IMPACT OF CLIMATE VARIABILITY ON SURFACE WATER RESOURCES IN HOMA BAY COUNTY

By

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DECLARATION

This Research project is my original work and has never been submitted for examination or degree award in any other university.

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This Research Project has been submitted for examination with our approval as the University Supervisors.

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To Leokadia Abuya my late grandmother, Parents; Harrison Okech and Petty Atieno.

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TABLE OF CONTENTS

LIST OF TABLES

TABLE OF FIGURES

LIST OF PLATES

LIST OF ACRONYMS

AFDB	Africa Development Bank
ANOVA	Analysis of Variance
BAMS-	Bulletin of American Meteorological Society
CLIVAR	Climate Variability and Predictability.
DEM	Digital Elevation Model
ENSO	El Niño Southern Oscillation
EPA	Environmental Protection Agency
GC	General Circulation models
GCC	Global Climate Change
GIS	Geographical Information Systems
GWD	Global Weather Data
HRU	Hydrologic Response Unit
ICIPE	International Centre for Physiology and Ecology
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Intertropical Convergence Zone
KMD	Kenya Meteorological Department
LULC	Land Use Land Cover
LVEMP	Lake Victoria Environnemental Management Programme
MWS	Ministry of Water and Sanitation
NCCRS	National Climate Change Response Strategies.
NEMA	National Environmental Management Authority
NOAA	National Oceanic and Atmospheric Administration
NRCPWCC	National Research Council Panel on Water and Climate Change.
S C	SWAT-CUP
SOV	Swat Output Viewer
SR	SWAT-Run
SWAT	Soil and Water Assessment Tool

UNEP	United Nation's Environmental Program
UNFCCC	United Nations Framework Convention on Climate Change
USGRP	United States Global Research Program
WARDO	Water Resource Planning Organizations
WCED	World Commission for Environment and Development
WCRP	World Climate Research Program
WMO	World Meteorological Organization
WRA	Water Resources Authority
WSTF	Water Services Trust Fund

ABSTRACT

Climate variability is a natural process that affects the atmospheric general global circulation system causing short term fluctuations on seasonal or multi-seasonal time scale with implication on water resources globally and it manifests through fluctuations in flooding, drought occurrences, surface water-levels, river volume flows, surface water quantities, precipitations and water vapour. This project focused on the impacts of rainfall and temperature variability on the river discharge in Homa Bay County. In order to assess the variability impacts, the main objective of the project was to determine the relationship between climate variability (rainfall and temperature) and the availability and spatial distribution of surface water resources. A purposeful spatial survey design method was used in this project. The main rivers studied were; Kibuon, Tende and Riana. The study relied on secondary data sets, the climate data were both in-situ data sourced from Kenya Meteorological Department and proxy data sourced from Global Weather Database. The river discharge data was sourced from Water Resources Authority, all were estimated using Soil and Water Analysis Tool model (SWAT). Data was analysed using both descriptive statistics and spatial analysis techniques to determine trends, seasonality, abnormal conditions in climate of Homa Bay County in relation to river volume flows and included; correlation, regression and time series analysis and these largely relied on the SWAT model. A long term mean variability as a measure of the trend in rainfall, temperature and river volume flows was determined using time series analysis, regression analysis technique was applied to determine the relationship between climate variability and surface water resources being assessed in relation to availability, distribution and Water Yield. The variability was in spatial and time context in relation to surface water resources and significant tests were at α 0.05. The study establishes that rainfall and temperature variability have an impact on the availability and distribution of surface Water resources in Homa Bay and recommends public education on climate variability impact, Hydrologic modelling at a Micro scale, considering data sources, Collection, retrieval and storage, policy interventions since Climate variability is an environmental challenge and impacts the hydrological cycle and needs to be addressed to improve surface Water resource conservation, utilisation, planning and management.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Homa Bay county lies within Lake Victoria south water catchment area and the latter accounts for the 3.0% of the total water resources in the country (WRA 2011).Other water catchment areas in Kenya include Lake Victoria North 5.0%, Rift valley catchment including the inland lakes 22.5 % , Athi catchment area 11.5%, Tana catchment area 21.7% and the Ewaso Ngiro catchment having 36.3%.Homa Bay County thus contributes a very small percentage of water resource availability in the country (WRA 2011).

The Surface water resources provide services including fishing, agriculture, transport and most importantly water supply for varied uses (Ntiba et al, 2001) and a major input to the regional water balance is purely rainfall that is influenced by temperature patterns (Flohn & Burkhardt, 1985; Nicholson, 2002; Tate et al., 2004) and implies that the rainfall and temperature variability influences the availability, distribution and quantity of different surface water resources in the region.

The distribution of water resources within the lake Victoria basin is approximately 28260m^3/km^2/over 750m/year per capita with an estimated renewable internal surface water estimated to be 20, 2000 mill.m^3/year of which about 3000mill.m^3/ year is considered to overlap between surface and ground water .The region therefore relies on the major water towers as sources of water for varied uses (WRA 2011). The irregular distribution and availability of surface water resources could be attributed to Climate variability including cycles of drought, floods and the general water balance (World Bank 2004).

Demands for water in Homa Bay is partially met from both the surface water (rivers) and the ground water (springs and boreholes) and all are hostage to the restricted water supply due to climate variability and interactions that causes diurnal, seasonal and interannual mean rainfall in the region due to the complex connection between the Inter tropical convergence zone (ITCZ), El Nino /Southern oscillation (ENSO) and different wind types including

Meso scale circulations and extra tropical weather systems (Ogallo 1988;Mutai et al 1988) ,the bimodal rainfall distribution directly impact on the river discharge patterns in Homa Bay County.

Availability of surface water resources on earth is an indispensable part of all forms of life and access to water is a human right (UNDP, 2006), since Climate variability is considered one of the most important natural phenomenon that influences many economic activities (Oguntoyinbo & Odingo, 1979) including the hydrological cycle and surface water resources through fluctuating wind speed, solar radiation, temperature, humidity and precipitation, it should thus be studied and mitigated.

In his study Kundzewicz et al, (2008) found that hydrological regime is influenced by the terrain, climate condition, land cover land use system and population growth and these controls surface water supply systems, flood structure, reservoirs and spillways in general (Moss & Parker, 1987). Changes in temperature and precipitation affects infiltration and vaporisation process of the hydrological cycle in the temporal and spatial scales (McGrane ,2016) and Hulme (1990) acknowledges existence of a connection between climate variability; surface and ground water availability; water quantity; and its replenishment for varied uses. In the view of Ominde & Juma (1991) Africa, Kenya and Homa Bay her natural resources are sensitive to climate variability which should be addressed to avoid future impacts.

