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Developing a Framework for a Sustainable Water Allocation Plan in the Tana River Basin, Kenya

A Master's Thesis submitted for the degree of
"Master of Science"

supervised by
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Vienna, 28.05.2014

Affidavit

I, **RICCARDO ZENNARO**, hereby declare

1. that I am the sole author of the present Master's Thesis, "DEVELOPING A FRAMEWORK FOR A SUSTAINABLE WATER ALLOCATION PLAN IN THE TANA RIVER BASIN, KENYA", 80 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
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Abstract

Sustainable and equitable water allocation is among the key principles of Integrated Water Resources Management (IWRM). However, developing a water allocation plan for the Tana basin, one of the most important river basins in Kenya, is all but a simple task for stakeholders and policy-makers. In fact, the increasing pressure on surface and groundwater resources and the numerous drivers of change such as population growth, climate change and new infrastructures like dams and irrigation schemes, pose a huge challenge to the allocation of water. In 2009, the Water Resources Management Authority (WRMA), which is the only governmental institution entitled to regulate water resources in the country, developed a strategy to ensure the conservation and protection of the basin as well as to guarantee the participation of the stakeholders in water resources management and governance. However, the objectives set are only partially met due to the lack of appropriate data, financial and human resources as well as institutional capacity. For this reason, WRMA, the United Nations Environment Programme (UNEP) and the relevant stakeholders are currently reviewing and improving this strategy in order to provide concrete and feasible solutions to the challenges posed by the Tana River basin. Among others, priority should be given to enhancing cooperation among the stakeholders, to empowering the Water Resources Users Associations (WRUAs), to developing sub-catchment management plans and pilot areas for water allocation along with setting the reserve quantity in order to meet the basic environmental and human needs.

This thesis investigates the challenges of the Tana catchment area and the key mechanisms and principles of water allocation. It further analyzes the catchment management strategy that was developed in 2009 to regulate water resources in the Tana basin and highlights its strengths and weaknesses. Based on scientific evidence and socio-political considerations, this thesis provides recommendations for the review of the Tana Catchment Area Management Strategy. In particular, the aim is to provide stakeholders and policy-makers with feasible solutions and new ideas to ensure equitable water allocation planning among users and regions as well as providing sustainable water resources management.

Keywords: Water allocation plan; River basin management; Integrated Water Resources Management (IWRM); Tana River; Kenya

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List of Acronyms

AGR	Artificial Groundwater Recharge
CAAC(s)	Catchment Area Advisory Committee(s)
CBO	Community-Based Organizations
CC	Climate Change
CMS	Tana Catchment Area Management Strategy, 2009
CMU	Catchment Management Units
e-flow	Environmental Flow
GIZ	Deutsche Gesellschaft für Zusammenarbeit
GoK	Government of Kenya
GWP	Global Water Partnership
IUCN	International Union for the Conservation of Nature
IWRM	Integrated Water Resources Management
KenGen	Kenya Electricity Generating Company
KES	Kenya Shillings
km^2	Square kilometers
m	Meters
m^3 / ha	Cubic meters per hectare
m^3 / y	Cubic meters per year
mm	Millimeters
MoU	Memorandum of Understanding
NIB	National Irrigation Board
NWMP	National Water Master Plan, 1992
NWRMS	National Water Resources Management Strategy, 2006
Q	Discharge
Qm	Mean River Discharge
R	Reserve
RBM	River Basin Management
RO	Regional Office
SCMP	Sub-Catchment Management Plan
SIWI	Stockholm International Water Institute
SRO	Sub-Regional Office
TARDA	Tana and Athi Rivers Development Authority

TCA	Tana Catchment Area
TRB	Tana River Basin
UNEP	United Nations Environment Programme
WAP	Water Allocation Plan
WRMA TCA	WRMA Tana Catchment Area
WRMA	Water Resources Management Authority
WRUA(s)	Water Resources Users Association(s)

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1. Introduction

1.1. Relevance and Motivation

> "Lack of effective management of water resources that ensures sustainable availability of water remains the biggest challenge of our time"
>
> (SIWI, 2010)

Water is the basic commodity for all forms of life as well as for the environment. In Kenya, water scarcity has been registered over the years and it is nowadays one of the most crucial issues that need to be addressed. A major cause for water scarcity is the constant population growth and the high number of people migrating from the rural areas to big cities every day (World Bank, 2010). As a consequence, increasing population leads to a higher demand, less availability of water and then to higher pressure on the existing infrastructures. According to Marshall (2011), other major reasons for water scarcity in Kenya are the periodic droughts amplified by climate change and climate variability and a general lack of governmental investment to build appropriate water infrastructures, especially in the rural areas.

These issues are exacerbated by a lack of coordination and management among the main stakeholders. In fact, in its National Water Development Report (2006), the Government of Kenya (GoK) underlines how the national water resources have been mismanaged during the past decades through unsustainable water and land use policies, laws and institutions. The report also remarks that weak water allocation practices and increasing pollution have led to severe degradation of rivers, lakes, wetlands and aquifers (Marshall, 2011). The majority of water bodies in Kenya are therefore in a precarious situation but one is particularly under threat: the Tana River. Its unique features and vital role for Kenya make the Tana River its basin the subjects of this master thesis which aims to address a crucial aspect of water management namely allocation and planning.

With its one thousand and fourteen kilometers, the Tana is not only the longest river in Kenya but also the most important source of livelihood for the majority of the catchment area's population (Knoop et al., 2012). The Tana River basin[1] supports important economic activities including coffee and tea farming, cotton production, livestock, various industries

[1] To simplify, in this thesis 'Tana River basin' will be used as a synonym for 'Tana Basin', therefore also including the other rivers and tributaries of the Tana River

and tourism. Consequently, there are numerous and varying challenges when it comes to the management of its water resources. The natural and climatic diversity of the basin are two of the most important concerns since the climate and the soil conditions vary in accordance with the difference in altitude and precipitation. This complicates the work of water experts since there is a high variability in terms of flow and availability of water for anthropogenic use within the basin. For example, the upper Tana is the part of the basin that registers most precipitation whereas the lower part of the Tana catchment area is mainly arid or semi-arid.

Furthermore, the increasing number of anthropogenic activities in the Tana catchment area has led to a severe degradation of the environment. Other threats to the Tana River basin's water resources include a weak institutional capacity to enforce laws and regulations and a poor level of dialogue and cooperation among the stakeholders. There is also an additional threat to the water resources of the Tana River basin ever since the Government of Kenya decided to boost the agricultural productivity following the 2030 development targets (Knoop et al., 2012).

In 2012, the GoK announced the Kenya Vision 2030 with the aim of boosting the development of sectors such as construction, health, environmental protection, water and sanitation as they represent the foundations for national transformation. Further, one of the goals of the GoK between 2013 and 2017 is to increase the share of power generated from green and more cost-effective sources of energy production as, for example, hydropower. This means that there is a high probability of increased exploitation of the Tana basin's water resources in the next decades with subsequently higher stress and repercussion on the ecosystem services.

Against this backdrop, different organizations such as the United Nations Environment Programme (UNEP) and the Water Resources Management Authority (WRMA) joined their forces to propose solutions to these threats and fill the management gaps through specific measures. The project "Institutional development and capacity building of the Tana Catchment Area for the rehabilitation of critical water ecosystems" signed in 2011, provided the newly established Water Resources Users Associations (WRUAs) and the WRMA Tana Catchment Area (WRMA TCA) with different trainings, for example on how to develop and implement sub-catchment management plans (SCMPs) for the tributaries of the Tana River. The project is currently in its second phase of implementation and the objectives are among others:

- A new catchment management strategy for the Tana River basin;
- A report on the status of the watersheds in the basin;
- A report on the value of the ecosystem services and environmental capital provided by the Tana River basin;
- A report on the institutional capacity development and improved ecosystem functioning;

These objectives aim to provide the stakeholders and policy-makers with concrete solutions to the challenges posed by water resources management and water scarcity in the Tana catchment area. According to Knoop et al. (2012), water availability in the Tana River basin has been on the decline over the past decades and remains one of the key challenges to address. Figure 1 shows that in 2006, the availability of water in the Tana catchment area was estimated at 520 m^3 per person / per year, meaning almost absolute water scarcity (FAO, 2013) while the red curve clearly illustrates the negative trend that has taken place since 1962.

The natural equilibrium of the river and the related economic activities are therefore under threat and require sustainable and long term strategies to cope with these increasing pressures on water resources. For these reasons, it is urgent to find solutions to both the need for environmental protection as well as the use of water for domestic use and economic development (WRMA, 2010). An equal allocation of water within the Tana River basin would be an important milestone in order to respond to these challenges and to optimize the use of existing water resources.

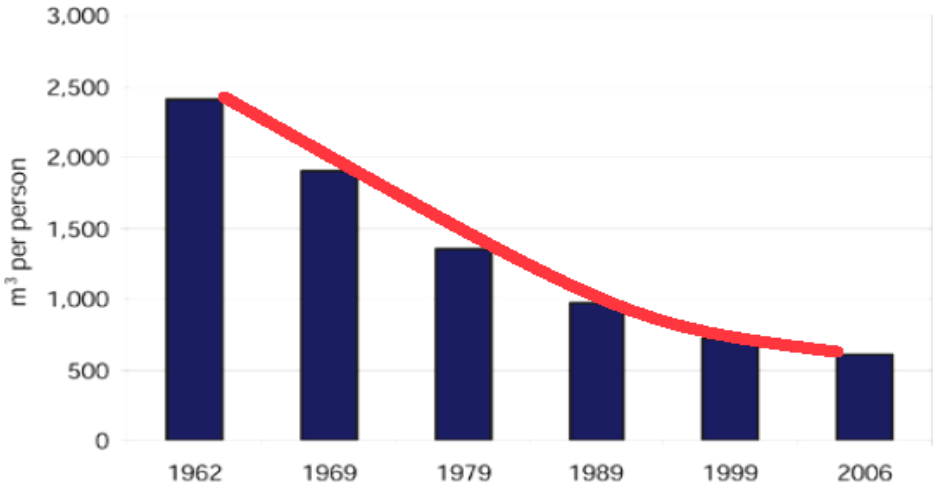

Figure 1: Elaboration of the "Water availability per capita in the Tana River basin" figure based on data for renewable freshwater per capita / year. Source: Knoop et al., 2012.

1.2. Hypothesis, Research Questions and Objectives

The Tana River basin is confronted with a number of challenges that have led to higher pressure on water resources. According to Knoop et al. (2012) this is due to:

- Population growth;
- Increasing rates of water abstraction and severe illegal water abstraction;
- Growth and change in the economy leading to a higher demand of water among different users;
- Degradation of the environment within the whole basin with subsequent repercussion on human activities;
- Aggravated scarcity and reduced availability of water due to climatic change and climate variability;

Water resources availability remain a crucial issue in the Tana River basin. In order to solve conflicts and issues over access to water, a water allocation plan (WAP) would determine how much water is available for anthropogenic use and how water resources should be allocated between different users and different regions (Speed et al., 2013).

The Kenya Water Act (2002) introduced radical changes to the legal framework of water resources management as it shifted powers away from the central government to a new institution, WRMA. Furthermore, the Water Act provided guiding principles according to which future water allocation plans should be drawn (Mumma, 2007). However, Knoop et al. (2012) highlight that despite an innovative approach for water resources management, the Kenya Water Act hardly managed to provide regulations to the Tana River basin.

The Water Act principles are of extreme importance to ensure equitable allocation of water for all users and regions. However, these concepts would have been successfully implemented if they would have fit the actual sitution of the Tana catchment area. To do so, it is important to have strong dialogue and cooperation among the stakeholders and clear scientific data regarding the basin which is not the case yet. These are the hypothesis of this master thesis which aims to provide a framework on how Tana River basin's water resources should be allocated in line with the current regulations and actual needs. Based on these hypothesis, this thesis aims to:

1. Develop a profound understanding of the main pressures in the Tana catchment area and of the problems regarding water resources faced by stakeholders and water users within the basin.

2. Develop a framework for a sustainable water allocation plan in the Tana River basin for the benefit of stakeholders and policy-makers and provide a solution to the gaps identified in the existing catchment management strategy, 2009.

To reach these goals, two main research questions with related subquestions have been defined:

A) What are the main drivers of change and pressures on the water resources of the Tana River basin?

- What are the main problems faced by water users and stakeholders?
- Have the Kenya Water Act (2002) and the other water-related strategies been effective in guaranteeing equitable allocation of water for all users and regions of the Tana basin?

B) What is the way forward for drawing a WAP in the Tana River basin?

- What are the possible solutions to the challenges encountered in the Tana basin regarding water allocation planning?
- Which actions should be taken by users and stakeholders to guarantee that water resources are well allocated and that the objectives of the regulations are met?
- Which actions and policies should be developed under the new Tana Catchment Area Management Strategy (CMS) to promote equitable water allocation among users and regions in the basin?

The thesis is structured in four chapters. After the first introductory chapter, the second chapter provides background information on Kenya and the Tana River basin and analyzes the main drivers of change and pressures on water resources. The chapter also introduces the topic of available, utilizable and allocable water resources before then introducing and reviewing the CMS of 2009.

The third chapter first looks into water allocation mechanisms and principles for a sustainable WAP in the Tana River basin. It then analyzes the role of the WRUAs together with the strengths and weaknesses of the current CMS.

The final chapter suggests recommendations for the review of the CMS and provides a synopsis of the framework for a sustainable water allocation plan in the basin.

1.3. Methodology

The methodology used in this thesis includes an extensive literature review to describe the current situation of water resources in Kenya and in the Tana River basin. The aim of the literature review is to provide an overview of water allocation mechanisms and principles. Furthermore, the literature aims to clarify why water allocation is a valuable means to address the challenges in the Tana River basin. The literature includes reports issued by international organizations, scientific journals, as well as academic and scientific papers. Legal and management-related documents issued by the GoK, international organizations, national and local authorities are also important as they provide information on the legal background and on the current policies in force regarding water resources in Kenya and in the Tana River basin.

The literature review is integrated to the empirical part of the thesis which consists of the analysis and elaboration of scientific and socio-economic data specific to the Tana River basin. These sources are fundamental in order to understand the challenges with regards to the river and to formulate solutions for a sustainable water allocation plan. The empirical part of the thesis is also the result of a field visit to Kenya in April 2014, in which meetings with representatives and experts of different organizations were set up and interviews were conducted with the relevant stakeholders involved in the project "Institutional development and capacity building of the Tana Catchment Area for the rehabilitation of critical water ecosystems" (E.g. UNEP, WRMA, WRUAs, et al.).

During the field research, direct contact with the local communities living in the Tana basin helped to understand the main pressures on water resources and the daily problems they face. In addition, interviews with the main stakeholders involved in the basin of which some are UNEP, WRMA, WRUAs, Tana and Athi River Development Authority (TARDA) were conducted during the field visit and selected parts included in the appendices.

According to Speed et al. (2013), in basins where water is scarce, it is essential to link water allocation to socio-economic and environmental planning. For this reason, the methodology used to analyze the main pressures and drivers of change in the Tana River basin and to develop a framework for water allocation planning relate to the principles of Integrated Water Resources Management (IWRM) and sustainable development.

On the one hand, the IWRM approach is particularly relevant to basin allocation planning since it recognizes the needs of the environment as a user of water resources. On the other hand, sustainable development means ensuring the availability of natural resources for future generations whilst promoting the well-being for the current users (Cinderby et al., 2010). For this reason, this master thesis seeks not only to analyze the current challenges and opportunities for water allocation in the Tana basin, but also to identify potential future changes to the planning.

To do so, this master thesis uses the DPSIR – Drivers, Pressure, State, Impact, Responses – approach which is commonly applied to modern river basin management. This approach allows the author to analyze the environmental problems of the Tana basin whilst identifying the drivers of change (D), the pressures on the water resources (P), the state of the environment (S), the impacts on anthropogenic activities and ecosystem (I) and the appropriate response (R) to these threats namely policies and strategies.

Therefore, this master thesis aims to provide policy-makers and stakeholders operating in the Tana River basin at local and at regional levels, with an updated framework for water allocation planning. The results should help them develop a WAP bearing in mind the current status of water resources in the basin and the ongoing and planned projects which are likely to impact the future water balance in the catchment area. As a result, policy-makers and stakeholders should not only be able to identify adequate responses for protecting and conserving water resources, but also to ensure equitable allocation of water resources among users and regions, at present and in the future.

2. The Tana River Basin

2.1. Kenya and Water Scarcity: An Overview

> "Water is essential for the national development of Kenya (…). With a largely agro-based economy and a rapidly expanding industrial sector, the demand for water is constantly rising (and) available water resources have to be managed in a sustainable and integrated manner. "
>
> (Agwata, 2005)

During the last decades, Kenya has experienced an overall increase of anthropogenic activities for different purposes such as industry, agriculture and power generation (Maingi et al., 2002). This increase has put additional pressure on Kenya's water resources which are already severely scarce (Marshall, 2011). Many interdependent factors contribute to water scarcity: firstly, Kenya is about 75% arid or semi-arid with a high variability in rainfalls among its regions (Sombroek, 1982). The average annual rainfall in Kenya is around 630 mm with a variation between a minimum of 200 mm in the Turkana region located in the north of the country and a maximum of 1800 mm around the slopes of Mount Kenya located in the Rift Valley (Marshall, 2011).

Climatic variability contributes to reduce the availability of water within the Tana River basin. For example, the downstream territories of the basin (E.g. Tana delta) register periodic droughts unlike the upstream territories. Other major factors that contribute to water scarcity in Kenya are global warming and climate change. These are considered to put pressure on the already scarce water resources of Kenya as regular droughts and floods are reported in different areas of the country, including the Tana basin (Marshall, 2011). Further, the last decades have seen important changes in the land-use and intensive deforestation, especially in the upper Tana where most of the population of the Tana catchment area lives and where the climate is favorable for agriculture.

