. HQ image of Lake Naivasha + Riparian Area



Annex VI. WAS Questionnaire

WATER RESOURCES MANAGEMENT AUTHORITY
WATER ABSTRACTION SURVEY FORM

ABSTRACTIONS SURVEY/MONITORING **SHEET NO. _**
PART 1 BASIC INFORMATION

1.1 Abstraction Point
Date _____ _____ (Date of data collection)
Abstraction Point Name _____
Name of Permit holder/Owner of water works----------
Contact information----------
Box----------
Land Registration No……..
Land Area (ha)……
Current water user----------
System of Land Tenure (Institutional, Ownership, Unknown, Water Project)----------

1.2 Position
Map sheet
Latitude(DD.DDDD)…….
Longitude(DD.DDDD)…….
Altitude(M ASL)…….

1.3 Permit & Water use details
Permit Status(Permit/Auth/New application/None……..
Permit No.----------
Date issued----------Date of expiry----------
Water Body----------
Permit Class----------
Authorised amount-(M^3/day----------
Actual amount abstracted(M^3/day)----------
Water Use domestic-(M^3/day ----------
Water use Public-(M^3/day ----------
Water use Livestock-(M^3/day ----------
Water use subsistence irrigation----(M^3/day ----------
Water use commercial irrigation--(M^3/day ----------
Water use industrial--(M^3/day ----------
Water use hydropower-(M^3/day ----------
Water use other-(M^3/day ----------
Authorized method of abstraction----------
Actual method of abstraction ----------

1.4 Measuring Devices
Measuring device installed (Yes/ No)----------
Type of measuring device----------

Water Meter installed (Yes /No)----------
Water meter working (Yes/ No)----------
Meter Reading----------

1.5 Water use charge payment
Water use payment—Yes/ No----------
Reasons for non payment of water use charge……
……
Last water use payment (upto-month ,year)----------

1.6 Informant
Informant on site----------
Contact----------

1.7 Action
Action required----------

Action taken----------

1.8 Remarks----------

PART 2 WATER ABSTRACTION ADDITIONAL DETAILS

2.1 Abstraction /Diversion
Location of Diversion (Borehole, Lakeshore, Left bank, Right Bank)
Method of Diversion (No weir, sand bags, Weir with flow regulation, Weir with no flow regulation) _____
Allocation Priority (Abstraction-Downstream flow, Downstream Flow-Abstraction, Not Clear/Variable) _____
Return flow to River (m^3/s) _____
Channel or pipe Details Line Length (m) _____
Unlined Length (m) _____
Piped Length (m) _____
Diameter (m) _____
Elevation change (m) _____
Material used _____
Remarks _____
_____

2.2 Irrigation
Actual Irrigated Area (ha) _____Potential Irrigation Area (ha) _____
Type of Irrigation (Drip, Flood, Sprinkler, Hydroponics) Crop Type _____

2.3 Livestock
No of livestock _____ Type of livestock)_____

2.4 Domestic Water Use
No of households _____ Persons per Household _____

No of people _____ Consumption rate (l/day) _____

2.5 Industrial Water Use

Production Amount _____ Type of Industry _____

2.6 Water Storage Facilities

Storage Type (Closed Tank, Open Tank, Dam, Pan)

Construction Materials _____ Capacity _____

Remarks _____

_____

2.7 Gaugings

Time _____ Direct gauge (yes/no) _____

Upstream or Direct gauging(m^3/s) _____

Downstream gauge (m^3/s) _____ Total(m3/s) _____

2.8 Volumetric

Time Observed Rate (m^3/s) _____ Operational hrs per week _____

Pump Head _____ Pump Type _____

2.9 Estimates

Time _____ Estimated Abstraction rate (m3/s) _____

Method of estimation (Capacity, Evapotranspiration, Pumping rate, Other) _____

2.10 Environment

Riparian Vegetation (Dense, Medium to Dense, Medium, Poor to Medium, Poor)

Agricultural Activity in surroundings _____

Clothes washing places in surroundings yes/no

Car washing sites in surroundings yes/no

Livestock watering sites in surroundings yes/no

2.11 Meter reading check – (where applicable)

Meter No.							
Meter Reading 1st October 2007							
Meter Reading On Day of visit							
Actual water used							