Climate variability is also affecting weather patterns in many parts of Kenya and this is inevitable, according to KMD (2010), events such as frequently occurring weather trends, unevenly distributed rainfall and fluctuating temperature records are evidences of variability. Mitchell et al., (1966) points out that variability involve all forms of atmospheric inconsistency regardless of their statistical nature, and occur in many different scales over time whether through natural or anthropogenic processes. This position concurs with the argument of IPCC (2007) that variability in climate is being experienced however, its impact on hydrology and water at a micro scale has not been widely documented. Variability is also occurring in all continents and oceans, over land and especially in the high Northern latitude (Kundzewicz et al., 2007).

Increasing temperatures caused by the heightened greenhouse effect is equally significant in impacting on the hydrological cycle and if not controlled poses the threat of both floods and droughts (IPCC, 1996) in many regions including Homa Bay county. There is a wide spread consensus that climate variability is real (Ermine et al., 2001) with warming temperatures, glacial melts and the ever shifting weather patterns.

The Water resources are complexly intertwined with variable climate conditions (WARPO, 2005) implying that water related hazards such as water stress, floods, drought will be more pronounced in future because of climate variability. According to a report by IPPC (2001), Climate variability has become a scientific reality with its impact being felt on global water resources in terms of availability, distribution thus water supply and demand should well be addressed. Gleick, (1998, 1999, 2000) affirmed that climate variability on water resources greatly affects its management and the condition will persist over a few decades.

There has been a major concern with the varying mechanisms of hydrological cycle (Bates et al., 2008) which lead to increased occurrence of various weather actions like rainfall, floods, drought in addition to heat waves. In the view of Ahen *et al*., (2009) the future climate variability scenarios will alter the patterns of rainfall and temperature leading to increased sea level rise. Further, Mutai et al. (1998) argues that tropical regions are expected to record the highest frequency in climate variables, Homa Bay County being one of the regions to be affected.

According to Kumar et *al.* (2006), the unpredictable nature connected with rainfall and temperature are vital components of the atmospheric systems which impact on water availability through alteration in water storage, evaporation and run-off. Human activities continuously increases the modification of the climate system by interfering with radiative balance resulting to a rise in temperature. The upward temperature trend across the entire globe since the early 20th century and mostly in the late 1970s has been due to increased fossil fuel emission brought about by industrial revolution. At the macro scale, there is a pattern that indicate regions with decrease and increase of annual runoff (Tao et al 2003, 2011) and the major climatic factor that determines the availability of water include rainfall, temperature and evaporation which is influenced by average radiation, wind speed and humidity in the atmosphere. Any imbalances in these climate drivers will lead to high risk of flooding, shortage of water, withdrawal of ground water and also aquifer recharge thus decreasing water availability and surface runoff systems. Variability in climate is expected to affect water resources in both inland and coastal areas, including Homa Bay County which experiences frequently occurring rainfall and high intensity variable rainfall events with increased and even decreasing runoff and erosion in the region.

Homa Bay County is located along the equatorial region and is affected by the General circulation system. This study investigated the daily rainfall and temperature totals (maximum/minimum) and stream flow impacts on spatial and temporal water resource availability, distribution and quantity using SWAT model.

1.2 Statement of the Problem

The study was carried out to determine the impact of climate variability on surface water resources in Homa Bay County. Climate variability was evaluated in terms of daily rainfall and temperature totals respectively while surface water resources were assessed using the daily river volume flows. The impacts were measured in relation to trends, seasonality, frequency, distribution, availability and quantity with the 1983-2013 periods. Specifically, the study addressed the extent to which daily rainfall and temperature variability impact on the mean daily river volume flows. The surface waters of Homa Bay County are represented by the channel flows most of which end up in Lake Victoria. The channel flows constitute most of the sources of surface water in the County and it was therefore considered important to assess their conditions in relation to climate variability.

Various segments and systems including sanitation, settlement, infrastructure, transportation industry, insurance, financial services and tourism sector highly depend on availability, distribution, quantity and supply of surface water. River volume flows are linked to the Hydrologic cycle and relates to climate variability. Changes in hydrological regimes are likely to impact on climate over a surface area and variability in the climate condition of a surface area directly affects the hydrologic regime as reflected in the availability of surface water resource and its distribution.

Surface water resources are essential for life existence and associated activities on earth. Climate variability is often used as a measure of distribution of life and associated activities on any given surface of the earth. Rainfall and temperature are the two major climate variables necessary in estimating the availability and distribution of water resources which are majorly measured by surface water on earth. The essential water is mostly found on the continents in terms of river flows within a region.

The variation in the availability of surface water resources tends to be related to the geography which also affects the climate conditions such as changes in temperature and rainfall thus affecting infiltration and vaporisation process of the hydrological cycle in the temporal and spatial scales. This study established the connection between climate variability and surface water resources both spatially and temporally, reflected trends, seasonality and frequency of climate conditions with regard to availability and distribution of surface water resources therefore climate variability determines the availability and distribution of surface water resources in Homa Bay County.

1.2.1 Research Questions

The specific questions addressed were:

i. To what extent does daily rainfall and temperature variability impact on daily river volume flows in Homa Bay County?
ii. What is the nature of the relationship between daily rainfall totals, mean temperature and river volume flows in Homa Bay County?

1.3. Study Objectives

1.3.1 Main Objective

The main objective of this study was to establish the relationship between Climate Variability and spatial distribution of surface Water Resources in Homa Bay County.

1.3.2 Specific Objectives

The specific objectives were to determine:

i. The extent in which daily rainfall totals and temperature conditions affect daily river volume flows in Homa Bay County.

ii. How daily rainfall totals and mean temperature relates to availability of surfaces water resources in Homa Bay County.

1.4. Study Hypotheses

The study was based on the following two hypotheses:

i. Rainfall and temperature conditions have limited impact on river volume flows in Homa Bay County.
ii. There is no significant relationship between climate variability and river volume flows in Homa Bay County.