Another explanation for water scarcity in Kenya is population growth. The World Bank (2010) has recently confirmed that Kenya has now a population of more than 43 million people which is expected to double by 2085. Population growth therefore puts additional pressure on water demand and supply, especially in the urban areas. As Marshall (2011) argues, 17 million Kenyans out of 43 million do not have access to clean water. Considering the constant growth of the population and the projections for the next decades, the number

of Kenyans without access to water will potentially rise as water resources will become scarcer. In fact, as argued by Roudi-Fahimi et al. (2002), the increased pressure on water resources is directly proportional to the increasing number of the population in a specific region.

With reference to the Tana basin, it is estimated that approximately 7.1 million people currently depend on the catchment's water resources while the increasing demand for water has also led to conflicts among users, especially in the area of the delta (WRMA, 2009). Another reason that contributes to enhance water scarcity is the weak institutional capacity among the stakeholders and the lack of adequate investment in the water sector (Marshall, 2011).

In the National Water Development Report, the Government of Kenya highlighted that the

> "country's water resources have been mismanaged through unsustainable water and land use policies, laws and institutions, (and) weak water allocation practices (…)". (UNESCO, 2006)

To resume, it is clear that Kenya is a country that suffers from water scarcity due to different reasons ranging from population growth to weak institutional capacity, change in land-use, climate change and climatic variability. Being among the most important river basins in the country, the Tana basin is highly affected by all these factors. To better understand these issues, the next section will provide an overview of the characteristics of the basin together with an analysis of pressures and drivers of change.

2.2. The Tana River Basin: Overview, Drivers of Change and Pressures

The Tana River is not only the longest river in Kenya but also a major source of livelihood for the population living in its catchment area (Agwata, 2006). The river originates from the Aberdare and Nyambene hills and the slopes of Mount Kenya and reaches the Indian Ocean after a journey of more than 1,000 kilometers through different regions and climatic zones (Knoop et al., 2012).

The Tana catchment area is about 126,000 km^2, corresponding to around 20% of the total surface area of Kenya. The catchment area is conventionally divided in three major

zones: the upper, the middle and the lower zones which are then sub-divided by WRMA into Catchment Management Units (CMU) for an easier management of water resources. Various physiographic situations contribute to make the Tana River basin an area with diverse climatic conditions which vary from humid to semi-arid or arid. It is estimated that the annual mean discharge into the Indian Ocean is around 5 billion m^3 (Agwata, 2005).

Figure 2 illustrates the main catchment areas of Kenya with number 4 indicating the Tana River basin.

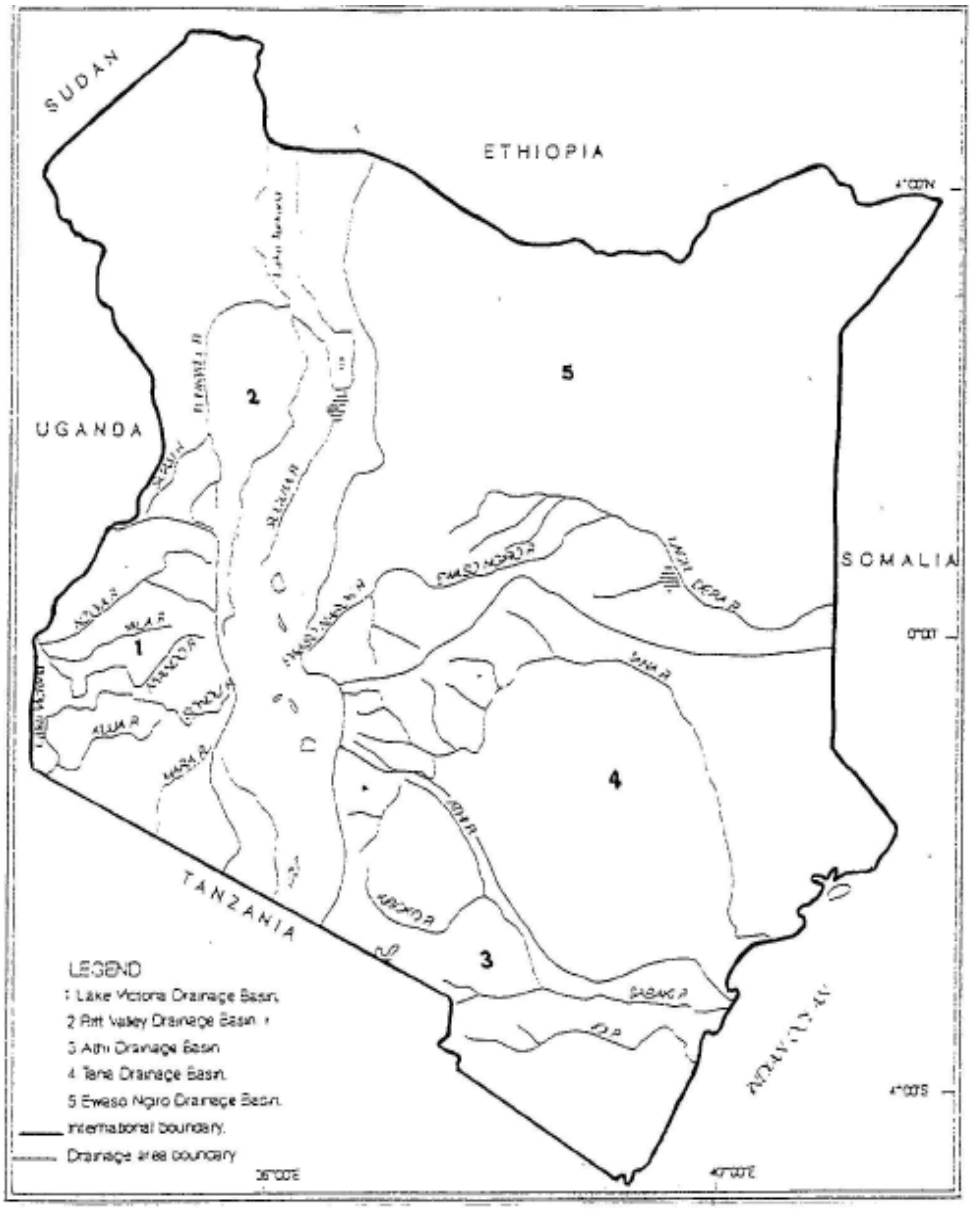

Figure 2: Map of Kenya indicating the main catchment areas. Number 4 corresponds to the Tana River basin. Source: FAO, n.d.

Table 1 summarizes the key facts to understand the Tana River basin and the three sub-basins.

Table 1: Summary of main characteristics of the Tana River basin. Source: Own creation based on Knoop et al. (2012), Maingi et al., (2002) and Agwata (2005)

	Upper Tana	Middle Tana	Lower Tana
Rainfalls mm / y	1000 mm / y	400 – 700 mm / y	350 mm / y
Avg. altitude	1000 m	1000 – 200 m	200 – 0 m
Type of climate	Humid	Arid or semi-arid	Mainly arid or semi-arid, humid in the delta
Partial km^2 cover	~15,000 km^2	~15,700 km^2	~95,300 km^2
Soil composition	Mainly volcanic	Volcanic and alkaline	Mainly alkaline
Type of agriculture - livestock	Tea, coffee, maize Sheep and poultry Dairy products	Cotton, tobacco, beans Dryland farming	Irrigation schemes Pastoralism
Use of water (anthropogenic)	Domestic use Irrigation Hydropower	Domestic use Irrigation Tourism	Domestic use Irrigation schemes Tourism
Remarks	Water supply of Nairobi through Ndakaini and Sasumua reservoirs Potential for new hydropower stations (e.g. Rukenya, High Grand Falls dam)	Presence of national parks and reserve LAPSSET project (Lamu Port, Kenya-South Sudan-Ethiopia corridor)	Riverine forest and endangered species LAPSSET project (Lamu Port, Kenya - South Sudan - Ethiopia corridor) One Million Acre irrigation project[2]

Figure 3 highlights the division of the Tana basin in three sub-basins: upper, middle and lower.

[2] It is worth noting that the One Million Acre project has been recently stalled 'due to lack of funds'. For more information on the topic see: http://www.nation.co.ke/business/One-million-acre-irrigation-scheme-stalls/-/996/2295284/-/wr2vagz/-/index.html [accessed: 21/05/2014]

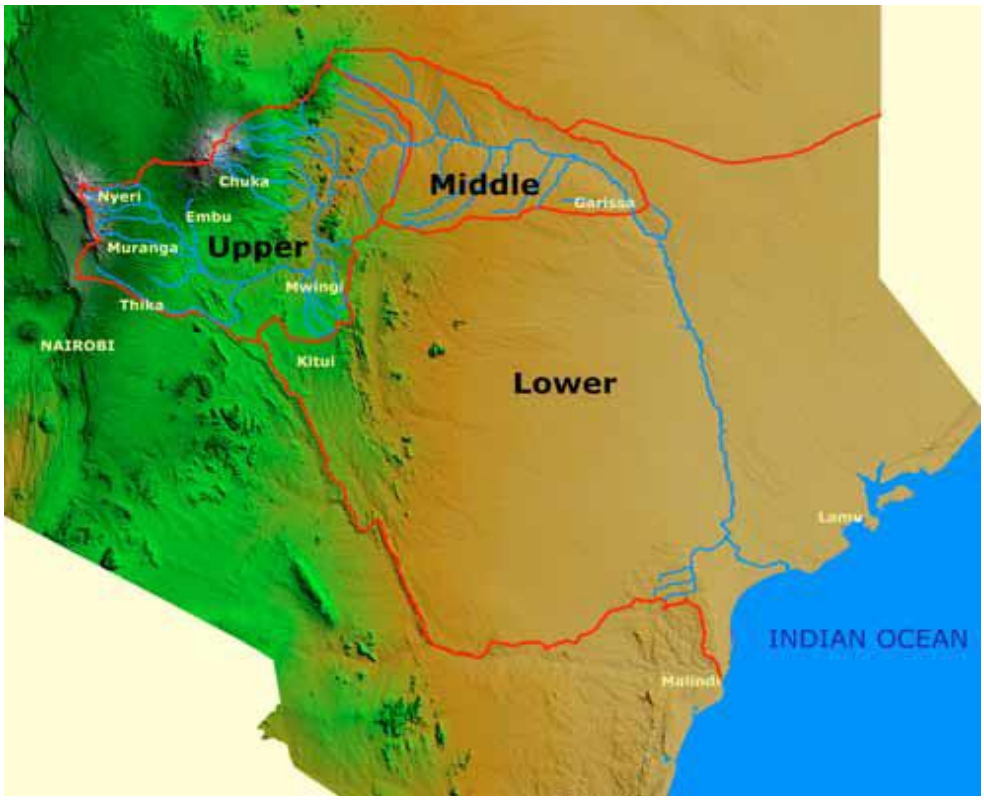

Figure 3: Map of the Tana catchment area with division in sub-basins. Source: Knoop et al., 2012

2.2.1 The Upper Tana

Knoop et al. (2012) highlight the importance of the upper Tana. Starting from the morphological reasons, this part of the catchment area has a high number of perennial and seasonal tributaries. These include among others, the rivers Thika, Sagana, Thiba, Mutonga and Chania. They are considered the most relevant ones as they have historically provided the Tana River with enough water to sustain agriculture and hydropower among other activities. The upper Tana is also the part of the catchment which shows the highest average annual precipitation rate, at around 1000 mm. The average altitude of the area is about 1000 m above the sea level and the climatic conditions are typically humid or semi-humid during the whole year.

In this part of the catchment, the soil is mainly volcanic, rich in nutrients and it is therefore possible for cultivating coffee, rice, wheat, tea and maize. Dairy production, poultry and sheep farming are also widely practiced (Agwata, 2005). Overall, water resources in the upper Tana are mainly used for agriculture, irrigation and hydropower.

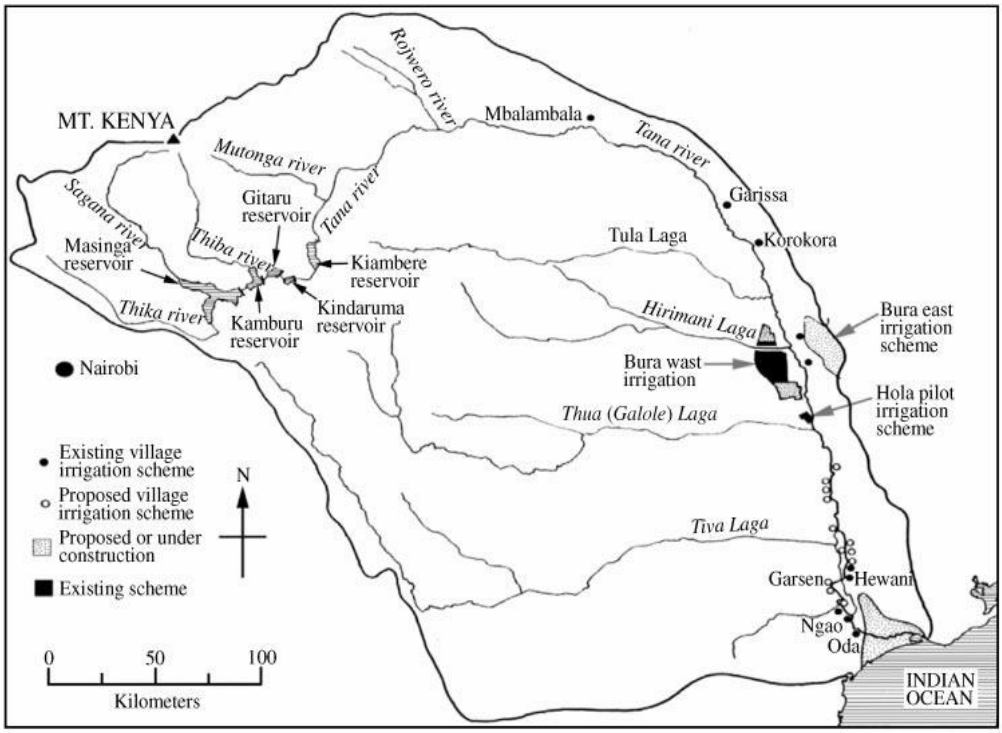

Figure 4: Map of the Tana catchment area with the main tributaries, dams (reservoirs), existing and proposed irrigation schemes. Source: Maingi et al., 2002

Energy production is a key area as it is estimated that three quarters of the overall electricity demand of Kenya is supplied by the energy produced out of the five hydropower stations – the Seven Forks scheme built between 1968 and 1988 – located in this part of the Tana catchment area (IUCN, 2003). Maingi et al., (2002) argue that the first three dams created rather small reservoirs that did not directly impact the flow of the Tana River. The case was different for the two other dams, the Masinga Dam and the Kiambere dam, built in 1981 and 1988, which have an installed generation capacity of 40 MW and 144 MW respectively (WRMA, 2009). It is argued that these two dams have drastically reduced the flow, the transportation of sediments downstream as well as the magnitude and incidence of floods in the Middle and Lower Tana.

As the GoK plans to further boost hydropower to meet the increasing electricity demand of Kenya, the upper part of the Tana basin has been proposed as an ideal place where to build additional hydropower stations like the High Grand Falls dam[3], which is projected to have a rated power output between 500 MW and 700 MW. These dams are key

[3] It is worth noting that the construction has been recently suspended due to corruption allegations. For more information on the topic see: http://mobile.nation.co.ke/business/High+Grand+Falls+dam+construction+suspended/-/1950106/1968064/-/format/xhtml/-/jc6yq0z/-/index.html. [accessed: 20/05/2014]

to producing electricity as well as creating additional reservoirs to supply the increasing water demand within the catchment area.

The increase of population, anthropogenic activities and demand for water encouraged the GoK to take measures aimed at ensuring water availability. Building another dam in the upper part of the Tana River basin is aimed at providing the lower part of the catchment area – especially the region of Lamu – with water and boost the energy supplied by the national grid. However, as highlighted by Snoussi et al. (2004), the impact of new dams in the upper part of the Tana catchment area might have additional repercussions on the flow, sediments transportation and flood frequency and magnitude which will impact the livelihood of the downstream communities as well as the ecosystem services. In fact, the Tana River used to flood the banks of the middle and lower basins twice a year, hence sustaining all ecosystems such as riverine forests, lakes and grasslands.

IUCN (2003) reported that after the construction of the last dam in 1988, the floods have drastically reduced with a consequent impact on the agricultural activities of the downstream communities. The presence of new dams along the upper part of the catchment area would not only mean the total control of Tana River's waters but it might also contribute to the end of natural floods in the middle and lower Tana, hence posing a serious threat to the balance of the ecosystem. Such a change downstream may also contribute to the rise of potential conflicts among users in the lower basin and the Tana delta, already subject to rivalry and conflicts for water (IUCN, 2003; Agwata, 2005).

2.2.2 The Middle Tana

The middle Tana registers humid to semi-arid conditions as the altitude rapidly decreases from 1,000 m to 200 m above sea level. The Tana is the most important of the few water bodies that permanently flow through this part of the catchment and therefore constitutes a major source of livelihood for the population (IUCN, 2003). In the middle Tana, the soil is mainly composed of cambisols and alkaline rocks and can therefore sustain the cultivation of cotton, tobacco, beans as well as dryland farming (Agwata, 2005; Knoop et al., 2012).