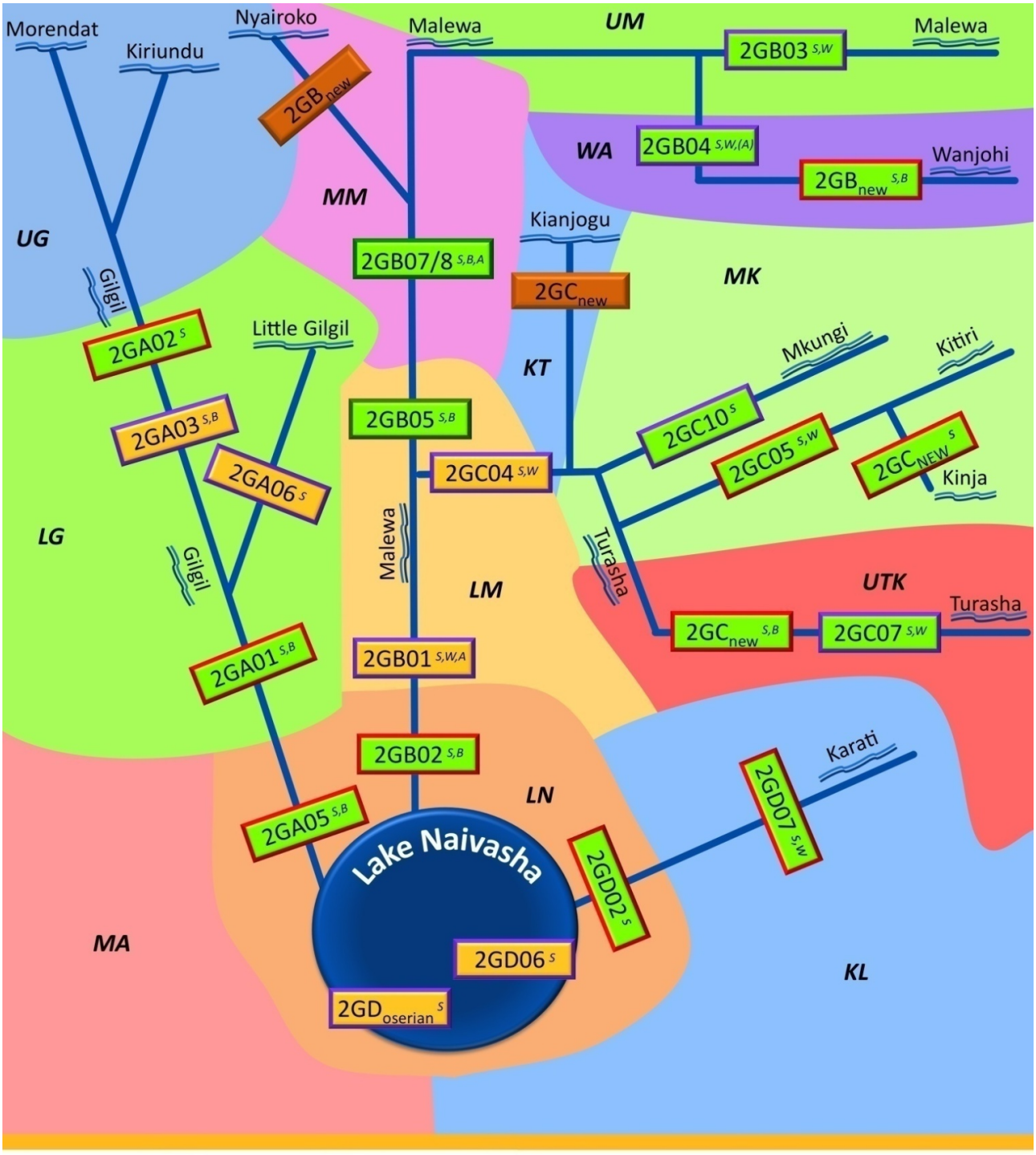
Signed by Data Collector: _____ Name: _____

Annex VII. Permit Thresholds

The table below shows the details on permit thresholds according to the: "Water Resources Allocation Thresholds for Classification of Permits" which was published by WRMA in 2007.

Thresholds in m^3/day per Permit Class				Source	Source details
A	***B***	***C***	***D***	5.1.1	
≤20	>20 - 500	>500 - 2500	>2500	**Lake Naivasha**	**2GD** – Lake Naivasha
≤20	>20 - 500	>500 - 1000	>1000	**River water**	**2GA** – Gilgil, Little Gilgil, Kiriundu rivers and their tributaries. **2GB** – Malewa, Upper Turasha Kinja, Oleondo, Nyairoko and their tributaries. **2GC** – Turasha, Mkungi, Kitiri, Sasini, Nandarasi, Kinja and their tributaries.
≤20	>20 - 99	100 - 999	≥1000	**Groundwater Lake Aquifer**	Within 2000 m.a.s.l. contour
≤10	>10 - 20	>20 - 40	>40	**Groundwater Kinagop Aquifer**	Outside 2000 m.a.s.l. contour

Annex VIII. Schematic drainage pattern Lake Naivasha Basin



Schematic drainage pattern showing the Regular Gauging Stations (RGS) in the different WRUAs* of the Lake Naivasha Basin

** WRUA areas are not representive in size and shape*

- *= Data +*
- *= Data +/-*
- *= Data –*
- *= Used in WAP*
- *= Not used in WAP*
- *= Yet to install*

S = Staff
W = Weir
B = Bridge
A = Automatic water level recorder

UG = Upper Gilgil
LG = Lower Gilgil
WA = Wanjohi
UM = Upper Malewa
MM = Middle Malewa
LM = Lower Malewa
UTK = Upper Turasha Kinja
MK = Mkungi Kitiri
KT = Kianjogu-Turasha
KL = Karati Longonot
MA = Mariba
LN = Lake Naivasha

Thomas de Jong (2010)