1.5. Justification of the Study

Several factors determine climate variability and their impact on surface water resources including geographical position, environmental and economic status and the capacity to mitigate and adopt to the conditions. Variable climatic conditions manifest themselves through fluctuations in flooding, drought occurrence, surface water levels, river volume flow, water quantities, rainfall and water vapour. In the opinion of UNEP (2007) very little has been done to assess the specific impacts of rainfall variability on water resources particularly along the Lake Victoria region. Climate variability in Homa Bay County was mainly influenced by the presence of the Lake and relief features that are barriers to the prevailing winds. The study area has a pressure belt that shifted with the movement of the overhead sun and created an equatorial trough also called ITCZ. The steep topography along the shores of Lake Victoria such as Gwasi, Gembe, Ruri, Huma and Wire hills were found to be responsible for the daily variations in temperature and rainfall in the area depending on trends, seasonality and frequency.

Changes in the rainfall and temperature patterns then impacted on the availability and distribution of surface water resources in the County. The study area is among many other regions in Kenya which are facing the challenges of availability, supply and distribution of water resources. This was attributed to the inconsistency in temperature patterns and rainfall brought about by climate variability.

There were many other reasons for concern about impending water scarcity in the areas under study. Population in the County was believed to be in the increase due to improved standards of living, this implied that there were increased demands for water used for agriculture, domestic and industrial purposes. In parallel, rising affluence in developing towns and urban setups within the County due to devolution made a larger number of persons in the area to adopt water intensive kind of lifestyles including car wash activity, and watering garden among others. Moreover, the rapidly developing economy in the devolved unit resulted in more water demand. Climate Variability was established to be catastrophic even in future in relation to availability and distribution of surface water resources in Homa Bay County if not addressed viewed alongside management and conservation.

This study concentrated on rainfall and temperature daily totals during the period. Homa Bay County was found to experience a modified equatorial type of climate and also the effects of Global Circulation Systems. , it was determined that a strong relationship exists between climate variability and water resources within the county including the declining and increasing rainfall and temperature patterns, surface water levels, river volume flows and the underground water recharge systems that lead to replenishment and sustainability of surface water resources thus justified the need for this study in addressing the surface water deficiency in the County.

1.6 Scope and Limitation of the Study

This study mainly focused on the impact of rainfall and temperature trends on river discharge as main surface water resources in Homa Bay County. It was projected to establish the possible impact on the availability, distribution and quantity of surface water resources and regional hydrological systems. The hydro meteorological data sets used were the long term observed daily records of rainfalls, temperature from various (KMD) weather stations plate 4.2 and river discharges (WRA) plate 4.1 for a thirty year period ranging from 1983 to 2013. The climatological period was long enough to establish the trends and variances in the climatic variability with their implications on water resources. Limitations experienced included; many rainfall station provided by the meteorological Department but, stations which were operational but had inconsistent records, some rainfall stations did not have personnel to undertake daily records while other had faulty rain gauges and were therefor not being used.

On river discharge data challenges included broken down gauges, some gauges had also been swept away by the floods or even vandalised and a request was thus made to WRA to replace them. Another limitation in this study absence of personnel in most Meteorological stations across the County, this was attributed to poor management of the devolved meteorological services and lack of adequate funding by the county Government, though this had little consequences to the general study. This study incorporated FAO land use land cover and Soils some of which did not conform with the Soil and Water Analysis Tool land use classes, a user tables was created to get the nearest approximates. Interpolation as a method was used to address missing and inconsistent data. Other challenges included unpredictable weather conditions, seasonality of some rivers remote regions with long and winding terrains and poor road network of which were addressed depending on the actual prevailing circumstances during the study.

1.7 Operational Definitions

Climate Variability: The daily upward or downwards trends in rainfall and temperature totals, a short term average condition or anomalies in terms of the average

Climate Dynamics: - refer to changes in climate system including variability on rainfall totals and temperature patterns.

Extent:-.the spatial and temporal magnitude, scope or scale of rainfall and temperature impacts on water resources.

Frequency: - the number and duration of occurrences of rainfall and temperature events.

Impacts:-measurable outcomes of rainfall and temperature and changes in the hydrological cycle and related systems.

Nature:-the way climate variability events manifest their impacts on water resources

Rainfall variability:-Short term rainfall fluctuations observed within a short time scale

Relationship: - interconnection between climate variability and water resources.

Seasonality: - rate at which the system is affected (beneficially or negatively) as a result of climatic changes. The changes could also be direct or indirect.

Space scale: - regional, subnational, continental and global coverage.

Time scale: - hundreds of days, monthly; annually and seasonally.

Trend: - the general direction of variation caused by climate variability events spatially and temporally.

Surface Water Resource: - a body of water that is flowing, available and can be used in adequate quantity in a region over a certain duration for a specific demand.

Water Yield- a mount of water that flows off in unregulated watershed in Homa Bay.

CHAPTER TWO

2.0 LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Introduction

The literature review presents more insight and a clear understanding of climate variability and its consequences on the hydrology and surface water resource systems. The general information on climate variability, analysis of rainfall and temperature patterns and water resource availability, quantity and distribution in different regions, in Kenya and specifically Homa Bay County was captured. The review outlines the magnitude of climate studies thus enabling the identification of strength and weaknesses and also give the trends significant to the research problem in facilitating the design of the techniques used in data identification, collection, analysis and the methodological approaches applied in this study.

2.2. The Review

2.2.1. Climate Variability

IPCC (2007) defines Climate variability as anomalies in the climate system varying annually and includes rainfall, temperature evapotranspiration and solar radiation. These Variability are borne by the deviation in the average mean state and other characteristics such as the standard deviation and extremes of the average condition of climate on spatial and temporal ranges which surpass the distinct meteorological conditions over a certain duration and the changes may be brought by both natural and human driven factors (IPCC, 2013). Rainfall according to (Conway 2002) is the major climate variability event spatially and temporally. The hydrological process is influenced by climate variability in several means in the opinion of (Olive & Olive 1994) and changes in the hydrological process and the watersheds regimes adversely impacts on surface water resources in terms of availability and quantity(Schnoor,2010) Many natural factors contributes to climate variability such as Solar radiation and even volcanic eruptions(NRC,2010).