The number of anthropogenic activities is drastically lower in this part of the catchment area compared to the upstream and downstream territories. The reason is that the population density in the middle Tana is low and the generally dry conditions of the area

are a limit for development. In spite of this background, this part of the Tana catchment is home of three national reserves, namely the Meru National Park, Kora National Park and Rahole National Reserve which border the Tana River. This makes sustainable management of water resources and water allocation priorities that need to be ensured.

In fact, drivers of change and further pressure in this part of the catchment might directly impact and affect the livelihood of the downstream community as well as alter the equilibrium of the river. Further, according to the principle of equity[4], policy-makers and stakeholders should ensure that water resources in the middle Tana basin are sufficient to sustain the environmental needs of the river as well as other anthropogenic activities. This means to allocate water resources in a fair and equitable way upstream, especially if the future plans to boost hydropower and agriculture are developed.

2.2.3 The Lower Tana

The lower Tana is the part that covers most of the Tana catchment area with approximately 95,000 km^2. This territory is mainly semi-arid or arid with local geography under 200 m whereas there is a difference in the agro-climatic situation of the Tana delta and the coastal region which register higher rainfalls and humidity (Knoop et al., 2012; Agwata, 2005). Despite the presence of seasonal tributaries called lagas crossing the lower part of the catchment area, the Tana River remains among the main sources of livelihood for the population living in the lower basin.

Along the banks of the river, between the municipalities of Mbalambala and the Tana River delta (see fig. 4), there is a unique riverine forest which is, according to the International Union for the Conservation of Nature (IUCN), home to rare and endangered species such as the Tana River Red Colobus and the Tana River Mangabey, both belonging to the primate family. Recent studies revealed the scarce regeneration capacity of the forest due to the lack of peak flows (Maingi et al., 2002). On the one hand, this is argued to be the consequence of climate change whereas on the other hand studies have demonstrated that the construction of dams in the upper Tana have significantly impacted on the discharge of the river and on the transportation of sediments and nutrients downstream. Similarly to the middle basin, the lower Tana is scarce in water resources mainly because of high evapo-

[4] Equity: the principle of equity implies that water resources are allocated in an equitable and fair manner among users and regions (WRMA, 2007; Speed et al., 2013)

transpiration rates and use for irrigated agriculture. This is the reason why a water allocation plan (WAP) would help regulate how water resources should be allocated among users at present and in the future years. In fact, planning the use of water resources is crucial as the drivers of change and increasing pressure (E.g. the Lamu Port and LAPSSET corridor project) might severely impact the availability, demand, supply and quality of water in the lower part of the Tana catchment area. A WAP might also be a useful resource to regulate conflicts between farmers and pastoralists over water resources in the Tana delta and in the area around Lake Kenyatta.

2.2.4 Drivers of Change and Pressures

Many are the ongoing and planned projects aimed at boosting the development of the Tana catchment area, especially regarding agriculture and infrastructures (E.g. the LAPSSET corridor project, new hydropower stations and new irrigation schemes).

According to Agwata (2005), the irrigation potential in the Tana River basin is estimated to be around 132,000 hectares with approximately 40% of this amount already in use under different irrigation schemes managed by governmental institutions and private users. It is estimated that this high irrigation potential will be among the most important drivers of change over the next years, especially in the lower part of the Tana catchment area. Here, the GoK seeks to increase the agricultural production for the food security purposes established under the Kenya Vision 2030. As a consequence, this change will have an impact on ground and surface water rates of abstraction and on the overall quality of surface waters.

Figure 5 captures the upper part of the Tana catchment area from the satellite, respectively in February 1987 (left) and February 2014 (right). The comparison of the two images clearly reveals a substantial reduction of woodland in the upper reaches of the Tana River and the consequent change in land-use over the years.

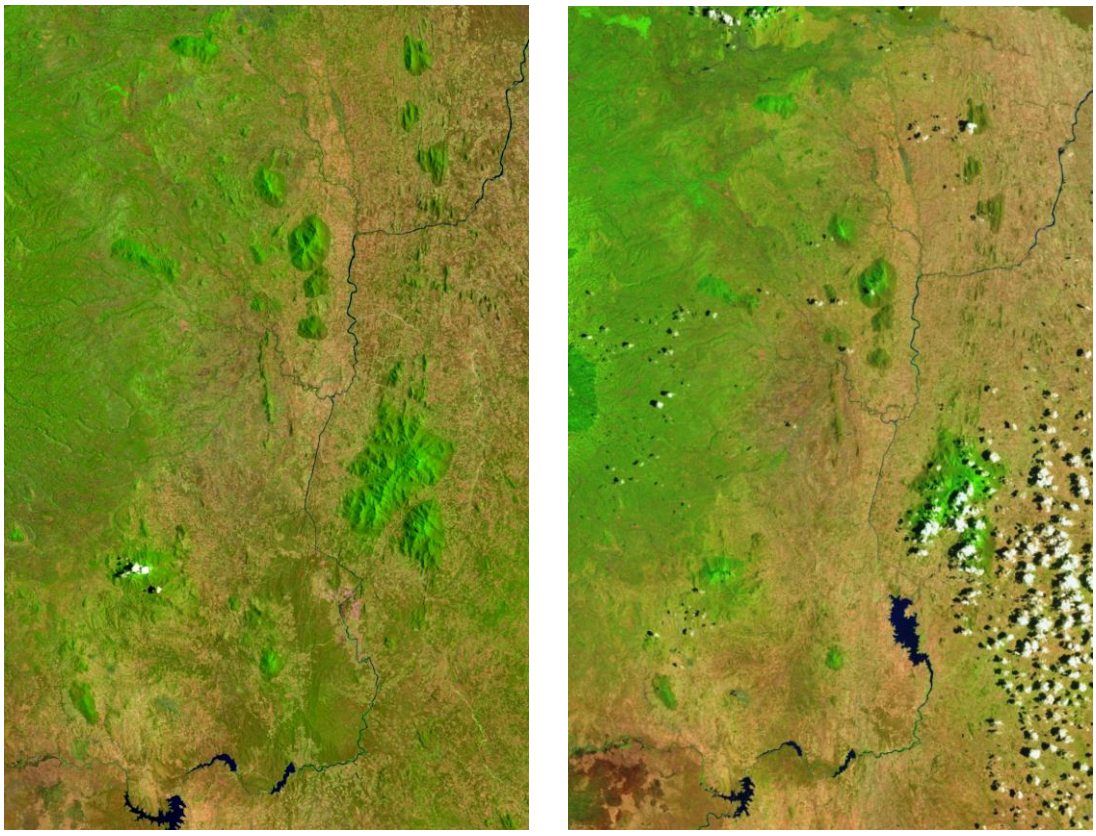

Figure 5: Satellite images of the upper Tana showing land-use change. Another major difference (see right image) is the new reservoir which was generated by the construction of the Kiambere dam (1988). Source: US Geological Survey, http://www.usgs.gov/. [accessed: 21/05/2014]

These drivers of change, together with climate change and climate variability, are expected to add pressure on the water resources of the Tana basin. So far, the weak institutional capacity has led to unsustainable water and land-use practices and to a general overlapping of mandates among the institutions that are currently working in the catchment area (WRMA, 2014).

If no appropriate strategy is implemented, it is likely that the overall quality and availability of water resources in the Tana basin will worsen and reduce over the next years. For this reason, policy-makers and stakeholders should cooperate more to enforce the existing strategies aimed at managing water resources sustainably, including the development of a WAP.

Table 2 summarizes the drivers of change which are likely to put pressure on the Tana basin's water resources:

Table 2: Summary of drivers of change in the Tana River basin.
X = Main drivers of change at present; (X) = Possible drivers of change during the next years
Source: Own creation based on Knoop et al. (2012), Maingi et al. (2002) and Agwata (2005)

Drivers of change in the Tana Basin	Upper	Middle	Lower
Infrastructures			
New dams (E.g. Rukenya, High Grand Falls)	X	-	-
New port (E.g. Lamu Port)	-	-	X
Others (E.g. LAPSSET corridor)	X	X	X
Agriculture and Land			
Irrigation schemes	X	X	X
Land-use change	X	X	X
Climate			
Climate change	X	X	X
Climate variability	X	X	X
Others			
Point and non-point water pollution	X	(X)	(X)
Population growth	X	(X)	X

These drivers of change are likely to impact the hydrology of Tana River and its tributaries, in particular the flow, the transportation of sediments downstream, the magnitude and frequency of floods and the quality of water resources. As a consequence, there will be repercussions on the ecosystem services such as riverine forests, savannah, mangroves, marine ecosystems and lakes. For all these reasons, appropriate strategies and responses should be drawn in order mitigate the threats to the equilibrium of the Tana River basin and to ensure sustainable management of water resources.

2.3. Available, Utilizable and Allocable Water Resources

Being at the core of water resources management, water allocation is not only a process aimed at giving entitlements for the use of water but it is actually an invaluable resource in order to avoid and solve conflicts between water users and among different

regions, especially in those contexts where water is a scarce commodity such as in Sub-Saharan Africa.

In order to develop a framework for water allocation, the amount of water available should first be assessed (Speed et al., 2013). In the case of the Tana basin, this is a challenge because of the unique complexity of the catchment and for the reason that there is a lack of updated data regarding the hydrology of the basin. In 1999, it was estimated that the Tana catchment area had an annual renewable freshwater availability of around 720 m^3 / y per capita whereas in 2006 this value dropped to around 380 m^3 / y per capita meaning severe water scarcity (WRMA, 2009). Further, according to the National Water Master Plan (NWMP) 1992, the surface and groundwater abstraction rates in the Tana catchment area were respectively 595.4 and 4.79 million m^3 / y (Knoop et al., 2012).

Figure 6 shows the average discharge of the Tana River at the gauging station in Garissa[5] between 1940 and 2003. The average value Qm (mean river discharge) over six decades has been around 183.45 m^3 / s. It is argued that no significant variation has been registered during this period apart except for the highest peaks in 1961 and 1997 caused by extreme rainfall events (WRMA, 2009; Conway, 2002). According to WRMA (2009), this stable trend is due to the fact that around the city of Garissa, the river might benefit from groundwater recharges.

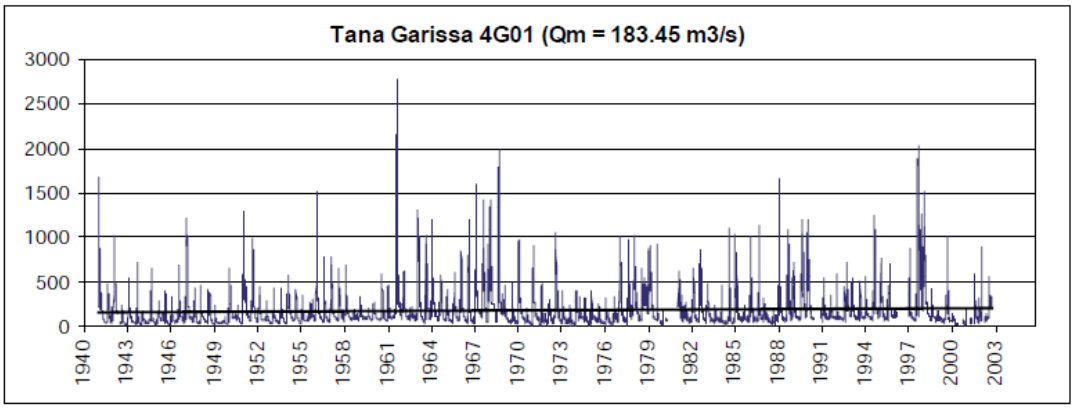

Figure 6: Mean river discharge at Garissa between 1940 and 2003. Source: WRMA, 2009

[5] Garissa is one of the main municipalities of eastern Kenya. It is located on the border of the middle and lower Tana and considered to be one of the best gauging stations along the Tana River for reliability of the data

Groundwater deposits vary according to the different parts of the catchment. For example, it is estimated that, being constituted mainly by volcanic and metamorphic rocks, the upper part of the Tana basin has groundwater storages which vary between 5 and 30 m^3 / ha. On the contrary, the arid or semi-arid climatic characteristics contributed to the formation of poor and localized groundwater reservoirs in the middle basin. Local and complex aquifers because of the neighboring coast are also registered in the lower part of the Tana catchment (WRMA, 2009).

The amount of utilizable water corresponds to the water available for abstraction. This amount depends on the hydrology of the basin as well as on the presence of infrastructures such as reservoirs which have the capacity to regulate floods and store water for further use (Speed et al., 2013). Utilizable water differs from allocable water which is the amount of water to be allocated among users and regions, given the value of utilizable water minus the reserve (R) and minus the interbasin transfers[6]. In the case of the Tana River basin, interbasin transfers have been proposed with the neighboring Ewaso N'giro River basin and with the Kapingazi River basin. However, WRMA (2009) has highly discouraged any transfer due to the impact that this could have on the water balance of the Tana basin. As a rule, interbasin transfers are not feasible solutions in cases such as the Tana catchment area where water resources are not sufficient to meet the needs of the different users within the basin (WRMA, 2009).

The reserve is a crucial concept that refers to the minimum amount and quality of water that the river itself needs to sustain the basic environmental and human needs. In the Tana Catchment Area Management Strategy (CMS), WRMA highlights that establishing the reserve is a priority and that it should be done before allocating water resources among different regions and users. To determine the reserve, WRMA has adopted the Water Resources Management Rules of 2007 which state that the reserve quantity for streams and rivers

> "shall, unless specifically stated to be otherwise, not be less than the flow value that is exceeded 95% of the time as measured by a naturalized flow duration curve at any point along the water course" (WRMA, 2009).

Figure 7 summarizes the concept of allocation of water resources as described in the CMS of 2009 and in the Water Resources Management Rules of 2007.

[6] Interbasin transfers means the transfer of water from one basin to another (WRMA, 2009)

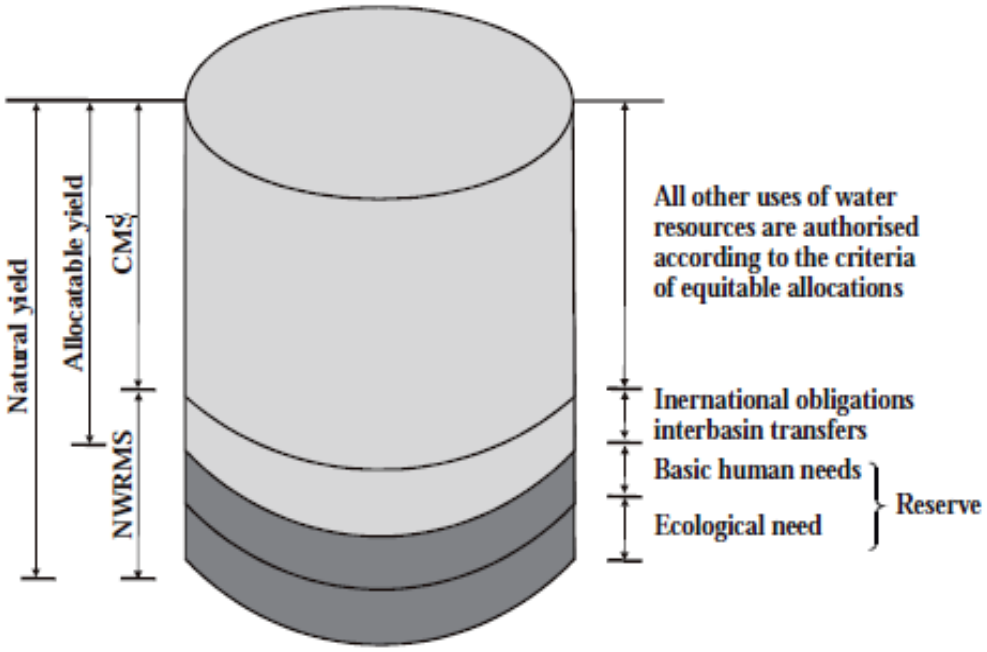

Figure 7: Concept of Allocation of Water. Source: WRMA, 2009

The concept of reserve is strictly related to water allocation as it constitutes the minimum amount and quality of water resources to be left for sustaining the basic environmental and human needs. Allocating water equitably therefore means giving priority to the reserve which, according to WRMA, corresponds to the Q_{95} (WRMA, 2009). Therefore, as shown in figure 7, the reserve should not be considered as allocable water.

At the moment, policy-makers and stakeholders are discussing about defining basic human needs. According to the CMS (2009), basic human needs correspond to domestic use meaning the use of water for households' indoor and outdoor purposes (USGS, 2014). However, there is much discussion about the quantity of water that should be allocated for this purpose as there are no clear criteria and data to determine it yet.

Furthermore, establishing the reserve quantity is particularly difficult in the Tana River basin as the ecosystem is very fragile due to natural and human-caused disturbances (WRMA, 2009). In addition to that, in the case of the Tana River basin there is also a lack of up-to-date information regarding the hydrology and particularly regarding the discharge (Q) which is necessary to establish the Q_{95}.

The reserve quantity is important in order to assess possible future scenarios of water allocation. As previously mentioned, it is expected that drivers of change such as population growth, climate change and climate variability will add pressure on the existing water resources and therefore impact the demand and the supply. Another important

aspect of water allocation planning is the yield. Speed et al. (2013) highlighted that the yield is the amount of water resources to be exploited and abstracted through reservoirs. After having allocated the reserve quantity, the remaining is considered allocable yield and it can therefore be allocated among different regions and users through permits and entitlements issued uniquely by WRMA.

2.4. The Tana Catchment Area Management Strategy, 2009: Overview

The Tana Catchment Area Management Strategy 2009, simplified CMS, is the most recent tool to regulate the management of water resources in the Tana River basin as it recognizes the great importance of protecting and conserving water resources while enhancing the participation of the public and the stakeholders in the decision-making process. The creation of the CMS was established under the Water Act 2002 according to which WRMA was appointed to create

> "a catchment management strategy for the management, use, development, conservation, protection and control of water resources within each catchment area" (WRMA, 2009).

For the first time in the history of Kenya, a strategy for water resources management in the Tana catchment area was drafted by WRMA in consultation with the other stakeholders. This was one of the major consequences of the Water Act which reformed the water sector and the rules of water management aiming to decentralize the decision-making and monitoring responsibilities. WRMA was created immediately after the Water Act for the purpose of managing water resources in the different catchments and sub-catchments of the country. In addition, WRMA is also in charge of releasing and enforcing the water rights and permits among users. In spite of the achievements, many are, however, the challenges in the Tana River basin that WRMA still has to face. Examples of such challenges are extensive illegal abstraction, lack of reliable data regarding the hydrology of the basin and regarding the status of water permits. Another major issue is the increasing pollution due to intense irrigation for agriculture and discharge of untreated wastewater from certain municipalities.

In the CMS, policy-makers established different strategies which, according to the IWRM approach, seek to ensure availability and good quality of water for all the users among

different regions. When the Tana CMS was formulated in 2009, it was agreed that it shall be reviewed every five years because of the expected changes in the environmental status of the Tana basin as well in the socio-economic situation of the population. At present, the first review of the CMS is currently ongoing under the UNEP – WRMA project "Institutional development and capacity building of the Tana Catchment Area for the rehabilitation of critical water ecosystems". The review is necessary because, in spite of the good strategies which have been generated in 2009, many of the objectives are only partially met. Therefore, the review is an opportunity to assess the strengths and weaknesses of the CMS and to provide the stakeholders with new ideas and possible solutions. As the strengths and weaknesses will be analyzed in the next chapter, this part rather aims at giving an overview of the CMS strategies as formulated in 2009.

The document has to be considered as an important step forward towards a more sustainable management of water resources in the Tana River basin. The first part of the CMS provides background information on the Tana River and describes the main challenges within the basin, from water scarcity to poor enforcement of water rights and permits, from water conflicts to illegal water abstraction. The second part consists of ten chapters that provide strategies aimed at addressing the issues of the Tana River basin while mainly focusing on land, water, public participation, monitoring and enforcement (WRMA, 2009). A brief overview of these strategies is undertaken in the following paragraphs.

Classification - One of the first strategies is the division of the catchment in Catchment Management Units (CMUs). According to the principle of devolution, the division of the Tana River basin in seventeen CMUs was among the first actions proposed by WRMA to encourage the local management of water resources. According to this, the newly established WRMA office for the Tana Catchment Area (WRMA TCA) located in Embu has been appointed to ensure sustainable water management in the Tana River basin with the help of five sub-regional offices (SRO) which are the reference point for two to three CMUs. As shown in figure The SRO in Kerugoya is responsible for the Ena, Thiba, Tana Karaba CMUs; Meru SRO manages the Ura-Tharaka, Mutonga and Kazita CMUs; Kitui SRO is responsible for the Lower Reservoirs and Tiva CMUs, etc.

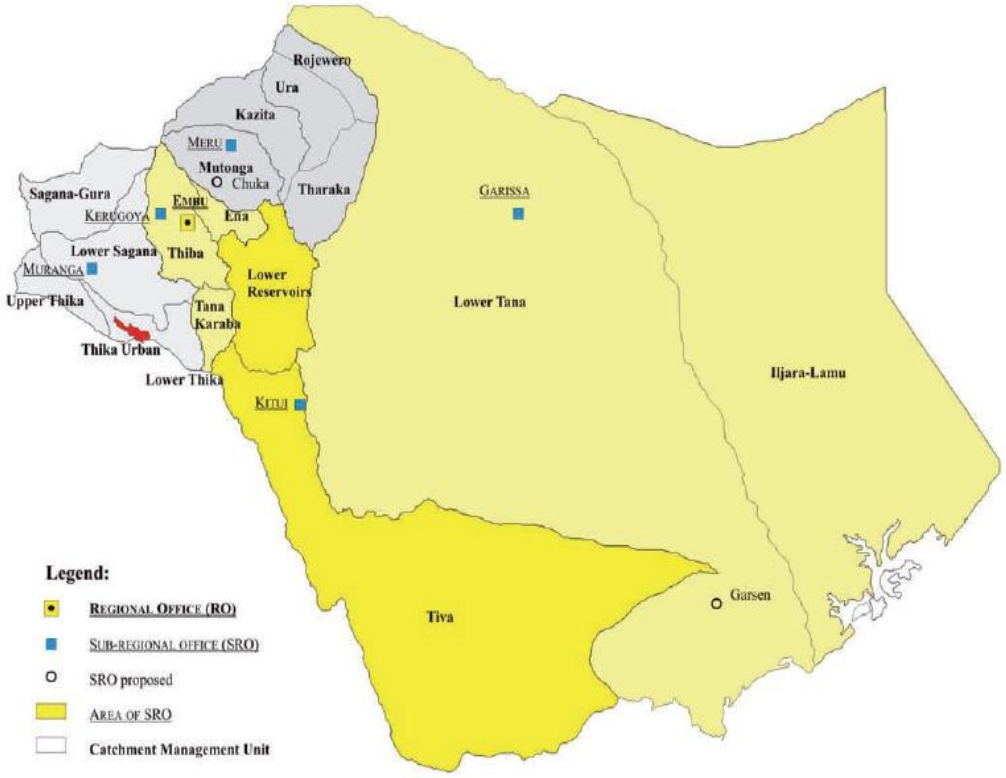

Figure 8: Map of the Tana catchment area according to the division in Catchment Management Units (CMUs). Source: WRMA, 2009.

Despite the lack of hydrological data, the criteria used to identify the possible CMUs included land use, vulnerability of water resources, their current quality status and the type, scale and nature of water demand. For this reason, water resources have been then classified according to three main types of uses, namely ecological (E), livelihood (L) and commercial (C).

Water Balance and Demand Management – The chapter highlights the importance to establish the reserve quantity by taking the Q_{95} as reference point. The assessment of the water balance for the Tana River basin is among the top priorities because of the high competition among different users such as industry, agriculture and hydropower. As highlighted in the CMS (2009),

> "the water balance for the Tana catchment was already negative 16 years ago (...). For the Upper Thika, Lower Thika and Tana Karaba CMUs, the water balance is positive only if the water demand for irrigation is not taken into consideration".

Considering the increasing number of anthropogenic activities and the overall water scarcity registered in the basin, it is a priority for WRMA to provide a feasible estimation of the water balance as this would also contribute to define the reserve quantity and help drawing a water allocation plan. At the moment, it is argued that no reliable estimations of the water balance are possible for the whole catchment. Only historical data based on the NWMP 1992 is currently available and it highlights that the water demand was higher that the quantity already available twenty years ago (WRMA, 2009).

In order to reach this balance, WRMA (2009) suggests to focus on the management of the renewable sources of water, namely natural surface water flows and renewable groundwater. Moreover, interbasin transfers are highly discouraged because of the overall deficit of water in the Tana catchment area and due to the already existing intra-basin transfers (WRMA, 2009).

Water Allocation and Use Management – Establishing the reserve quantity is among the first targets before allocating water. However, this is a very complex process that requires a profound understanding of the hydrology of the basin. Although according to WRMA, the reserve quantity for the Tana River and its tributaries should correspond to the Q_{95}, other recent estimations have suggested that the reserve quantity ought to be 30% of the flow and that this should also be applied to the tributaries.

As highlighted in the CMS (2009), the final objective is to draw a water allocation plan (WAP) for the Tana basin in order to regulate availability and demand for water while taking all users, including the environment, into account. However, in order to perform these tasks, WRMA needs complete and up-to-date data regarding water abstraction in order to perform

"effective metering, monitoring and compliance" (WRMA, 2009).

According to the permitting system currently in force, there are four different categories of water permit. Category "A" corresponds to a maximum 200 m^3 / day meaning low-risk of impacting the water resources (WRMA, 2010). This is the case for example of individual water abstractors for whom the permit is easy and rapid to be issued without any charge. Category "B" and "C" abstractors might have respectively a significant and measurable impact on the water resources. Factories, industries or irrigated agriculture usually fall under these categories. Category "D" is issued in case of complex situations that

have measurable impacts on water resources. Category “A”, “B”, “C” and “D” permits are issued by the WRMA Regional Office (RO) but category “C” and “D” first need the approval of the Catchment Area Advisory Committee (CAAC) (WRMA, 2010).

Despite the great efforts of WRMA TCA, the permitting system remains vulnerable. These are major issues that affect the enforcement of permits and consequently, the possibility to allocate water. As for example,

- Cases of permits which have expired and that are not renewed by the user;
- Cases of legal permits issued that do not correspond to the actual amount of water abstracted, either because of over or under-abstraction;
- Cases of permits issued and renewed that are, however, simply not used;
- Cases of permits that are simply not reviewed while the user continues abstracting water resources;

These cases demonstrate how difficult it is for WRMA staff to track and update the permitting system, in spite of the new technologies and means of communication. The reasons to explain the high rate of illegal abstraction are multiple. On the one hand, water was considered in the past a free good and the GoK used to provide it for free. Therefore, many users are now reluctant to pay for it. On the other hand, in many cases the measuring and controlling devices are not installed properly, do not work correctly, or are not installed at all or removed. In these cases, the water services providers may help measuring but this work has obviously a cost that many users do not want to pay.

Water Resource Protection - As the main goals of WRMA are to ensure that water resources are kept at their natural status, the protection of the water resources is widely discussed in the CMS. The protection and conservation of the good status of water resources influences the quantity of water that can be allocated. The overall status of water resources within the Tana catchment area is generally considered on the decline because of the increasing pollution due to discharge of wastewater along with agriculture based activities (E.g. coffee, tea, production of dairy products and meat).

Given this scenario, WRMA has set three criteria to classify both surface and groundwater resources according to the quality and quantity status, namely “satisfactory; no immediate stress, pressure or threat”, “alert; pressure or threat identified or anticipated” and “alarm; water levels declining and water quality deteriorating” (WRMA, 2009).

Considering the tributaries and streams within the Tana catchment area, WRMA (2009) has estimated that more than 40% are reporting an alarming status whereas only 10% are considered to be satisfactory.

Among WRMA's top priorities is the protection of the status of those rivers considered to be "satisfactory", to avoid their deterioration and to take and enforce measures that upgrade the status of polluted or severely polluted water bodies. The CMS (2009) highlights that in order achieve these targets, there is urgent need to collect reliable data to classify all water resources and to control the pollution. Moreover, the polluters, the interested parties and the lead and enforcement agencies such as WRMA, the National Environment Management Authority (NEMA) and the Water Resources Users Associations (WRUAs), should all be involved in actions to ensure the protection and conservation of the water resources.

If the current trend of declining water quality continues, it might be extremely difficult to allocate water in the future. Enhanced cooperation among the stakeholders is therefore crucial to ensure that the objectives of the CMS are met.

Catchment Protection and Conservation – Recommendations on the importance of limiting the degradation of land and water resources within the catchment are made in this chapter of the CMS. As previously highlighted by comparing the two satellite images of 1987 and 2014, the Tana basin has been subject to severe changes in land-use during the last decades. Consequently, phenomena such as deforestation, soil erosion and loss of natural vegetation have contributed to the degradation of the catchment with effects on both quantity and quality of water resources (E.g. increased surface runoff, reduced recharge, increased likelihood of experiencing floods, etc.) (WRMA, 2009).

This change in land-use and the consequent catchment area degradation have led to conflicts among residents of both rural areas and municipalities such as the Tana delta and the Kitui municipality, where water resources are becoming scarcer and scarcer. Further, the catchment area degradation has also led to the increase of pollution emitted by agricultural practices, runoff from the urban sites and extensive use of fertilizers.

In order to protect and conserve the water resources, WRMA (2009) identified seven types of land-use[7] to fit the different areas of the catchment and then identify the

[7] The seven types are namely A) Protected areas – water towers / forests, B) Groundwater conservation areas, C) Springs and wetlands, D) Riparian zones, E) Farmlands, F) Rangelands and G) Coastal zones (WRMA, 2009).

stakeholders responsible for protection and conservation. Enhanced cooperation among stakeholders is crucial in order to restore degraded ecosystems and enforce measures aimed at conserving and protecting water resources.

Institutional Development Support – This is a crucial part of the CMS as it describes the relationships between WRMA and the WRUAs and reinforces the need for public participation in its approach:

> "new management approach is the recognition that the people living in the catchment should be made aware of their valuable catchment assets and ensure that they actively participate to protect and preserve them" (WRMA, 2009).

With this statement, WRMA recognizes that without the involvement of all stakeholders and especially the contribution and support of the local population, sustainable management of water resources cannot happen. The CMS (2009) also highlights that WRMA's tasks include helping with the formation of the WRUAs and sustaining their activities. The relationship between the two institutions should be forged through capacity building trainings and programmes conducted by WRMA for the local users and through a mutual beneficial cooperation, which allows WRMA staff to also acquire new and useful knowledge of the local issues. Deepening the cooperation between WRMA and the WRUAs would help solve issues such as the water users' lack of management skills or the managing authority's lack of knowledge regarding the local issues. Further, WRUAs are responsible for the production of a sub-catchment management plan (SCMP) for their respective sub-catchment which is complementary to the objectives and principles of WRMA and which could help manage local water resources sustainably.

Water Infrastructure Development – The availability of water resources in the Tana catchment area is also low in areas such as the upper Tana, where rainfalls are frequent. For this reason, the strategy proposes to increase both the availability of water in the basin through surface and groundwater storage as well as the safety against floods. The construction of dams is a way to meet this goal although the Tana River basin is already home to all major reservoirs built in Kenya.

Table 3 provides facts and figures regarding the main dams built and planned in the Tana basin:

Table 3: Own creation, summary of the main dams and reservoirs built and planned in the Tana River basin. Source: WRMA, 2009. For more information: http://mobile.nation.co.ke/business/High+Grand+Falls+dam+construction+suspended/-/1950106/1968064/-/format/xhtml/-/jc6yq0z/-/index.html. [accessed: 20/05/2014]

Name	Year	River	Catchment Area in km^2	Gross Storage in Mm^3	Remarks
Sasumua	1956	Chania	65	16	Water supply to Nairobi
Ndakaini	1993	Thika	71	70	Water supply to Nairobi
Masinga	1981	Tana	7335	1560	Electricity production (40MW)
Kamburu	1975	Tana	9520	150	Electricity production (94.4MW)
Gitaru	1978	Tana	9525	20	Electricity production (147MW)
Kindaruma	1968	Tana	9807	16	Electricity production (44MW)
Kiambere	1988	Tana	11975	585	Electricity production (144MW)
High Grand Falls	2014 (planned)	Tana	-	Triple as Masinga Dam	Electricity production (500-700MW); As of June 2014, currently on hold)

Due to the sensitivity of the topic, WRMA has ensured that the construction of water storages such as dams will be strictly subject to environmental impact assessment and to large stakeholder participation. However, the construction of further reservoirs has led to a vivid debate between those who are in favor and those who are against these projects. On the one hand, stakeholders such as TARDA believe that the construction of the planned High Grand Falls dam will have a positive effect in regulating the floods by increasing the normal flow and reducing the peaks (Interview, 2014). On the other hand, other studies have highlighted how this new dam might reduce the transportation of sediments and nutrients downstream and have a negative impact on the riverine forest and frequency of floods in the floodplains located in the lower Tana (IUCN, 2003; Maingi et al., 2002).

Right Based Approach and Poverty Reduction – This chapter of the CMS elaborates on cross cutting issues[8] relevant for water management. The water permitting system elaborated by WRMA was established with the intention to include objectives such as poverty reduction, good governance and gender equity in parallel to managing water resources. The concept of reserve is strongly linked to this goal as it establishes the minimum quantity and quality of water to be left for the basic human and environmental needs.

When establishing the reserve, particular attention should be given to the needs of disadvantaged groups as this might contribute to solve potential conflicts over water resources. This is particularly relevant in the dry lands and in the Tana delta where the number of people living under extremely poor conditions is between 50% and 70% of the total population (WRMA, 2009). The same concept applies to the water permitting system with different categories of users which takes the socio-economic condition of the users into account (E.g. "A" users, usually individuals, do not pay the permitting fee).

Monitoring and Information Management – Priority should be given to restore and expand the monitoring and information management systems as they are both poor and heavily deteriorated. Sustainable water management and water allocation cannot be done without correct and up-to-date data. Therefore, revamping the monitoring and information management systems is a necessary step in order to provide users and policy-makers with reliable data on the condition of water resources in the Tana basin.

An alternative solution is suggested. This consists of monitoring surface and groundwater quality and quantity with the help of the WRUAs, the local communities and the relevant stakeholders. The acquired information, intended to be for the public and every other stakeholder, can be accessed from databases at regional and sub-regional level. Ultimately, the chapter highlights the importance of

> "continuously evaluating the achievements and failures so that the management strategy for monitoring can be revised and the lessons learned are acknowledged" (WRMA, 2009)

[8] For cross cutting issues, WRMA identifies human rights, conflicts resolution, poverty reduction, water security, good governance, gender equity and HIV / AIDS mainstreaming (WRMA, 2009)

Financing and Implementation – Substantial investments are needed for WRMA to perform its mandate. At the moment, self sufficiency is not possible because of the many gaps in the compliance and enforcement sectors. Therefore, contributions are needed from the GoK and from other supporting organizations and donors. Among the strategies aimed at reaching self-sufficiency, the proposal to retain the revenues collected from the water fees within the original CMUs is particularly relevant. As the water sector has always been on a budget or without sufficient funds, it is important to collect revenues from other applications namely wastewater discharge and hydropower.