Variability is also occasioned by drivers including El Nino and La Nina events, periodic variation in oceanic and atmospheric circulations according to Mutai, (1998) which also causes changes in rainfall and temperature in terms of trends, seasonality and frequency. In the view of Karlet et al (1995) variability has significant impact on the hydrological cycle of a region including impacts include frequency of droughts, trends in rainfall, changes in river discharges and the lake levels. Rainfall in particular affects the availability and quantity of water resources for varied uses (EPA, 2012). An increase in rainfall precipitation may not necessarily increase the amount of surface water due to imbalance created by rise in temperature also increases evaporation and vice versa (SUG 2012; RCP, 2012), water resources are stressed due to increased demands and reduction in availability and supply. It's significant therefore to understand the impact of climate variability on hydrological cycle to enable good management of water resources. This study therefore focused on the definition as proposed by the IPCC (2007) and investigated these relationships as outlined in the theoretical and conceptual framework.

2.2.2 Surface Water resources

Surface Water resource is the existence of a body of water that is flowing, available and can be used in adequate quantity in a region over a certain duration for a specific demand. Many areas worldwide continue to experience impact of climate variability on water resources (IPCC, 2007) though this differs from one region to another. In the opinion of NASA& NOAA (2014), on the list of warmest years on record since 1992, 2015 was the hottest year and this is expected to continue in the rise. The earth surface is estimated to be seventy-one percent covered with water although water availability on land is not uniform on the global scale.

Different zones experience varying averages in terms of rainfall and temperature variability causing either surplus or deficit (Arnell, 1999) and by the year 2025 an estimated 5billion people out of a projected 8billion people are bound to live in nations facing water crisis and Homa Bay County may not be spared either. In the opinion of WCED (1997) human beings should focus on sustainable development to achieve a healthy living standard.

According to Karl et al (2009), the hydrological cycle reduces or increases evaporation of moisture and surface runoff which also impacts on water availability and reuse. The concept of climate changes and related impact on water resources in this study was assessed with regard to the rise and decline in temperature and the likely impact on hydrological cycle that included an increase in evaporation, rainfall and change in the seasonality and timing of both temperature patterns and rainfall (IPCC, 1996).

Barnet et al., (2005) argues that areas which depend largely on rainfall as the main source of water are negatively impacted by drought. Frequency of floods in a region is also accelerated by climate variability and this in the opinion of Milly et al., (2002) increases the availability and distribution of water resources as affirmed by (Chen et al., 2013; Labat et al., 2004) including surface runoff and the hydrological system. In addition, the stream flow and groundwater are key mechanisms of the hydrological system. They are all connected with the processes that link the atmosphere with the earth surface through the atmospheric branch of the hydrological cycle.

In the opinion of Poff & Ward (1989) climate variability alters the quantity, variability and timing of runoffs, consequently (Naiman et al., 1992; Cayan & Peterson, 1989; Redmond & Koch 1991,; Arguado et al., 1992) affirmed that when climate variability affects many ecological processes the existing relationship between atmospheric circulation, temperature, precipitation and runoff is inevitable and results in changes in in the hydrological cycle.

Rising temperature and high evapotranspiration causes subsequent loss of soil moisture and droughts; this leads to surface water decline in stream flow, underground recharge volume and a general surface water stress. The increased rainfall on the other hand causes flooding, sea level rise and replenishment of surface water resources. Gleick (1989), acknowledges that a shift in the cyclic distribution of runoff has major consequences for water resources management in the regions including Homa Bay County.

The projections of USGCRP (2000), on climate variability in mutually seasonal runoff systems and interannual runoff inconsistencies is connected to availability and distribution of water resources. According to Berger (2012), variability is the main cause of stresses such floods and drought. Rise in the sea level is expected to continue progressively in future.

The IPCC (2007) projected that water shortages in future may be brought by increased climate variability on parameters such as solar radiation, temperature and rainfall. Studies and hydrological research strongly advocates that climate variability will alter the general hydrological processes, affect the quantity, availability and even the distribution of water resources leading to water stress (IPCC, 2007)

Many arguments including that of Barnett et al. (2005); Middelkoop et al., (2001); Krysanova & Wechsung (2002); Krysanova et al., (2005) suggested that individuals residing in snowmelt-fed basins experiencing decreasing snow storage in winter may be negatively affected by decreased river flows in the summer and autumn. Evapotranspiration will also increase by 2050 and this will decrease river flows, underground aquifers thus affecting agricultural productivity though Homa Bay County wasn't affected by this since it's located in a sun free zone.

In the view of FAO (2009), Africa is said to be second most populated and driest continent in the world after Asia and that the relationship between water, energy and climatic is significant one. Climate variability would create an imbalance in this relationship and affects food, water and energy security (NASA & NOAA. 2015). Sub Saharan African countries including Kenya suffer the most severe and overwhelming climate variability effects due to its geographic location, low income levels, poor technology advancement and institutional incapacity.

According to Eboh and Anyadike (2009) African states are not able to cope up with the changing environmental conditions; they still rely on renewable resources which are linked to climate processes which is a key indicator of susceptibility to climate variability. This is coupled with the desert encroachment, decreasing water runoff from catchment areas, decreasing soil fertility and over dependence on subsistence form of agriculture. In the explanation of (Psenner & Schmidt, 1992; Sommaruga-Wograt et al., 1997; Bates et al., 2008; Rogora et al., 2003) that nearly more than 70 per cent of inhabitants in African experience inadequate water supply and distribution and other related hazards A reliable and regular water supply defines healthy living, sustainable energy, proper agricultural practice, recreational activities, navigation and manufacturing process. Water availability is also influenced by runoff and underground aquifer, the IPCC (2002) thus affirms that provision of safe water for drinking highly depends on the infrastructure put in place rather than the quantity of surface runoff. Nevertheless, it is a challenge to achieve the availability, reliability, distribution and supply of surface water for varied uses in regions experiencing climate variability in daily totals of rainfall and temperature leading to deficit in all forms of water (IPCC, 2009) thus creating an additional cost in the provision of water.

Climate variability also creates an increase in economy and related costs for curbing surface water shortages especially in regions stricken with drought, poverty and population growth. The existence of climate variability on surface water in addition to increased population and economic instability is bound to put more pressure on already dwindling surface water resources in different regions. A report by UN Habitat, (1998) indicates that the potential for increased demand for water is due the various forms of water use including domestic consumption, particularly outdoor activities such as watering the garden and irrigation.

Varying temperatures have an impact on evaporation and transpiration rate, soil moisture content, cloud characteristic and storm intensity regimes. An increase in temperature creates a shift in cloud formation to form rain, this causes a change in timing of the peaks of stream flow in both mountainous and continental regions (Barnett, 2005). Frequency in drought and floods are projected to increase and most regions are bound to experience an increase in total rainfall due to high precipitation rates (IPCC, 2007). However, according to Jimenez (2003), most studies have only assessed the potential effects of climate variability on water in developed countries other than in the developing world.