3. Developing a Framework for a Sustainable WAP in the Tana River Basin

3.1. Water Allocation Mechanisms and Principles

Before introducing the mechanisms and principles, it is important to define the concept of water allocation planning. This is generally referred to as a process to determine the total amount of water available within a region or a basin. The result of this process is the water allocation plan (WAP) which defines the entitlements of water among different users and regions. These entitlements are usually defined on an annual or long-term basis and refer to different categories of water resources. Commonly, water allocation plans might take into consideration the total amount of available water resources in a basin, consisting of surface water and groundwater. Further, they could also refer to either the amount of water available for abstraction, depending on the hydrological situation of the basin and the infrastructures in place, or to the amount of water that can be shared among different users and regions (Speed et al., 2013). In short, WAPs aim to confer entitlements to users and describe how water resources are shared in a particular region on an annual or longer-term basis. According to the IWRM principle, WAPs are valuable tools as water is, in many cases, the limiting factor for food and energy production as well as for economic development. Historically, water allocation planning was aimed at solving issues over control and access to water resources and to regulate the utilization of water among different users and regions. More in detail, Speed et al. (2013) define water allocation as a process to determine

> "how much water is available for human use and how that water should be shared between competing regions and users".

At present, the objectives of water allocation planning still remain the same but the way water resources are shared among different users has become increasingly complex. In fact, during the last decades, the socio-economic changes of our global society have brought a new approach towards water allocation planning as population growth, changes in the economies, climate change and other relevant factors emerged and impacted water demand and supply. Water allocation planning evolved from a historical local or regional tool that was aimed at sharing water resources equitably among few users, to a more complex instrument that defines who uses a certain amount of water and for which purpose over

larger river basins (Speed et al., 2013). One important difference with the past is that, according to the IWRM approach, policy makers not only assess the tradeoffs for anthropogenic use, but include the environment as such by entitling it as a specific user of water (Speed et al., 2013).

There is one main precondition to develop a water allocation plan namely the assessment of spatio-temporal variations with reference to users and allocable water. On the one hand, it is necessary to know who the users are – including the environment – in order to estimate how much water each one of them needs to perform its activities – or in the case of the environment, to sustain its ecosystem services. On the other hand, before policy-makers decide how water should be allocated, it is essential to know how much water is available in the region or in the river basin chosen for the plan (Speed et al., 2013). In river basin management (RBM), it is important to know the amount of surface and ground waters within the catchment area and to analyze the differences in terms of geology, climate as well as socio-economic development. Further, the bigger the river basin is, the more challenges policy-makers will have to face whilst drawing a water allocation plan.

The Tana River basin is an extremely complex case of a catchment area that suffers from increasing pressure on its water resources. It is a perfect case study for water allocation planning since the drivers of change (E.g high climatic variability, population growth, plans to boost agriculture and hydropower production in the basin, higher demand and lower supply, illegal abstraction, etc.) pose a series of unique challenges for policy-makers and stakeholders. As water is the limiting factor for energy and food production as well as for water supply and socio-economic development, a clear understanding of the total available water resources within the catchment area is needed in order to develop a water allocation plan.

As previously discussed, the goal of planning water allocation is to assign permits and entitlements for the use of water. The way to assign it varies according to the different geographical region and rules but there are certain core criteria and principles that are universally valid:

- *Equity*: the principle of equity implies that water resources are allocated in an equitable and fair manner among users and regions (Dinar et al., 1997; Speed et al., 2013). Water resources might be scarce and extremely valuable and in the case of Kenya they are subject to diverse phenomena such as illegal abstraction and fast environmental degradation. For this reason, WRMA (2007) highlights that the

implementation of the principle of equity is among the biggest challenges in Kenya and especially in the Tana River basin.

- *Balance between demand and supply – predictability:* according to this principle, WAPs are aimed at balancing water demand and supply. The goal is to minimize the uncertainty due to natural variability and anthropogenic activities and to avoid unexpected events such as shortfalls of water (Speed et al., 2012).

- *Efficient use of water resources – flexibility and security*: Policy-makers and stakeholders should allocate available water resources in the most efficient way. Therefore, WAPs should maintain a certain degree of flexibility in order to include possibilities for quick reallocation. Flexibility, however, should not impact the already allocated amount of water as security for existing users should be maintained. WAPs should therefore include, where possible, a reserve amount to be allocated in cases of unexpected events (Speed et al., 2013; Dinar et al., 1997). In the case of the Tana River basin, this is particularly challenging because of the drivers of change such as population growth, climatic variability and climate change, and due to the severe scarce water conditions of the basin.

- *Development and environmental protection*: Speed et al. (2013) affirm that water allocation should also promote and sustain socio-economic development. However, this should not be done to the detriment of the river, i.e. it is important to protect its ecosystem services (E.g. water quantity, quality, sediments transport, wildlife conservation, etc). The trade-off between sustaining development and protecting the environment is therefore a key challenge for policy-makers and stakeholders when allocating water resources. The same applies to the Tana River basin because of the various hydropower and irrigated agriculture projects ongoing or planned according to the Kenya Vision 2030.

- *Political and public acceptance, administrative feasibility and efficacy*: as Dinar et al. (1997) highlight, water allocation mechanisms should be feasible, should also allow for changes and should expand their effect on other users. Moreover, public, stakeholders and policy-makers should be the first ones to accept and recognize the value of water allocation plans as they are set to provide society with solutions to

problems and new objectives to reach. Efficacy is another key aspect of WAPs. This means that their implementation should ameliorate the current situation of the users (E.g. regarding pollution, depletion of water resources, etc.).

Generally, water allocation plans are subject to two main challenges namely variability and uncertainty. Variability affects the amount of available water resources because of seasonal and annual differences. Depending on the region, the phenomena of variability can be due to monsoons, droughts but also interseasonal differences. For example higher precipitations and snow melting in higher latitudes or the difference between dry and wet seasons at the equator (Speed et al., 2013). Variability is particularly an issue in river basins that register high seasonal variations and climatic differences like the Tana River basin. In these cases, the arid season can be accompanied by variable rainfalls which challenge water allocation planning. Despite the difficulties, implementing rules and regulations and planning how water resources should be allocated is the only response to variability in order to provide users and environment with the adequate amount of water to sustain socio-economic activities and ecosystem services.

Uncertainty is another challenge in water allocation planning. As many studies highlight, climate change (CC) is one of the leading factors for uncertainty. For example, CC contributes to rising temperatures, which might increase, among others, eutrophication. CC will also bring changes in the seasonal patterns of the rivers which alter the frequency of floods and droughts and the availability of water resources. The uncertainty due to climate change and climate variability makes water allocation difficult to plan. Another major cause of uncertainty is unforeseen socio-economic developments that impact the water demand. Overall, these causes contribute to making future water allocation scenarios very uncertain in the long run. With reference to the Tana basin, variability and uncertainty are two major challenges to address when allocating water. This is because current climatic variability, rapid socio-economic development and future plans of boosting agriculture and hydropower are likely to pose additional pressure on water resources.

Water allocation plans should not only consider options to reduce short-term uncertainty and variability (E.g. by reducing the amount of water resources allocated for a specific agriculture practice; by maintaining allocation for domestic use unchanged) but should also take into consideration the impact of socio-economic development and climate change in the long run. For example, a water allocation plan in the Tana basin should not only cover the current needs but also provide possible scenarios on how water resources

should be allocated to meet the Kenya Vision 2030 objectives. Uncertainty could be reduced by including reserves in the WAP, and allowing for sufficient amount of water to meet possible future increases in the demand. Moreover, policy-makers and stakeholders should draw a WAP which can withstand unforeseen and unprecedented events. However, these two strategies can only be possible if information is regularly collected, monitored and constantly updated and if the competent authorities are able to enforce the decisions established within the plan.

WAPs are complex tools as the stakeholders involved are usually many and the uncertainty and variability might be high. Further, water allocation plans are unique as every region is profoundly different. For this reason, the approach used by the competent authorities to develop a water allocation plan should fit the single river basin and its unique natural and socio-economical conditions. To give some idea of what policy-makers and stakeholders should take into account when planning, Speed et al. (2013) distinguish among three different categories of river basins. Table 4 summarizes the main concepts:

Table 4: Own creation, summary of three different categories of river basin and related strategies for water allocation planning. Source: Speed et al., 2013

River basin	Strategy for WAP
Unregulated and low-utilized basins	Focus on how to allocate water during the dry seasons and droughts Possible caps on abstraction
Hydropower and developing basins	Annual rules for water users (need to be established in detail) Set environmental needs (reserve) Consider the tradeoffs with socio-economic development
Fully allocated or over allocated basins	Tradeoffs among users and need to solve conflicts Detailed allocation plan Consider reallocation

The first category refers to basins where water stress in confined to droughts and dry season and where the major challenge is to allocate water resources among users during those periods. In this case, a simple water allocation plan focused on allocation during dry periods constitutes a first solution. The category of hydropower and developing basins refers to water bodies which have a high hydropower potential and developing possibilities, as their waters are not fully utilized yet (E.g. high storage capacity). In this case, policy-makers and stakeholders need to develop a more detailed allocation plan which addresses both anthropogenic and environmental needs. Regarding the last category, fully allocated or over-allocated basins, there needs to be very detailed allocation plans so as to avoid that no or little quantities of water remains for further allocation.

According to these considerations, the Tana basin has characteristics of both hydropower-developing and fully allocated basins. The numerous ongoing and planned projects and the need to set the reserve quantity require careful and precise regulation and planning. Further, the scarcity of water and the high probability of conflict among users need to be addressed through a detailed allocation plan that also includes reallocation as an option. A water allocation plan for the Tana River basin is needed not only to regulate the use of water resources for anthropogenic activities and environmental needs but also to control phenomena such as illegal abstraction and the rise of possible conflicts among users.

3.2. The Role of the WRUAs in the Tana River Basin

The community is among the most important stakeholders meaning that the organizations and the people living in the basin are key to solving management related issues (WRMA, 2009). For many African countries including Kenya, political decentralization helped address unsustainable water management. The centralized governance system which ruled the water sector before the Water Act (2002) failed to manage rivers sustainably. This has been demonstrated by the extensive degradation of the basins and by widespread illegal abstraction. The lack of up-to-date data and implementation of the existing management regulations further contributed to enhancing these problems and required the GoK to find prompt solutions.

WRMA has the mandate to manage water resources and to promote a strategy for the conservation, protection and sustainable management of water resources for each river basin in Kenya. This shift of powers from the government to WRMA was a turning point marked by the adoption of integrated water resources management. This was however also a challenge as the institution needed to be responsive to the needs of the local population and the many stakeholders. For this reason, the 2002 Water Act established that the country would be divided into six main catchment areas and that two other institutions, the Water Resources Users Associations (WRUAs) and the Catchment Area Advisory Committees (CAACs) would help WRMA in managing water resources while engaging the local community.

Around the world and in Africa, several water users associations have been formed in the last decade aimed at engaging the local community in water resources management.

According to the principles of IWRM[9], the water users associations have the potential to bring together users that want to administer, protect and conserve water resources for their mutual benefit. The way users are engaged and the way they manage water resources varies from country to country and from place to place but the general goal is to help the authorities to solve conflicts, enforce laws and regulations as well as monitor the status of water bodies. This is also the reason why these associations have high potential for being successful in managing water resources sustainably as they represent the interests of the users and are more aware of the challenges and opportunities in their local area than anyone else (WRMA, 2009).

According to the Water Resources Management Rules of 2007, a WRUA is defined as

> "an association of water users, riparian land owners or other stakeholders who have formally or voluntarily associated for the purposes of cooperatively sharing, managing and conserving a common water resource". (WRMR, 2007)

Among others, the WRUAs have the potential to increase the availability of water and maintain good water quality. As highlighted by Watson (2007), the mandate of the WRUA

> "ends when its river joins another of a different name below the confluence".

A WRUA might also be defined simply by considering the catchment area, namely an area of land bordered by natural features from which surface water flows into streams and rivers. In regards to the Tana River basin, this has been the criteria for the formation of the Gatondo – Icakimangu WRUA located in the region of Kerugoya, upper Tana.

[9] The principles of IWRM are also known as the Dublin Principles established at the World Summit in Rio de Janeiro in 1992. These are: A) Water is a finite and vulnerable resource; B) Water development and management should be based on a participatory approach; C) Women play a central part in the provision, management and safeguarding of water; D) Water has an economic value in all its competing uses and should be recognized as an economic good. Source: International Conference on Water and the Environment, 1992. For more information: http://docs.watsan.net/Scanned_PDF_Files/Class_Code_7_Conference/71-ICWE92-9739.pdf. [accessed: 23/05/2014]

According to the Secretary of this WRUA, who has granted an interview during the field visit in Kenya in April 2014,

> "the direction of the river and its catchment area indicates the WRUA you belong to. Our WRUA belongs to the catchment of the rivers Gatondo and Icakimangu. For you to be a member, you have to be a riparian, or an individual user" (WRUA, 2014).

Figure 9: Chairman and Secretary of the Gatondo – Icakimangu WRUA with the representatives of WRMA TCA and Kerugoya SRO. Source: Author, 2014

The Water Resources Management Rules of 2007 define the relationship between the WRUAs and WRMA, including the legal status and the aspect of financing. After having obtained recognition as trusts or in the registrar of societies, the WRUA is officially recognized by WRMA. The two institutions sign a memorandum of understanding (MoU) according to which WRMA may provide financial, technical and administrative support (WRMA, 2007).

The membership of the WRUAs varies from association to association. However, the members are generally organized in formal and informal institutions. Riparian users, namely those that own land along the river, single abstractors (E.g. those users that have a regular permit to abstract water from the river) and non-consumptive members (that is those that

are not making use of water resources but still contribute to the association) are grouped under the umbrella of informal institutions. The formal water users are mainly governmental organizations other than the main water management authority, NGOs, etc. These users mainly maintain their position in the association as observers.

According to Wanyumu (n.d.) a WRUA is formed through various steps. First of all, the stakeholders need to be identified. This is generally followed by the election of a committee which guides the association towards the adoption of its constitution. The next step includes capacity building trainings conducted by WRMA which will also financially support the activities of the WRUA.

Over the years, the WRUA will be responsible for developing a sub-catchment management plan (SCMP) which aims to identify the key issues, problems and priorities of the local catchment area. The SCMP will also help the WRUA setting the rules for water resources management within their sub-catchment.

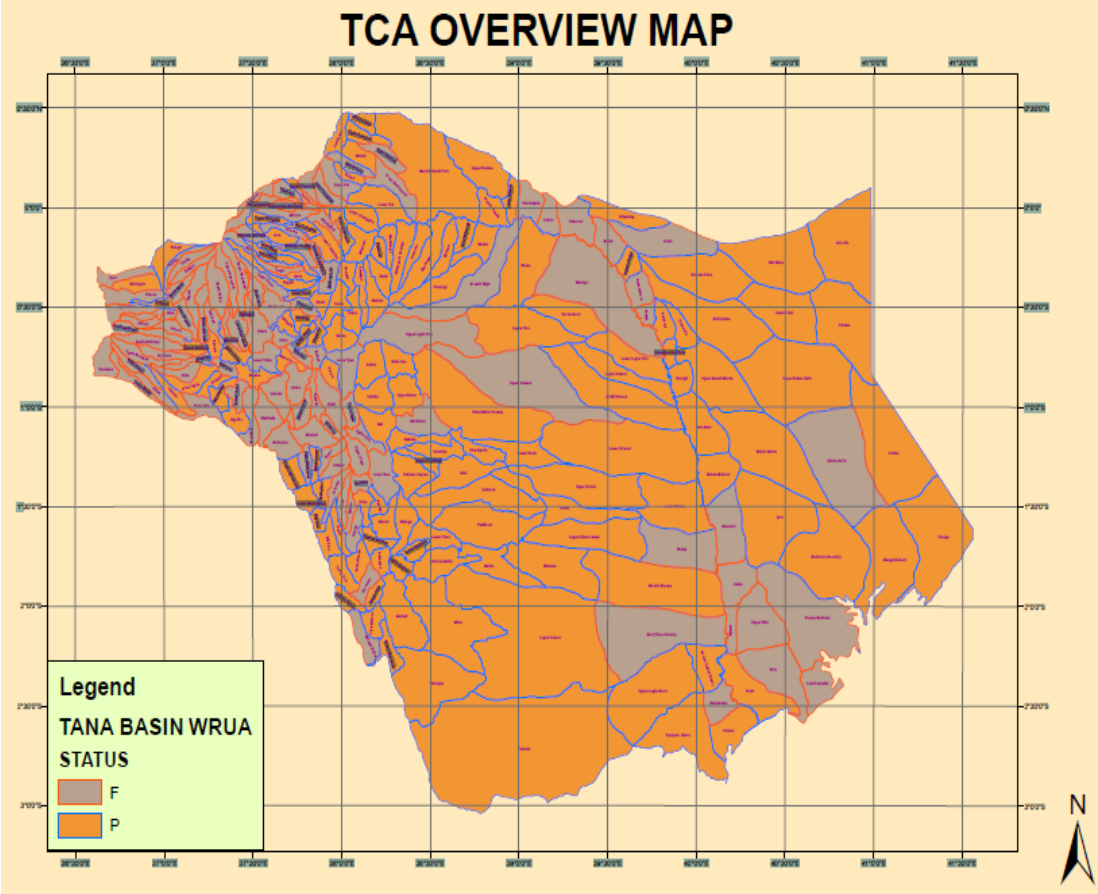

Figure 10: Map of formed (F-gray) and proposed (P-orange) WRUAs within the Tana catchment area. Source: WRMA, 2014

In the case of the Tana River basin, the WRUAs have potential to be key players in water resources management as water scarcity and conflicts over existing resources require further mediation among regions and users. The strong involvement of WRUAs constitutes a way to ensure equitable allocation of water within a sub-catchment. Further, the involvement of WRUAs might also contribute to solving technical issues such as monitoring the abstraction and reporting the data to WRMA.

However, the establishment of a WRUA is a complex process. First of all, the case of WRUAs in other areas of Sub-Saharan Africa revealed that it is not sufficient to just have a committee, regular meetings and a statute. Most importantly what is needed is the financial support of the water management authority – in the case of the Tana River basin, WRMA. Further, it is important for the WRUAs to have a stable institutional basis and a clear organizational scheme (Elias, 2011). This is a fundamental prerequisite to fight corruption or manipulation which would undermine the role and effectiveness of the association. Other major issues include monitoring the organization and ensuring that the rules on which the users have agreed upon are respected. A further crucial aspect for the success of the WRUA is to plan ahead and to involve as many users as possible. As highlighted by many studies, water scarcity and rural poverty do not encourage many users to plan the future as they mainly focus on immediate benefits and consumption of water resources (Elias, 2011). It is therefore important for the WRUAs to engage the local users and explain them the advantages of being part of an association that looks to the future and ensures that the mutual benefit of the users remains a top priority.

According to Watson (2007), the role of the WRUAs as representatives of the local users is particularly relevant to solve social issues as opposed to technical problems. However, the WRUAs might also contribute to solve other problems like for example data collection. As previously discussed, the lack of reliable data does not allow WRMA to draw a water allocation plan. From the literature and the interviews conducted during the field visit, this remains an issue for all sub-catchments within the Tana River basin. The intervention of the WRUAs can therefore make a difference as their presence in the field can guarantee monitoring and collection of data which can then be transferred to WRMA and used among others, for water allocation planning. Further, the WRUAs might also contribute to enforce water permits and report illegal abstractors.

The field visit to the Gatondo – Icakimangu WRUA has helped understand why the WRUAs might be potential key players in water resources management. The Gatondo – Icakimangu WRUA is located in the region of Kerugoya, upper Tana, approximately 120 km

north-east of the capital city Nairobi, within an intensively cultivated area. The main problems, as explained in a recent interview[10] by the secretary of the Gatondo WRUA, are floods during the rainy season, water pollution due to erosion, siltation, fertilizers and wastewater from houses and competition over water resources during the dry season. Since its establishment, the WRUA has worked to solve these issues and has created its own SCMP which set the rules for a sustainable management of the water resources. For example, regarding abstraction the Secretary (2014) said that

> "(…) the people living from there up to the source will be watering their crops on Mondays and Thursdays. Two days because we know that the crops require water two or three times per week. From here up to that bridge, they will be doing the same on Tuesdays and Fridays. In another portion they will be doing it on Wednesdays and Saturdays. This way, we have covered everybody. Sunday is left in case someone needs some extra (…)"

Furthermore, other measures to prevent floods and soil erosion have been implemented. These include building terraces and fences, planting napier grass and water fed trees along the borders of the Gatondo catchment area to retain more water. These simple measures allowed the users to reduce the impact of erosion and siltation which consequently resulted in better water quality. Despite the progress, issues of water pollution, especially during the rainy season and due to fertilizer runoff remain.

[10] The interview with the Chairman and Secretary of the Gatondo – Icakimangu WRUA took place during the field visit in Kenya, April 2014. A selected part of the interview can be found in the Appendices of this thesis.

Figure 11: The Gatondo tributary affected by siltation and soil erosion, especially during the rainy season. Source: Author, 2014

The good results achieved by the Gatondo – Icakimangu WRUA are useful to demonstrate that WRUAs can really make a difference in terms of promoting better and more sustainable water resources management, starting with the sub-catchment management plan. Maintaining this good trend is, however, a challenge. Huge investment in energy, time and financial resources are needed, especially at the beginning. Further, establishing and maintaining a WRUA might be easier in the upper Tana due to access to infrastructures and because of the relative personal wealth of the population. The situation is different in the middle and lower Tana, where poverty or no access to infrastructures, dry climatic conditions and tribal conflicts can prevent the establishment of a WRUA. In fact, figure 9 shows that the majority of the formed WRUAs are located in the upper part of the Tana River basin. Further, the constant support of WRMA is necessary to financially sustain the WRUAs and to enhance their capacity.

Financing is another major issue as the main source of income for each WRUA comes from WRMA or from private farmers or individuals who have a personal interest in contributing to the functioning of the association. Individual contributions help the financial condition of the WRUAs but are a risk for the democratic stability and organization of the association. Therefore, enhanced cooperation with WRMA should be prioritized.

As suggested by Watson (2007), a solution would be that WRMA diverts

> "some of any money it ultimately raises from water charges back to help the formation of new WRUAs or to fund existing ones. It would certainly be good for consumers who pay for water to see some of their money being recycled back into the system".

As highlighted by Watson (2007), there are opportunities for the WRUAs to apply for further funding (E.g. the Service Trust Fund or the Constituency Development Fund) but these are too little to cover the needs of all associations registered in the Tana River basin. Regarding future developments, the Secretary of the Gatondo – Icakimangu WRUA highlighted in the interview (2014) that there is a need to fill the gaps in data collection and enforcement. In this regard, hiring new professionals to link WRMA to the WRUAs would be beneficial for all. These new professionals should contribute to collect important hydrological data and monitor the sub-catchments. They could be chosen among the members of the WRUAs and should be duly trained by WRMA.

Figure 12: A woman walking nearby the Gatondo tributary. Source: Author, 2014

Overall, the challenges and opportunities of establishing and managing a WRUA have been presented. The WRUAs are crucial to ensure a sustainable management of water

resources and should therefore be empowered accordingly. All the major stakeholders and partner institutions that work in the Tana basin such as WRMA, UNEP and GIZ have understood the potential key role of the WRUAs. In fact, these associations can really be a solution for the various issues of water resources management, not only for the Tana River basin but also for Kenya. Empowering the WRUAs will help fill the gaps between WRMA and the local communities and enforce the implementation of existing strategies. In the future, this requires allocation of additional funding to support the activities of WRUAs, to train them and work on capacity building.

The creation of WRUAs is among the most successful results of the top-down delegation of powers and might also be among the best solutions to the challenges faced in the Tana River basin. Further recommendations will be made in the next chapter.

3.3. Tana Catchment Area Management Strategy, 2009: Strengths and Weaknesses

This part consists of a personal evaluation of the strengths and weaknesses of the Tana Catchment Area Management Strategy based on stakeholders' opinions, interviews and information, collected during the field research trip to Kenya in 2014.

The catchment management strategy is extremely valuable as it addresses the need for sustainability in water resources management. However, many of the objectives and strategies set in 2009 are not yet achieved and need more time and resources to be implemented. There are many reasons to explain this including, among others, lack of accurate and up-to-date hydrological data, environmental degradation, climate change and climate variability and lack of financial and human resources. The overlapping mandates among the stakeholders have been another issue that negatively impacted the implementation of the strategy.

The current situation reveals that, during the formulation and implementation of the new CMS, the dialogue among the stakeholders should be enhanced as well as cooperation. WRMA should be consulted regarding water resources management at any stage of the decision-making process. According to the IWRM principles[11], enhanced dialogue, participation and cooperation would be beneficial for WRMA, for the other stakeholders and

[11] Principle 2 of IWRM establishes that "water and development should be based on a participatory approach, involving users, planners and policy-makers at all levels". Source: Gumbo et al., 2001

the public which would then be in a position to actively manage the water resources of the Tana River basin together with the other stakeholders.

Water allocation is broadly discussed in the CMS and a WAP for the Tana River basin is the ultimate goal. However, there are many challenges to creating a WAP including, among others, lack of data regarding the hydrology and massive illegal abstraction. In fact, it was recently estimated that more than 50% of surface water abstractions in the Tana catchment area are illegal and do not comply with rules and permits. Many users do not want to pay for a permit or do not renew it and in many cases the quantity abstracted does not correspond to the limits established by WRMA in the entitlement. As enforcement is crucial in order to fight illegal abstraction, the monitoring and measuring system needs to be carefully reviewed.

The strength of the CMS lies in the bottom-up approach which encourages the inclusion of policy-makers, public and stakeholders in the decision-making process. Further, the CMS also recognizes the importance to start the implementation of the strategy from the local level, meaning from the sub-catchments. In spite of the many challenges, this approach should help collect reliable data, encourage monitoring and enforcement and ultimately, allow the formulation of a water allocation plan for the Tana catchment area.

According to the opinion of the major stakeholders, the interviews and the information collected during the field visit in Kenya, a critical assessment of the main issues discussed in the CMS is elaborated in this thesis.

Classification: The creation of the CMUs is among the strengths of the CMS as WRMA intended to group similar areas of the Tana catchment together in order to simplify the management of water resources. Further, the classification of the water resources according to their main use namely ecological (E), livelihood (L) and commercial (C), helps understand the Tana River basin and provides stakeholders and policy-makers with a good overview of which quality of water should be expected in a specific area. Due to quick socio-economic and environmental changes, it should be noted that this classification needs to be continuously reviewed and updated by WRMA in cooperation with the WRUAs and the stakeholders. More accurate and up-to-date data regarding both quality and quantity of water resources in the Tana River basin is therefore needed. Lastly, the quality objectives for each category of use need to be set.

Water Balance and Demand Management – This is one of the most challenging topics because water balance and demand management might be extremely variable in the Tana catchment area. For this reason, the differences such as climate, socio-economic development and land-use are to be considered. The establishment of pilot areas can help WRMA TCA to better study a certain area, to collect important data and to attempt defining the future water balance. The engagement of the local WRUAs is fundamental as they could help WRMA in monitoring the pilot areas. Moreover, the estimation of water balance and demand should be made by consulting all the relevant stakeholders since any new infrastructure or agriculture project might severely influence the current and projected water balance and demand of a certain area. Further, interbasin transfers between catchments and regions should be excluded as this might negatively impact the water balance and the demand where water resources are already scarce.

Water Allocation Planning – The CMS provides an overview of what are the challenges for water allocation in the Tana basin. Illegal water abstraction, definition of the reserve quantity and enforcement of the water permits are among the most important ones. Regarding the fight against illegal abstraction, WRMA would benefit from the strong involvement of the WRUAs as their presence in the field could help the enforcement of water permits. Moreover, the WRUAs could conduct daily or weekly inspections to verify the compliance of water users while collect relevant data not only on abstraction rates, but also regarding water balance and demand. As the WRUAs' contribution is crucial to implementing these strategies, their position and role should be carefully reviewed and empowered.

The new CMS should highlight the need to set the reserve quantity because this would help understand the amount of allocable water for other uses. As previously explained in chapter 2.3, the reserve quantity can be set as the Q_{95} value. However, other recent estimates suggested that in the case of particularly fragile rivers such as the Tana River and its tributaries, the reserve should correspond to 30% of the flow. Setting the reserve should be done based on up-to-date data which in many cases is not available. For this reason, careful studies should first help determine a reserve quantity that should then be tested in specific pilots in each sub-catchment.

Water Sources Protection – The strategies regarding water quality also need careful reviewing. In fact, there is need to assess the quality of both surface waters and renewable groundwater. Further, it would be crucial to understand who the major polluters in the Tana

basin are, what the impact of their activities on water resources is and how it is possible to bring them back into compliance. This should be done by WRMA with the help of the WRUAs, the local communities and the relevant stakeholders which can further contribute in monitoring, data collection and enforcement. In case the stakeholders do not have the necessary skills, WRMA should provide them with trainings to acquire knowledge on water quality and monitoring. The review of the CMS is an opportunity to emphasize the issue of water quality as a top priority. In fact, in cases of severe pollution of water resources, the allocation of water is no longer possible.

Catchment Protection and Conservation – The new CMS should strongly emphasize the important link between land-use and water resources. In fact, there are cases of water related conflicts that find their origin in land-use issues. Once more, the new document should highlight the need for stronger cooperation and information sharing among the stakeholders. A first step forward has been the classification of the basin according to seven different types of land. This should help identify the relevant stakeholders for the conservation and protection of water resources. Also in this case, the involvement of the local communities and the WRUAs could help WRMA in implementing the CMS strategies. Up-to-date data is also needed to identify groundwater storages which, being non-renewable water resources, need particular attention.

Institutional Development Support – The institutional development support is the key for a successful and sustainable management of water resources during the next years. The CMS 2009 emphasizes the importance of the WRUAs and the relevance for them to develop a sub-catchment management plan to manage the local water resources. As previously discussed, the role of the WRUAs should be carefully reviewed as many current issues of the Tana basin might a find solution thanks to a stronger cooperation between WRMA, the WRUAs and the local communities. Within five years, the presence of the WRUAs should be guaranteed in 50 – 75% of the Tana catchment area. This would mean an important step forward towards a more sustainable management of water resources in the Tana basin. It is also recommendable that within five years, all the already established WRUAs have written their own SCMP and implemented the pilots for water quality monitoring and determination of the reserve.

Water Infrastructure Development – The development of new infrastructure is a sensitive topic and should be subject to a strong debate to allow for public participation during the decision-making process. The new CMS should give priority to the construction of low impact projects such as small, stream based WRUA dams, rain water harvesting and groundwater recharge. At the same time, the new document should emphasize the need for careful review of proposed and ongoing high-impact projects (E.g. the High Grand Falls dam) as these might severely affect the quantity and quality of water resources in the Tana basin. Finally, the new document should highlight the need for WRMA to increase its capacity in the decision-making and regulatory processes. Further, in spite of the different mandates, enhanced cooperation and dialogue among the stakeholders should be the priority.

Figure 13: View of the Masinga reservoir from the Masinga dam. Source: Author, 2014

Right Based Approach and Poverty Reduction – After having set the reserve, priority should be given to ensure basic human needs for all users in the catchment area. The new CMS should take into account the drivers of change and the possibility that more people might be affected by shortages of water due to population growth, scarcity, climatic variability and climate change during the next years. On the one hand, the WRUAs could be a solution to ensure that the basic needs for users and local population are met and that water is allocated sustainably. On the other hand, WRMA should promote capacity building trainings to empower both WRUAs and vulnerable groups.

Monitoring and Information Management – Another key issue is to ensure that information is shared among all stakeholders, local communities and institutions. In spite of the new technologies, this aspect requires the appropriate amount of funding from WRMA and the stakeholders, but also from those donors who are asked to sustain the monitoring and information management activities (E.g. buy monitoring equipment, facilitate lab facilities, etc.). For the next five years, substantial support from the WRUAs and the other stakeholders is needed to create an up-to-date and reliable database of relevant information regarding the hydrology and the permit system. In this regard, WRMA should consider the option of providing users with a meter to monitor the quantity abstracted. The data can be collected by the WRUAs and then transmitted to WRMA RO and SROs. In spite of the huge cost that this would involve, this operation could benefit data collection and monitoring.

Financing and Implementation – As funds from the GoK are limited, ensuring the enforcement of water rights and permits as well as the collection of the revenues from water fees should be a priority over the next five years. The involvement of the local community and the WRUAs is therefore necessary to reach this goal. Further, resources should be mobilized to support the creation and implementation of the SCMPs.

4. Recommendations and Synopsis

4.1. Recommendations

> "The issue with water allocation is that it is not that the strategies are not there. In fact, we have the strategies; it is rather an issue of implementing and management" (WRMA, 2014)

Water resources management in the Tana basin is particularly difficult due to the presence of many tributaries along the Tana River, its natural diversity, the scarcity of water within the catchment area and the many projects aimed at exploiting its waters. This makes the Tana River basin a perfect case study for water allocation planning. Although drawing a WAP for the whole basin, is a challenge that needs more financial and human resources as well as time to be developed, this study will provide stakeholders and policy-makers with some final recommendations to help draw a sustainable water allocation plan. Considering that the catchment management strategy is currently under review, this is the moment to reflect on the successes and failures of water management in the Tana basin during the past five years and to plan ahead.

4.1.1 On hydrology

Recommendation 1: Priority to the reserve

When allocating water, priority should be given to satisfy the quality and quantity of water necessary to sustain the basic environmental and human needs. However, stakeholders and policy-makers in the Tana basin should agree upon the way to quantify the reserve and should define what basic human needs mean with regards to the Tana basin. In order to quantify it, up-to-date and reliable data and hydrological models are necessary and developing pilot areas in different parts of the basin should help reaching this goal. Further, the reserve quantity and quality should be included as a priority in each SCMP drawn by the WRUAs. This might help the allocation of water resources within the area covered by a specific WRUA. Any violation of the reserve should be considered as a violation to the basic human and environmental needs (WRMA, 2010).

Recommendation 2: Agreement on the Q_{95}

At present, there is no agreement on what is the Q_{95} quantity to be taken into account in order to establish the reserve. This is because of the lack of hydrological data and uncertainty on what are the basic human needs to which the CMS refers to. In order to establish the Q_{95}, a profound understanding of the hydrology of the basin is needed together with an agreement on what should be considered as 'basic human needs'. In the meanwhile, a different approach to establish the Q_{95} might be considered by policy-makers and stakeholders. For example, the ecological need (e-flow) might be considered as Q_{95} leaving the remaining quantity subject to management. As the discharge (Qm) in the Tana River is highly influenced by anthropogenic activities and abstraction, an assessment of the Q_{95} should be done by using hydrological modeling.