UNEP Focus (2020) pinpointed that heavy precipitation events could impact the intensity of river discharges and groundwater flow volume. The water resources distribution with respect to temperature and rainfall variability has serious impact on water supply and may force water managers to decide between creation of dams for purpose of individual computation and relocating people to live closer to the water reservoirs among others. Water is usually held in the atmosphere, soil, dams, lakes and widespread aquifers.

According to Walling (1996), the Nile is the world’s largest river and that more often rivers in Africa have cyclic variations and inter-annual variability that shows the trends of precipitation in those basin. Climate variability particularly as revealed in the trends of rainfall covering many regions Homa Bay included is an indication of the increasing shortage of surface water in such areas (Milly et al 2005). The global annual runoff has continued to change with regions experiencing high and others low runoff (Milly et al., 2005; Hyvarinen, 2003; Walter et al., 2004; Tao et al., 2003). In the view of Manase (2009) many models have continuously predicted likely increases in temperature in high altitude areas and in the tropical regions of Africa.

Most parts of Africa experience an inter-annual rainfall variability and places such as the Sahel, multi-decadal variability in rainfall is of great magnitude and (Hulme, 1996; Sum low 2005) argues that there are numerous evidences of drying in such regions. South-east Africa on the other hand displays a stable system but with noticeable inter-decadal changes.

AFDB (2009) stated that the demand for water has increased with the rapid population growth. This growth in demand for water is not even matched with the corresponding development of water resources. Semi-arid Africa experiences water stress and yield reduction and this will worsen by 2030 (IPCC 4AR; UNFCCC, 2006).

Surface Water scarcity brought by variability in climatic conditions is bound to escalate aridity and the earth's temperature will continuously rise. A significant impact on the fresh water supplies is likely to be experienced with devastating effects on the resources. US GCRP (2009), argues that an increase in temperatures increases evaporation resulting to droughts. River flows distribution and the ground water recharge over space and time and the associated changes is also determined by varying evaporation, temperature and significant rainfall.

Major effects on hydrological processes have already been witnessed and more change is expected to differ between seasons and various regions (Chiew, 2007; Rosenzwng et-al 2007). The effect of water shortage brought by climatic variability increases chances of water being withdrawn from low quantity sources, highly contaminated masses from diffuse sources due to substantial rainfall, water infrastructure malfunctioning during floods and extreme rainfall (Kistemann et al, 2002; Kundzewiczet et al., 2007). In addition to sea -level rise, flooding and decline in underground water recharge. Water resources are therefore the most vulnerable systems to climatic variability (IPCC, 2007).

East Africa particularly Kenya show a comparatively stable regime and long term wetting because of such variability that in the view of (UNEP 2008), a blend of severe drought and abstraction of irrigation water will be experienced in the study area. According to the UN (2003), many non-climatic drivers also affect water resources but climate variability poses major future threat to Kenya and Homa Bay County included. The ever increasing population, growing economy, high technology, changing lifestyles and high value attached to water increases demand and water use, this is also coupled with management criterion at the National and International level.

A recent research by Oludhe et al., (2006) acknowledged serious humanitarian crisis caused by climate variability reported in Kenya between the years of 2005 and 2006 due to failure and irregularities in several rainfall cycles. Ocha (2006), asserted that it affected approximately 60,000 people who were displaced in Coast, western and eastern Kenya. Many people succumbed due to poor living conditions and lack of water and proper sanitation.

The degree to which the surface water availability, distribution and resources of the numerous regions of Kenya, Homa Bay in particular will be affected by climate variability and the serious impact on daily rainfall and temperature trends, seasonality and frequency is worrying (Odingo,1997). The availability and distribution patterns of surface water resources was instead the basis of the study and increase in drought could probably be witnessed in limited potential areas of Homa Bay County. Apparently, there could be a fluctuations in the amount of rainfall in regions that already receive a favourable rainfall amount. This research study bridged the gap and provided data that pointed at a strong indication on impact of climate variability on the availability, distribution and improvement of water resources in Homa Bay.

Climate variability coupled with factors that put pressure on water resources including population increase, land use and land cover, varying state of living, growing water demands and pollution of environment were found to be serious challenges to water management in Homa Bay County. The literature cited the possible magnitude of impacts and outlined the most probable uncertainties. It showed an increasing broader conclusion on water resource and effective methods of adjusting to changes and variability.

2.2.3 Rainfall Variability

Rainfall variability refers to the degree to which the amount of rainfall varies and its effect on water availability, distribution and quantity of resources for varied uses (EPA, 2012) According to IPCC (2007), an escalation in the hydrological cycle affects both the ground and surface water supplies through fluctuating amount, frequency and intensity of rainfall. Low rainfall causes drought due to increased temperature and higher aridity therefore resulting in a reduction in runoff and ground water recharge, through evapotranspiration surplus irrigation water percolating back to the water table (Maxiner et al., 2016).

Rainfall variability pressures on water resources include increased intensity within short duration, changing patterns, increased occurrence and amount of floods and droughts. All these pressures are directly associated with the changes in states of water such as availability, distribution, ground water levels recharge ,reduction in water infiltration in the soil, reduced soil moisture and decline in river flows. Rainfall variability is also linked to sea surface temperatures (Nicholson, 1986) Lake Victoria for this study and the subsequent weather patterns.

The Bimodal rainfall pattern experienced in eastern Africa, Homa Bay County in particular brings rainy season from March to May and also October to December with more interannual variability from October to December (UNEP, 2000). Mutai et al. (1998) opined that spatial and temporal trends of rainfall in Homa Bay County is moderated by the Lake Victoria and its topographical influences.

Many studies conducted have suggested an increase (Mason and Joubert, 1997) and others a decrease in total rainfall events (Huwitson, 1997) in terms of frequency, causing both short term run and long-term effects on the natural resource systems; wetlands, rivers and lakes (Glnatz, 2001) and their existence for varied uses (Hayward & Oguntoyinbo, 1987) in relation to availability, quantity and distribution in a region due to irregularity in floods and drought events.

Climate system is generally is linked to the environment, hydrological cycle, and atmosphere and it is considered as a key component in the determination of rainfall (UNEP /GOK 2000). Rainfall variability in this study is examined by the daily totals in relation to trends, seasonality, frequency and distribution (Thompson, 1957; Griffiths 1959 and Trewartha, 1961).