Recommendation 3: Allocate more resources in research, data collection, for the WRUAs and the local communities

At this stage, substantial financial and human resources should be invested to collect data and conduct field research. WRMA and the WRUAs are the most important stakeholders because their joint work could contribute to finally have new data regarding the hydrology of the Tana River basin. Reliable and up-to-date data is indeed the key to develop and implement the CMS strategies. These include the assessment of water balance and demand management, water allocation as well as the enforcement of water rights and permits. Further, there is an urgent need for the GoK to provide the water sector and especially WRMA with more funds to perform its activities. The funds from external donors and the revenues from the enforcement of water permits are not enough.

Recommendation 4: Each WRUA should develop a sub-catchment management plan (SCMP[12]) and a pilot / draft for water allocation within the local sub-catchment

[12] According to different WRUA's SCMPs, a five-year activities budget for a WRUA might require up to 30.000.000 to 40.000.000 KES, approximately between 15.000 and 20.000 EUR, depending on the location and characteristics of the area.

A sub-catchment management plan is the starting point before then developing a water allocation plan. The WRUAs, who are responsible to develop the SCMP together with WRMA, will benefit from this plan as it will contribute to solving the issues of each sub-catchment. Due to the current insufficient collection and documentation of data, the objective of allocating water should start with a pilot project in each sub-catchment. A pilot will allow the WRUAs and the local community to first concentrate on a specific part of the sub-catchment. The benefits are the progressive acquisition of knowledge of the sub-catchment and the collection of data which will then help draw the water allocation plan.

The first step towards the definition of the SCMP is to conduct an abstraction and pollution survey in the sub-catchment. These surveys are crucial as they are intended to clarify the current situation over who is abstracting water legally and illegally and what is the quality of water along the tributary or within a certain area. The WRUAs and WRMA are generally in charge of conducting these surveys which require substantial financial and technical support from WRMA[13].

Once these surveys are ready, the WRUAs should then sensitize the local population on the use of water. A first draft of WAP should be drawn before creating awareness of water rights, water permits and enforcement. The last step would be to enforce compliance according to the rules established within the SCMP. As highlighted in the interview with the Gatondo – Icakimangu WRUA (2014), a first water allocation plan could already be drawn by deciding who among the users are entitled to abstract water from the tributary on a certain day and who are not.

Among the recommendations, each already established WRUA should, within the next five years of implementation of the new CMS, have a SCMP. In addition to this, they should have a draft plan on how to allocate water resources within the local area.

4.1.2 On policy-making

Recommendation 1: Enhance public participation and cooperation among the stakeholders. Be collaborative, not competitive

[13] According to different WRUA's SCMPs (2009), the cost of abstraction and pollution surveys might vary between 2.000.000 and 3.000.000 KES, approximately between 1.000 and 1.500 EUR, depending on the location and characteristics of the area.

The Water Act 2002 established that public participation is necessary to manage water resources sustainably. During the last decade, the approach in water resources management has changed from a top-down to a bottom-up approach as stakeholders and policy-makers realized that devolving the power from the central government to the local authorities is the best way to deal with the current and future challenges of water resources management in Kenya.

The formation of the WRUAs is a first important step forward in the process of including the public in the decision-making process. These organizations have great potential to be key players in conflict resolution over water related issues and manage water resources sustainably. In the next CMS, capacity building trainings for the WRUAs and the local communities should be set as a priority in order to raise awareness of water-related issues. All users within the local area should be encouraged to comply with the rules set in the SCMP. Further, the support from NGOs and researching institutions should also help enforce compliance while sharing the available information.

Recommendation 2: Empower the WRUAs and rethink their invaluable potential in local water resources management

Empower the WRUAs and rethink their potential in local water resources management is the key for the future of the Tana River basin. The WRUAs are key players for the success of many of the activities set in the CMS as they are the link between the local communities and the governmental institutions responsible for water resources management. Their voice is crucial to raise awareness for local problems and for implementing strategies together with WRMA.

Besides the crucial role they have in the process of developing the SCMPs, it is worth noting that they could also play a key role in enforcing the rules and permits, promoting compliance and monitoring illegal abstraction. Further, they could also facilitate WRMA's work in collecting the revenues from the users while acquiring important data regarding the hydrology of the local area.

These are activities which the WRUAs are partially in charge of. However, the field visit clarified that there is still a substantial gap in their capacity. WRUAs would also need more financial and human resources to perform abstraction and pollution surveys and to monitor the status of water resources within the local area. Regarding water allocation, the WRUAs can provide a draft of a WAP after having conducted the abstraction and pollution

surveys. The two surveys should be performed for every sub-catchment and should represent a milestone in the development and implementation of the SCMP strategies.

WRMA should consider the option to select some of the representatives of each WRUA and hire them to fill the existing gaps between the local communities and the authorities. In fact, the WRUAs could execute many of the activities that the single ROs are not able to perform. Despite the initial investment, this measure might be of great benefit in the long-term as it could contribute to solve many of the issues within the sub-catchments of the Tana River basin and to better incorporate the WRUAs into WRMA's structure. The new professionals could be chosen by the community and by WRMA RO and should then be in the position to work full-time on the local management of water resources.

Within the next five years, the WRUAs network should expand to cover up to 50 – 75% of the Tana catchment area. Further, the membership fees to join the WRUAs should be kept as low as possible to incentivize new users to join the associations. Frequent capacity building trainings will be necessary to empower the WRUAs and to put them in the condition to perform their duties successfully. The financial support from the Government of Kenya, from NGOs and donors is crucial to ensure that these objectives are met in the next years.

Recommendation 3: Develop a compliance and enforcement mechanism (for each SCMP)

Compliance and enforcement are two main aspects of water allocation planning. WRMA has clearly not enough human and financial resources to enforce water rights alone and to bring illegal abstractors into compliance. The WRUAs should become key players in facilitating both enforcement and compliance and for this reason they should be put in the condition to perform these two activities. A priority should be to empower the WRUAs with appropriate capacity, tools and financial resources. At the same time, a mechanism for compliance and enforcement should be developed by WRMA in close cooperation with the WRUAs and should be included in each SCMP.

Education and capacity building should help bringing illegal abstractors back into compliance. The following is a list of pre-conditions to sustain the compliance mechanism (WRMA, 2010):

- There must be adequate information to prove that users are not in compliance;
- Adequate amount of gauges to measure water levels;

- WRUAs communicate to WRMA the state of the resources via emails, SMS and regular meetings;

Enforcement should be responsibility of both WRUAs and WRMA. The WRUAs should be the first to seek solutions and in cases when compliance cannot be reached, WRMA should intervene to enforce the law (WRMA, 2010). The enforcement mechanism should include:

- Reporting the violation (E.g. who is violating, what is the nature of the violation);
- Appointment of an investigator (E.g. a member of the WRUA) who reports the nature of the violation to WRMA;
- Application of first and second yellow cards and red card depending on the gravity of the violation[14];
- Possibility to introduce a fine to be paid according to the yellow or red cards;

If the yellow and red cards fail to bring the abstractor back into compliance, WRMA with the help of the WRUA should then remove the sources of the illegal activities (E.g. illegal pumps, manipulated devices, etc.), suspend or remove the permit and prosecute the violator. Penalties should also be considered as a means to bring the violator back into compliance. These could be, for example, in form of financial penalties or limitations on water use (WRMA, 2010).

Ultimately, WRMA should consider opening a water rights and enforcement office at each sub-regional office. This measure would contribute to collect information from the WRUAs and manage it locally before transferring it to WRMA TCA in Embu.

4.1.3 Other recommendations

Recommendation 1: Invest in efficiency, reduction of losses, reuse of water and in the wastewater sector, not only in water supply

At present, governmental institutions, NGOs and donors involved in water resources management within the Tana catchment area prefer to invest in water supply and in low-

[14] According to WRMA (2010), the first yellow card consists in a written instruction from the WRUA to the violator who has to cease the violation within two weeks. An inspection from the WRUA then follows. The second yellow card includes the notification to all WRUA members. The red card includes the inspection from WRMA and publication of the violation on the national newspaper. Also in the last two cases, violation has to cease within two weeks.

cost technologies for water supply as these activities produce revenues unlike the wastewater sector. However, in the next five years, it will be paramount to invest an adequate amount of resources in the wastewater sector. As the water supply sector expands due to the increasing population and due to the higher demand for water, there is an equal increase in the amount of wastewater resulting in worsening water quality, especially in the proximity of certain municipalities (E.g. Karatina, Kitui). Water pollution is strictly linked to water allocation. Consequently, severely polluted water cannot satisfy neither human nor environmental needs. Therefore, governmental institutions, water services providers, with the support of donors, should invest more into the development of wastewater infrastructures as well as into solutions aimed at protecting the quality of water. Water allocation cannot be done unless good quality is maintained.

Recommendation 2: WRMA and WRUAs should provide the other stakeholders with possible future scenarios in order to encourage decision-making and anticipate possible consequences

Following the previous recommendations, WRMA and the WRUAs should be key players not only in managing water resources but also in providing the other stakeholders with information on the feasibility and sustainability of a project (E.g. High Grand Falls dam or One Million Acres projects). Further, they should be in the position to evaluate the requirements and the impacts of a certain project while paying particular attention to water resources. This measure should help the other stakeholders understand the consequences of the project and make them aware of whether or not to take a certain decision. To do so, data is indispensible to provide reliable facts and figures.

Recommendation 3: Clarity, transparency and profound understanding of current issues

Clarity and transparency should be the priority of all the stakeholders involved in water resources management within the Tana River basin. During the Environmental Impact Assessments (EIA), the involvement of all the relevant stakeholders and the local population is essential to make the decision-making process as transparent and as free-from-corruption as possible.

Recommendation 4: Regarding water allocation, install a water meter and a controlling device at the moment when the permit is issued

The installation of water meter and controlling devices could happen immediately after the permit is released. WRMA, in collaboration with the WRUAs should be responsible for this activity while the WRUAs could then ensure monitoring and data collection.

Although these recommendations are not enough to exhaustively cover all aspects of water resources management in the Tana River basin, they link the scientific aspects with policy-making, thereby representing a starting point from which to formulate more accurate and appropriate solutions under the new CMS. The direction taken by the Kenyan authorities and the concerned institutions after the Water Act 2002 is encouraging. However, many efforts are still needed to make water resources management in the Tana River basin, sustainable.

Despite the fact that these recommendations address issues pertaining to the Tana River basin, they can easily be applied to other river basins where the situation and the challenges are similar. As highlighted by Knoop et al. (2012), “this [work] is about a river in Kenya called the Tana – but it is more than that, it is also about the challenges and the opportunities facing river systems everywhere”.

4.2. Synopsis

The Tana River basin is confronted with many challenges that affect water resources management. At present, climatic variability, climate change, population growth, illegal water abstraction and new infrastructures such as dams or irrigation schemes are among the drivers of change putting additional pressures on the already scarce water resources. In order to fight this trend, stakeholders and policy-makers need to set up feasible measures in order to prevent conflicts among water users and ensure equitable access to water resources.

Lack of reliable and up-to-date data on the hydrology, weak enforcement and compliance mechanisms and overlapping mandates among the stakeholders have until now limited the effectiveness and correct implementation of the existing strategies. For these reasons, the Water Act 2002 and the other regulations and strategies have not been effective in ensuring equitable allocation of water for all users. After the first five years, the review of the Tana Catchment Area Management Strategy constitutes an opportunity to fill the existing gaps and develop a framework for a sustainable water allocation plan in the Tana catchment area based on the principles of integrated water resources management.

In regard to WAPs, this thesis has demonstrated that there is urgent need to collect reliable and up-to-date data on the hydrology of the Tana River and its tributaries. The acquisition of new data is crucial in order to establish the reserve quantity needed to sustain the basic environmental (e-flow) and human needs (domestic) before then attempting a water allocation plan. Abstraction and pollution surveys conducted by WRMA in close cooperation with the WRUAs should help gather important information at the local level.

The possibility to allocate water in the future also depends on reducing water losses, controlling pollution and ensuring good water quality. During the last years, governmental institutions and donors have allocated funds, mainly for the development of the water supply sector due to the increasing population and the higher water demand. As wastewater infrastructures remained unchanged, the quality of water started to decrease, especially in proximity to the main municipalities. For this reason, there is a need to upgrade the existing wastewater treatment infrastructures and networks, especially in the upper Tana where the highest number of anthropogenic activities is registered. In this regard, stakeholders and

policy-makers should remember that the allocation of water resources is not possible if the quality worsens.

In order to reach these goals, WRMA should work closer with the local communities and the WRUAs in order to implement the existing strategies. In parallel to this, WRUAs should start with local water allocation plans and pilot areas. Being constantly in the field, the WRUAs can contribute to the collection of hydrological data and can be key players in enforcing water rights and permits as well as bringing violators and illegal abstractors back into compliance. Further, every WRUA needs to develop a sub-catchment management plan that defines how to manage local water resources and how to allocate them among local users.

The work of the WRUAs and their constant presence in the field can also help limit soil erosion and pollution and contribute to protecting and conserving the water resources in the Tana River basin. However, their presence is at the moment limited and mainly confined to the upper part of the Tana catchment area. Within the next five years, the WRUAs' network should be expanded to cover up to 50 – 70% of the basin. Consequently, substantial financial and human resources should be allocated to sustain the work of the existing WRUAs and to establish new ones, especially in the lower and middle Tana.

Enhanced cooperation, public participation and dialogue among the stakeholders are crucial to ensure that water resources are managed sustainably. In spite of the different mandates, all the stakeholders should intensively collaborate with each other and work together to provide feasible solutions to the challenges encountered in the Tana River basin.

Overall, the study has shown that managing water resources in the Tana River basin is an extremely complex task. Consequently, government, stakeholders, policy makers and local communities should all cooperate with each other to ensure the attainment of the ultimate goal, i.e. the protection and conservation of the water resources in the Tana River basin. After all, it is a question of management and strategies implementation.

Figure 14: The Tana River after the Masinga dam. Source: Author, 2014

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Appendices

The followings are selected parts of the interviews which have been conducted with representatives of WRMA TCA located in Embu, the Gatondo – Icakimangu WRUA located in the region of Kerugoya and the TARDA regional office located in Embu during the field visit in Kenya in April 2014. These interview transcripts are aimed at clarifying the current status of water resources management in the Tana River basin through the voices of some of the relevant stakeholders.

A: = Author; **R:** = Respondent

(*Brackets*) = Author note

Appendix 1: Interview with WRMA TCA on water allocation planning and wastewater in the Tana River Basin

A: What are the major challenges in the Tana River basin?

R: The challenges are so many and one of them is pollution control. However, wastewater treatment does not generate revenue, it is not productive, and therefore it is not a top-priority topic.

A: What about the standards for water quality?

R: The standards are there but those who are responsible for treatment (*the water service providers*) are not (…) in the condition to treat water as it should be. These are the water service providers, which are responsible to provide water and sanitation, to collect wastewater and treat it. Then you have the issue of many industries, that simply discharge the used water without treating it, and the issue of fertilizers (...). The same water ends up to be used again by the people downstream, but what if it is too polluted? There should be a radical change because wastewater is an opportunity if you have the appropriate infrastructure as (…) it can be reused.

A: What are the major causes for the worsening of water quality in the Tana River basin, especially here in the upper catchment?

R: Back in the days, towns were small. Now, the population is booming and the current infrastructures can simply not sustain the amount of wastewater coming in. In other words, if a certain amount of water is supposed to remain there for treatment for some time, this does not happen as the retention time is so short.

A: So then what is the problem with the water service providers?

R: The problem is the lack of responsibilities as many of the water service providers argue that they just have to manage a facility (*wastewater infrastructure*) which is not their property. You see, the Water Act of 2002 has separated water resources management from water service provision. Initially everything was under a single Ministry's control but it was then separated. WRMA now manages the water resources and other bodies supply water to the people. However, these (*other bodies*) are actually dependent from WRMA because they need a permit to abstract and a permit to discharge.

A: And what about the infrastructures?

R: This is another problem. The systems are generally old and they were supposed to accommodate less wastewaster in the past. Now that the population is booming, if the infrastructure remains the same, there is no way it can sustain the current loads. But for the reason I told you before (*separation between water management and water provision*) there is misunderstanding on who should be responsible for expanding and upgrading the facilities. This is the reason why you cannot, in the end, meet your standards even if they are there. Another problem is that, even the political will might be there, but what is also lacking is the finance. There is no other money that we (*WRMA*) can generate for developing further infrastructure (…). It is just the Government that can do it: if financial (*help*) is there, we would expand the wastewater infrastructure even tomorrow! But no or very little money has been usually allocated for wastewater treatment.

This is also another issue. It is better to choose to expand or upgrade the water supply network than the wastewater facilities, it sounds better to the public. But the more water you provide, the more wastewater treatment facilities you should build to balance it. In other words, the input should equal the output. To conclude, at the moment there is no proportionate development for water supply

and wastewater treatment. Actually water supply networks and facilities are expanding while wastewater facilities are not.

A: Again, why this?

R: As I said, because wastewater treatment does not generate income whereas water supply does. Another problem is also that farmers and generally water users (…) are keen to say no when it comes to irrigate fields knowing that the water comes from the treatment plant. And this obviously impacts water allocation. But this is wrong. I will tell you a story: the last day I was called to the field to check a spill of wastewater into a small tributary. People argued that they could not use that water anymore as it smelled bad and was polluted. You see how water allocation and wastewater are strictly related to each other?

Appendix 2: Interview with WRMA TCA on water allocation, water rights and permits

A: What are the major challenges regarding water permits and enforcement?

R: Illegal abstraction is definitely one of the most important challenges. Some people do not want to pay for the amount of water they use, some of the users misuse the permit they are given, many others conduct illegal abstraction practices and some people do not renew the permits (…). Then you also have users that have a legal permit (*issued by WRMA*) but when you go and check the real situation in the field, they do not abstract water from the river. The major challenge is to have a clear picture of what happens on the ground, so that we can plan effectively.

A: Your work is actually a huge challenge.

R: You are right, it is a huge challenge, entitlements and rights are strictly related to conflicts among water users, it is a matter of ownership of water. The problem is that, many users think that the water which is passing through (*their*) land, is automatically (*theirs*), some even think it is a gift from God, and therefore they should not be charged for it. Now, (…) explain to them that pumping huge amounts of water without permit is illegal, it takes time. That is (*the reason*) why we call it a conflict of ownership among riparians. And to be true, it now goes beyond the

riparians, it also includes the counties, the tribes etc. So, it is a conflict of ownership at all levels.

A: And how could you overcome this challenge?

R: First of all, you have to have data. Let's take (*the example of*) river Rupingazi: it is very hard to know how much water passes through river Rupingazi at a certain place and time. It is very difficult to have a complete source of data. To do so, you should have readers. You see, there are readers in the Tana but (*not*) in the tributaries in the upper catchment (*which*) are also really important and crucial for water allocation. Then another problem is the law which says (*that*) if you are entitled to a certain amount of water, you should use it, you should abstract it. But to monitor it, you as individual, should have a measuring device and it is you that you have to install it, not WRMA which is just coming to confirm. But this is crucial, because the user is the one that has to (*measure*) and monitor, so if he does not do that, we cannot tell how much he is abstracting. In fact, we as WRMA always find mismatch between what are the entitlements and the records. Generally, we assume that what is allocated is also abstracted but this is not the case (*in many circumstances*). And do not forget, that another thing is the payment. (…) Those people that (…) (*are not*) paying the fee are even taken to court and their illegal pumps are removed. There has been a case of a farmer that abstracted the whole river for irrigation.

A: But there should be a way to control this, right?

R: It is really hard. You have to give priorities. First priority is for domestic use then for irrigation. But then what happens if a farmer does not irrigate his field? He will have no food. And what do you do if you do not have food? You cannot survive. Beyond that, there is a clear overlapping and confusion in terms of primary objectives among the different Ministries. The Ministry of Agriculture (*Livestock and Fisheries*) says that agricultural security in the country is the most important objective. At the same time, (*The Ministry of Environment, Water and Natural Resource*) says water for domestic (*use*) is the priority.

A: So, what about the One Million Acre project?

R: (…) We have a lot of water in the upper Tana, and you can see it. All the rivers are concentrated here, in the upper Tana, Murang'a, Nyeri, Embu. We have so many

rivers. But, people own a quarter of an acre, and they have everything there, the house and their own cultures. Can you feed the nation just from these terrains? No. The issue in those lands (*in the lower catchment of the Tana River basin*) is that there are thousands and thousands of acres free. But (…) there is not enough water to irrigate them, as rainfalls are really low. So, the announcement of the project is definitely a source of conflict, as they (*National Irrigation Board, NIB*) want to provide the nation with the appropriate amount of food. You see, they are called irrigation, not agriculture. For agriculture you can use the rain but not for irrigation. What they do is business with irrigation; that is why they are called irrigation board. So they look for places, they know they cannot look for such a huge land here in the upper Tana but there is plenty of space in the lower part, where however, there is no water. And to do that, they just need to see that there is water flowing without really considering the reserve and the downstream communities. Like here in the upper part where somebody says "I can see a lot of water flowing" without really thinking that you still need the 30% for the reserve (…). You see, this generates a lot of conflicts (*over water resources*) (…).

A: I understand.

R: Then, (*an*)other challenge regarding water allocation is data availability. Further, we have the skills and the capacity meaning that we know how and what to do, but when it comes to financing... There is a lack of staff too. And the last challenge: politics. But given what we have, we are trying to come up with a solution for water allocation. We are conducting a three-phase project. First, what we have done, it is the resource mapping namely the identification of the points of allocation that we can call abstraction survey (*together with the WRUAs*). Then we arrive at phase two when we do some enforcement. If you are an illegal abstractor, we force you to abstract only what you need (…). If you are a user that had a permit and you are not abstracting anymore, this is the chance to update your status as for us you are still doing your activities according to the issued permit. (*By*) having these two initial steps ready, we can go to phase three namely establishing a pilot for water allocation plan. Regarding water allocation, in the country we only have one pilot which works according to these steps and rules, in Naivasha (*Lake Naivasha, 75km North-West of Nairobi*).

Regarding the permit system, the representative of WRMA added:

R: Today, I have 653 expired authorizations in my database, with reference to the whole Tana. When you come to apply for an authorization, for a permit, you are then given a permit of five years. Regarding (the authorization), when (it) expires, you need to come here and tell us that your works are not finished so that you extend the permits. Now, in Tana we have five sub-regional offices but there is only one water rights and enforcement office which should be dealing with this issue (*the one in Embu*) which is not facilitated to move from the office where the farmer is. What happens is that the permit remains expired and this is against the law. It is a big problem (because) when they expire, somebody is using water illegally.

A: What can be, in your opinion, the strategy to developing a water allocation plan in the future?

R: According to the CMS, every river needs its water allocation plan. All these rivers are tributary of the main river. Now, WRMA is nine years old. If we would have done a water allocation plan for each river we would have been now halfway. But this is not the case, now we just allocate blindly. The issue with water allocation is that it is not that the strategies are not there. In fact, we have the strategies; it is rather an issue of implementing and management. Concretely, there is no possibility for me to go to Kapingazi to do enforcement by myself. It is also a matter of security: when you start walking around the river, people start thinking "what are they doing there?". Another issue is simply compliance. For example, there are cases when if a member of the local community does not pay, also the others do the same just because he is not paying.

Further, regarding the permit system:

R: I cannot issue any permit without a technical evaluation of ground and surface waters. Those responsible here in WRMA will tell me that there is a certain amount of ground or surface water here according to the hydrological survey, therefore I can issue (*this*) amount (*of water through permits*). I also have to rely on the wastewater department to issue a permit for effluent discharge. Generally I would say that we need actual data, accurate data to be the water resources management authority.

Without that, we cannot manage something we do not know and I cannot just tell assumptions.

Again, we need accurate data of water available and we need accurate data of water abstracted. Because at the moment the situation is that I have allocated that amount X to Mr. A, that other amount Y to Mr. B, but in the end I am not sure if they are abstracting, and how much. You cannot do these things in the office but you have to go to the field. This is why we need accurate data, and we could collect them for example through abstraction surveys; then I need to do the same for the whole basin. For example, in the lower (*part*), these surveys would be actually easier as the abstractions are fewer than in the upper (*part where*) we need to pay specific attention because of the (*huge quantity*) of (*abstractions*). Then another issue we also mentioned in the CMS is that we need to sensitize the community, the public and we need more support from the Government because without WRMA managing water you would not have water in the pipes. It is very sad but I think if the whole system goes on like that, in five years we might have the pipes but no water in there anymore.

A: It is extremely difficult, especially if you consider the challenges and drivers of change in the Tana River basin like lower availability of water resources, population growth, climate variability, etc.

R: Yes, plus no jobs for young people meaning that many will go into farming, without real knowledge and (*probably*) using a lot of fertilizers that inevitably affect the quality of water.

A: Regarding the abstraction, what if WRMA would provide the users with the appropriate devices to measure how much water is abstracted?

R: Well, it has been proposed many times. But the point is that for this usually you pay the water service providers. Again, you pay, so it is an additional cost and this is also one of the reasons why you have a lack of data regarding water abstraction. And bear in mind that it is not because reading costs a lot, it is actually only 50 KSH for a single reading. This is easy and affordable especially in the municipalities. However, the issue (…) in the countryside (*is that*) the person in charge of reading has to come by his own means, like by piki-piki and needs to be paid. The problems are encountered when you are going to the villages, outside the municipalities. I can

assure you, however, that the proposal for WRMA to (*provide*) read(*ers*) has been proposed many times. Again, it is a matter of management.

A: In your opinion, what is the importance of the WRUAs and how can they play a role in water allocation?

R: WRUAs are there to mitigate and regulate the conflicts which may arise over water-related issues. They can see the water, they can smell it if it is polluted, more than me that I stay here at the office. These people can help us a lot, for example, (*they can*) collect the fees for the permits in (*a certain area*). Supposedly, this WRUA has twenty abstractors: I will not go to each one of them; I will simply go to the one who has collected the revenues. There (*should*) be a mechanism to pay them for their work, maybe one or two (*of them*). And believe me that the issue has been discussed in many, many forums. However, the issue is that they need to be faithful to their work because otherwise they will just bring additional stress.

Appendix 3: Interview with the Gatondo – Icakimangu Water Resources Users Association on the Role of the WRUAs in Water Resources Management

R: I can start by telling you that the WRUAs are associations for members of a particular catchment. The direction of the river and its catchment area indicate the WRUA you belong to. For us, our WRUA belong to the catchment of the rivers Gatondo and Icakimangu. For you to be a member, you have to be a riparian, or an individual user. Then we also have groups of users that (…) join the WRUA.

Regarding the current status of the WRUA, the Secretary says:

R: Up to now, with the help of WRMA, the Gatondo – Icakimangu WRUA has done the SCMP by calling all the stakeholders within the (catchment) (…) (*who told*) the problems they have. The stakeholders in this case are all the members all the way from Kerugoya, including people from the church and farmers. We acknowledged the problems that people have concerning water, the (*reasons*) for those problems. We found a solution for those problems and we then wrote a sub-catchment management plan (…). We are funded (*by WRMA*) (…) for the implementation of the sub-catchment management plan.

A: And what are the main problems encountered here?

R: (…) We have the problem of floods. The water you have seen now is colored. Normally, that water is colorless. But that color is because of the flooding and erosion around the catchment area. The thing is that, many children go there to fetch water but the water is polluted. So, there is need to fix this problem (*by using for example*) naiper grass and by planting trees. By planting trees, the roots then trap the sediments and the napier grass (*traps*) the silt, so that it does not get into the river. So, in the sub-catchment management (*plan*) we have talked about terracing the slopes in the riparian area. We have to plant some waterfed trees.

Another issue we had is educating the masses. If we (*would*) have had by now the capacity building for the community, those people you saw at the river would have not been there. If the river is polluted they can get so many diseases. Capacity building is education: the problem is that we have though that capacity building is very cheap, but in reality it is very expensive. And you know, the issue with siltation is also important for the Masinga dam, which has a very low, reduced storage capacity due to deposited silts.

Another issue we have is competition over water resources, especially during the hot season and after the rainy reasons when all kinds of catch crops (E.g. French beans, tomatoes) grow very well here as the weather is simply perfect (…). Another major issue is that we lack the capacity to enforce some of the rules.

A: But now the WRUA comes in, right?

R: Exactly, now the WRUA comes in. WRMA funded us for few projects, for example, we did the abstraction survey and we have started from the source by saying, how many people are using pumps? We did it, although there were some people that on purpose withdrew their pumps. The aim of the survey was to establish (*the numbers of*) how many pumps withdraw water from Gatondo, so that we can find out how much water we have in Gatondo and how we can share that water in Gatondo equitably leaving the reserve, because being a gift from God, the river also needs its part.

The Secretary then elaborated on how the WRUA has managed to regulate the use of water:

R: (…) We have established that in this area, up to this bridge, the people living from there up to the source (…) will be watering their crops on Mondays and Thursdays. Two days because we know that the crops require water two or three times per week. From here up to that bridge, they will be doing it on Tuesdays and on Fridays. In another portion, they will be doing it on Wednesdays and on Saturdays. This way we have covered everybody. Sunday was left in case someone sees that there is need for extra abstraction (…) for irrigation. For domestic use the quantity abstracted is negligible. And just to clarify, within the catchment of Gatondo – Icakimangu, there are some factories but no water service provider.

A: This already sounds like an allocation plan. What happens in the case of over abstraction and illegal abstraction?

R: Mostly there are guardians and persons from the WRUA entitled to monitor this aspect and mostly, cases like this end up in court. Then going back to the issues, we have the issue of pollution. Especially during the rainy season, the challenge is pollution, whereas in the hot season the main challenge is abstraction. Related to pollution, there is also a pollution survey. Other sources of pollution are for example washing piki-pikis, animal feces or even cleaning and washing clothes as there is no running water at their (*people's*) homes.

A: And regarding the quality?

R: Well, that is a good question. Generally I would say that at the source the water quality (*is*) very good and it decreases when you go from upstream to downstream areas.

A: Regarding the membership?

R: We have many different members, from individual users to churches, to schools and factories which all have to comply with the rules set by the WRUA. The fee to join the WRUA is according to the category of users you belong to. But this is a main issue because many people ask after having paid, so which kind of benefit I have? The benefit is clearly that everyone benefits.

A: I think the WRUAs have a great potential to addressing this issue. I was wondering, how often do you meet?

R: It depends. In the dry season, we can even meet weekly. Otherwise, our meetings will be once per month. Of course, people listen to you more during the dry season when they have problems.

A: And are you doing this on a voluntary basis, right?

R: Yes, just on a voluntary basis.

A: What would you do to engage society more?

R: I think the support of WRMA is crucial, because people get support from WRMA through the WRUAs who are doing capacity building.

A: Do you think that if you would have more capacity, or if you, as chairman and secretary, would receive an income to actually serve your community, you would be in the position to help more?

R: It would help a lot, simply because we would have more time. At present, we have our own activities, and then suddenly we have to leave our work and come to maybe help solve a problem. For example, I was in Kerugoya last week and someone told (*me*): "You know, since you have been here, water has been flowing, but now it happened again that we do not have it". You see, if we had more time, we could definitely concentrate on this (*or that issue*).

A: And of course, if you are more present in the river, you could also acquire data regarding the hydrology, monitor it, etc.

R: Yes, and then send them to WRMA. For example, on a weekly basis, they can monitor the discharge of the river or, with other measuring devices also something else. Then (*we could*) send the data to WRMA even by phone. I can even ask other people to do the same in other parts of the basin. The WRUA can do so much work. But this requires a change of policy, an institutional change, and legislation to properly fit the WRUAs into WRMA's structure.

A: Can this be the way forward, also regarding water allocation?

R: Yes it can, because WRMA's staff does not have the human resource capacity to do this.

A: And what about the interaction with the other WRUAs?

R: At present, there is only interaction when WRMA organizes seminars. This is another aspect that should be developed as problems are of course individual, but many WRUAs have to solve the same issues, like pollution, illegal abstraction, and it would be good to share the experience.

Appendix 4: Interview with WRMA TCA on water monitoring and allocation

A: In your opinion, what could really be the solution to illegal abstraction, which in the upper catchment is estimated to be around 70% of the total quantity of water abstracted?

R: Well, first I would say that the reserve quantity, when allocating water, should be higher than in theory, because we do not really have clear numbers on illegal abstraction. Then, the Q95, that is the level at which the river should remain when we have the hardest times. But the Q95, how much is it? That is what we are now working on. Of course, we can calculate the volume out of the gauging stations, but even if we calculate it (…), do we know the water demand downstream? This is why it is so complicated (…). And at present, the only (*allocation*) planning possible is at the sub-catchment level.

A: How does the CMS help water allocation planning?

R: Well, (*the CMS*) can give a sense of direction, but in terms of water allocation is not enough. For example, we have the CMUs, but we still do not know the characteristics of each one of them, as there as some gaps in data collection. You see, these are the limits.

A: How about the WRUAs, can they be a key in order to solve these issues?

R: That is good, but let me elaborate on a different perspective. Not everybody is a WRUA member. (*Let's*) suppose we have a sub-catchment with a population of one million, but only five-hundred people are WRUA members. How reliable would be the information coming from these people, especially in terms of water allocation? The limit is also that many WRUAs do not know how much water is abstracted along the tributary. I saw WAPs made by WRUAs but those plans are not reliable. You see, a water allocation plan is both qualitative and quantitative as we are talking not just

about water, we are talking about usable water. So, theoretically they can provide solutions, especially in terms of tracking the illegal abstractors, but at the moment they do not have the capacity.

Appendix 5: Interview with TARDA

Regarding the High Grand Falls dam project and the involvement of TARDA:

A: We agree that the river needs its waters, the e-flow.

R: Yes. The water shortage is usually experienced during the dry season, but for example now, during the rainy seasons, there is no issue. And actually that was the essence of constructing the Masinga dam, to store water as a reserve and then supply it for irrigation, for domestic supply, to the community. So, now we intend to supply Lamu with the water of the High Grand Falls dam. The point is that we have to ensure that we have enough storage capacity during the rainy season. The same will be done in Rukenya, in the Kirinyanga County for (*supplying water to*) the rice fields in Mwea.

Regarding the relationship among the relevant stakeholders:

R: TARDA is not mandated with the allocation of water. The allocation of the resources is managed by WRMA. Well, there is no way that we cannot talk to WRMA as WRMA in the end, expects us to pay. TARDA has its own hydrologists, experts, etc. (…). So my opinion is that we need to consult more. TARDA needs to consult with WRMA, WRMA needs to consult with TARDA. The issue is that there is a lot of repetition of duties because we use the same resources. It is good to ensure that we consult, that we work for the same objective. But, it is not TARDA to do the environmental impact assessment, it is actually NEMA (*National Environment Management Authority*), and that has to evaluate the impacts, for example the volume of water needed in the reservoir, etc. (…).

A: So, there is still a lot to do in terms of policy-making and enforcing the rules and regulations.

R: Yes, we need to have very clear policies for the management of our resources. These policies must be there.

Regarding the feasibility of creating a comprehensive water allocation plan for the whole Tana River basin, the representative from TARDA said:

R: (*A water allocation plan that covers the whole basin*) I do not really think it is feasible (*at the moment*). Because of the increasing population, planning a limited resource (*water*) will be extremely difficult in the future.