The diurnal, seasonality and interannual variability of rainfall is caused by the interconnection between ITCZ, El Nino/South Oscillation, winds and extra tropical weather systems (Ogallo, 1998; Mutai et la, 1998; Nicholson and Yin, 2002). There is concurrence that the wind patterns, pressure belts and effects of the ITCZ modify the climate variability of a region (Nicholson and Trewartha, 1981; Mukhabana and Piekle 1996). A general rise in temperature was projected in the study area to be a reflective of an increase in rainfall totals and vice versa hence needed to be investigated (Hulme et al, 1999) so as to ascertain the changes in temporal and spatial variability in rainfall patterns.

The rainfall patterns in the study area had two major peaks and the mean annual rainfall and season of maximum rainfall varied between the long and short rains in March to May and October to December respectively. The expected spatial and temporal variability of rainfall in the region could have been occasioned by the location of the highlands, the presence of the Lake in addition to the meso-scale created by varied topography ranging from the steep topography along the shores including Hills such as; Gwasi, Gembe, Wire, Homa and the Kisii and Nyamira highlands.

The circulations caused by the presence of Lake Victoria had an influence on the seasonal variability of rainfall patterns. A contrast in temperature created over the land surface and in the lake in the study area brings the effect of breezes at different time scales both in the day and night. There was a convergence zone created over the named uplands and the highlands leading to thunderstorms and high amounts of rainfall in the afternoon, the average amount of rainfall varies and the rainfall days was higher in regions such as Gwasi, Oyugis, Ndhiwa and Parts of Rangwe and lower in some regions of the county including Kendu Bay, Mbita and Sindo from the lake shore towards the highlands.

Higher rainfall and temperature drops led to increased humidity, excessive runoff and flood. Water on the other hand had a complimentary impact on hydrological balance; this explained how Lake Victoria influences a micro climatic condition significantly by reducing temperature and increasing humidity through evaporation from the water bodies and soils.

2.2.4 Temperature variability

As the global average temperatures continues to increase the occurrence of dangerous weather actions like alteration in the magnitude of rainfall and flooding also increases (Bonell et al., 1999; Karlet et al., 1995 and Tsoni1996), and this was witnessed in some regions within the study area. Higher temperature increased water holding capacity and evaporation into the atmosphere resulting in high rainfall and more droughts trends across the years.

Rising temperature also accelerates the hydrologic cycle. In the opinion of Houghton (2006), an increase and decrease in precipitation from one season to another change the water system in a region and Homa Bay County was not spared. Arnell (1992) argues that variability in temperature also alters the evaporation rate, solar radiation and all these impact the surface water resources affecting availability, distribution and the general water yield.

Due to seasonal variability of the conditions of the atmosphere, the quantity of solar radiation on the earth's surface also varied, a relationship then existed between temperature and the general hydrological cycle. Temperature variability was in terms of daily minimum and maximum averages. Rising temperature caused decline in rainfall, depletion of soil moisture content, reduction in stream flow and ground water recharge as is projected to be in some parts of the study area. Interannual variability therefore had a direct influence on the hydrological cycle. The long term water balance is also depended on potential evapotranspiration needed for water storage in the soils (Milley et al, 1994).

The phenomenon of climate variability created a concrete encounter to management of water resources by presenting insecurity in future hydrological conditions. This was also to estimate any major trend according to (Wilby, 2006) therefore any adaptation decisions should be provide mitigation in case of the would be changing water regimes due to variability even in Homa Bay County. In the view of Beuhler, (2003); Simonovic and Li (2003); Dessai et al., (2005); Arnell & Delaney (2006), water management system in view of climate variability should adopt an approach that mitigates on the rainfall and temperature variability events, this study investigated the scenarios in Homa Bay County.

2.2.5 The Hydrological Modelling

This is a simplified, conceptual representation of a part of the hydrological cycle to show the physical processes that control the processes of rainfall to river discharges (Droogers et al, 2008) Hydrological model applications have a variety of uses. The objective of hydrological modelling relies on the need for that particular model. According to Singh and Woolhiser (2002) hydrological models are applied for temporal and spatial extrapolation of point measurement, improving the recognition of system and helping in the establishment of effects of climatic variability on water resources as was applied in this study.

New models can also be created in addition to upgrading the old ones for management decisions on water resource development procedures in a sub basin and catchment. In the argument of Mutua (1986), river discharges are influenced by the meteorological; hydrological; topographical; soils and land use land cover distribution. It is vital to recognise that precipitation and temperature are significant elements used in climatology for forecasting climate variability, calibration as well as validation of models in hydrology (Rwigi 2004).

The Geographical information System (GIS) Interface

This is a Database management System that is computerised to capture, store, retrieve and analyse geospatial datasets. The data to be used in GIS must be georeferenced and intergraded (ESRI 2004). GIS creates room for overlay of numerous datasets such as LULC, Soils and Slope in the Watershed

Soil and Water Assessment Tool (SWAT) Model Description

The Soil and Watershed Assessment Tool (SWAT), developed by Arnold et al. (1998) is a computerised conceptual and continuous time model. This model was initially established to help in water resources management and in assessing the impacts on water supplies, sediments and agriculture chemical disposal in diverse and complex watersheds with various soil, land use and management system in the long term. Currently the model is also being used to estimate the effects of climate changes and land use management on water resources.

According to Arnold et al. (1998), SWAT is a basin scale hydrologic model that is statistically effective, handles significant spatial element, uses already existing inputs, and that it is an all-time model that functions on a regular basis at basin scale level and also of simulates land use management components, and yields reliable results. As input data, SWAT is fed with definite data on weather, terrain, land use land cover practices and the soil types found in the watershed from which the physical processes in relation to movement of water are modelled directly.

SWAT model comprises system that describes the process of precipitation, humidity effects on plant growth, temperature, evaporation and runoff generation among others and can be used to examine climate variability impacts (Abbaspour et al, 2009). The model allows hydrology, weather, sedimentation, soil temperature, and agricultural management among other physical processes in the watershed to be simulated (Arnold et al, (1998). It is also connected with the Geographical Information Systems (GIS) interface in order to facilitate efficient analysis of the impacts of varying watershed management techniques on water yields (Van Griensven, et al, 2012). In the opinion of Neitsch et al, (2011), the Soil and Water Assessment Tool and Geographical Information System interface allows the model to integrate the spatial characteristics of the terrain, soils and land use databases and thus conserving the wide variety of nature of the model parameters.

This model replicates hydrologic loads at different spatial levels both annually and on monthly basis as contained in a number of researches involving the application of the model (Gitau, 2008; Faramarzi et al., 2009; Schoul et al., 2008; Gassman et al., 2007). The model is adept of executing non-stop, long-term analysis for watersheds comprised of different sub-basins with varying soils, crops, weather, land use and topography among others (Neitsch et al, 2011).

The basic model products evaluated by SWAT consist of surface runoffs, percolation, weather, transmission loss, evapotranspiration, crop growth, pond and reservoir storage, return flow, irrigation and ground water flows. The model delineates the watershed into a number of sub-basins and Hydrological Response Units (HRUs) for efficient simulation of the components. Taking into account the differences in land use and soils in different parts of the watershed is important because they impact differently on the catchment hydrology (Neitsch et al, 2011).

The Characteristics of Soil and Water Assessment Tool (SWAT) Model

The Soil and Water Assessment Tool (SWAT) is a hydrologic model on water quality that was designed by the USDA-ARS, (Arnold et al., 1998) as a constant duration, semi-distributed and process-based river basin model used to analyse the impact of rainfall on alternative land management and water resources (Arnold et al., 1998).

The model operates on a regular period and is intended to simulate the impact of land use and management practices on hydrology and weather over extended duration (Neitsch et al., 2011). It is materially based and uses available feedbacks. The selection of the model is based on its computational efficiency and capability of continuous simulation with minimum data inputs over long time periods (Mango et. al., 2011) as was in the case of this project.

It has an interface with Geographical Information System (GIS) Arc SWAT, Arc GIS interface 10.2 which makes it suitable to organize, manipulate and store related spatial and tabular datasets and to describe hydrological features of a watershed (Di Luzio et al., 2002).The model is also integrated with the simulator input data base SWAT 2012 and includes SWAT editor for automatic editing of input data and an Output viewer to read the outputs. SWAT CUP is in cooperated into the model for input data calibration. The model uses a knowledge structure for direction-finding of runoff through watershed, these commands are incorporated for steering systems through streams, reservoirs adding flows and recording measured data. The Sub basin and Watershed components in SWAT includes soil temperature, weather, hydrology, plant growth, pesticide and land management, nutrients, erosion and sediments.

Based on the above qualities, this study applied Soil and Water Assessment Tool model to quantify the effects of rainfall and temperature variability on surface water resources in Homa Bay County. The extent of variability in river flows were quantified based on variations in the mean as a central value in the hydrological cycle, the climate systems as well as land use activities that results in increased or decline in river discharges. Increase in surface runoff, erosion and evaporation have negative implications on the water balance and environmental quality. These activities interfere with both the surface and underground water reserves and therefore have direct input into the water balance equation which may be seen in reduced base flows and increased peak flows.

A change in any of the climate element or land use activity affects community or some sector thereof with magnitudes commensurate to the shift in existing use of natural resources including land and water. The impacts include loss of biodiversity, reduction in rainfall, increased temperatures and drought occurrence with further implications on livelihoods and food security. Mitigating these impacts should aim at sustainability in terms of policy interventions and institutional framework.

The Input Data requirements for Soil and Water Analysis Tool (SWAT)

The data required to run the SWAT model includes of the projected Digital Elevation Model (DEM), land cover, soils and Weather Data such as daily precipitation, amount of solar radiation, relative humidity, wind speed and minimum and maximum temperature patterns. From the DEM, the stream network is generated automatically under the ArcGIS environment. The stream network and LCLU is used to estimate the HRUs. Meteorological observed data in different regions in the stream network delivers enough data to run the SWAT model (Droogers et al, 2006).

An advanced exponential equation is applied to come up with daily average wind speeds computed by the mean monthly wind speed data. The relative humidity model makes use of triangular distribution to evaluate the daily average relative humidity from the monthly means. The average relative humidity on a daily basis is accustomed to account for wet and dry day properties (Neitsch et al, 2011). The outputs from the SWAT model simulations are distinguished into stream flow output and land based results. Stream flow included the hydrologic components for every stream in the watershed. The land based results are broad and involves all the components of the hydrological cycle in addition to the erosion, pollutants, nutrients and crop growth. (Neitsch et al, 2011).

Various researchers have effectively used a standardized and authenticated SWAT model to gauge the effect of land use and climate variability on water availability. Most of these studies have established the applicability of the SWAT Model by evaluating the effect of climatic variability on soil crop yield and water availability in different watersheds. The SWAT model is also significant (Allen 2007)   in accessing components of water balance including stream flow (Fu et al., 2007), groundwater recharge (Scibek and Allen et al, 2006). Again Zhang et al., (2012) employed the SWAT model to predict hydrologic reaction to climate variability in the Luo River Basin, from the research conducted, it is evident that SWAT to some extent is effective in evaluating the hydrological effect of climate variability as in the case of this project.

In Kenya, the Soil and Water Analysis Tool hydrological model has been applied in many river basins to study the hydrological responses. Jayakrishnan et al. (2005) made use of SWAT to evaluate the hydrology of river Sondu as part of assessment of the impacts of modern technology on the small holder daily industry. Sang (2005) used SWAT to evaluate the impact of climate change, land usage and reservoir storage in the Nyando basin. In these studies, it was established that SWAT model produced outstanding results in the simulation of streamflow and was also be applied to assess the impacts of land use and climate change on the flooding in the basins namely: Tana and Sondu (Jayakrishnan et al, 2005); Nyando (Sang, 2005); Tana (Jacobs *et al*, 2007); Nzoia (Githui, 2008) and the Mara (Mango et al, 2011) to establish the hydrological answers to changes in LULC and environmental conditions. Jacobs et al., (2007) applied the Soil and Water Analysis Tool Model to evaluate the ecological effects of reforestation in the higher elevations of the upper Tana basin as part of mitigation of economic damage studies.

Githui, (2008) used the SWAT model in the Nzoia river basin as part of the assessment of impacts of environmental change studies. SWAT model is of more advantage to use since it is provided freely, can be used with available data and properly recorded, uses many databases with good technical support systems (Gassman et al., 2007) it is also incorporated with GIS through Arc SWAT for overlay of data. (Winchell et al., 2013)

2.3 Conceptual Framework of Impact of Climate Variability on Surface Water Resources

This framework uses climate Projections to simulate variability impacts on surface water resources and accounts for Climate variability with associated impacts on surface Water resources including availability, distribution and quantity. This is dependent on the Hydrological cycle which is a representation of the flows, water and energy including dissolved materials.

The major regional climate outputs that impact on surface water resources including rainfall, temperature and river flows are fed into the hydrological model to help in the prediction of runoff, groundwater recharge, distribution, extraction rates in terms of quantity and quality parameters and all stored input and outputs in the Hydrologic system together with the flows form the sub systems such as the Watershed, atmosphere and the various water stores.

The model concept is of a distributed spatial representation of the Watershed which is also based on the principle that Water flows downhill under the force of gravity, hydraulic pressure in ground water aquifer and also through evapotranspiration. Soil and Water Analysis Tool model is therefore applied in this study to simulate the Hydrological process and climate variability interactions and impact on surface water resources. This is an indication of negative effect of climate variability and double revelation on future availability and distribution of water resources (Arnell, 2001).The model functionality included the use of Digital Elevation Model (DEM) to characterise the surface in relation to slope, aspect and to calculate boundaries and delineate drainage systems, stream networks which helps in quantifying soil moisture, flow times and the general catchment Hydrological responses.

The Conceptual frame work also incorporated other land controlling factors such as; Digital elevation model(DEM), Land cover land use and soils, hydro meteorological indicators including simulated weather data; rainfall, temperature, relative humidity solar radiation and wind speed. Observed rainfall and temperature measurement and river discharge data all of which were crucial in modelling process.

In order to assess the impact in line with a specific variability event, it's important to focus on the probability or chances of its occurrence. The impact of variability and related consequences in water resources are described by standards (typically thresholds) that relates the effects of climate variability and their probable effects (Carter et al., 2007) such as variability in daily rainfall and temperature totals. The process of Calibration is undertaken in the model to improve the model performance and reduce prediction error and uncertainties.

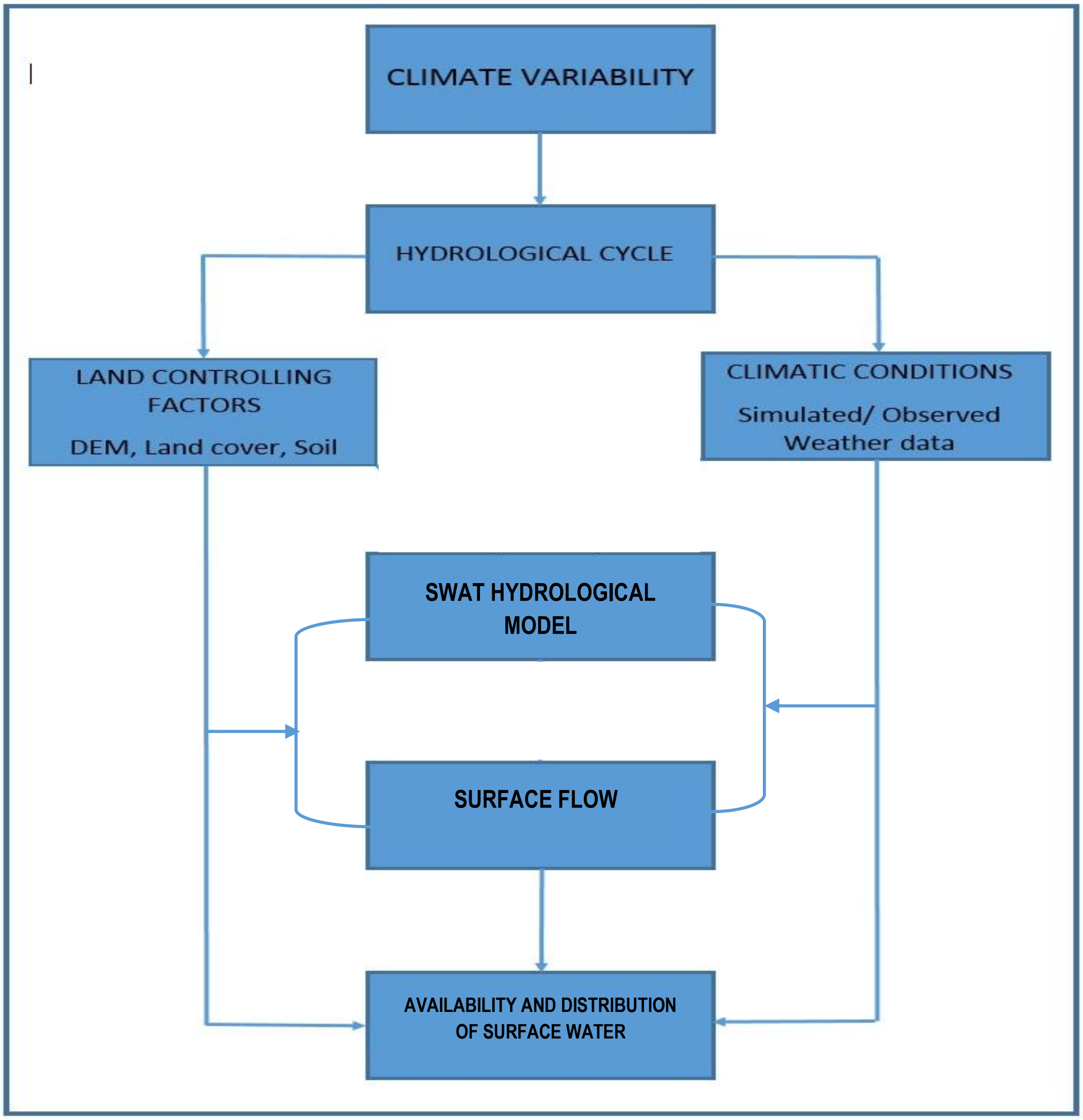

Figure 2.1: The Conceptual framework
Source: Modified from Kelleners et al., 2009

CHAPTER THREE

3.0. AREA OF STUDY

3.1. Location and Size

Homa Bay County is in the western part of Kenya along the Lake Victoria basin(Fig 3.1).It is bound by latitudes 0°32'6.15"S, 34.453097 and longitudes 34°27'11.15"E, 0.535043. It covers an approximate area of 3,342.2km^2 of which approximately 1.227 km^2 is covered by surface water resources .To the South of the study area is Migori County, Lake Victoria is found in the Northern and Western parts, Kericho and Kisumu to the North east region and Kisii and Nyamira Counties to the Eastern side.

The study basins stretches from the Kibuon River Basin which covers five sub basins namely 2,3,5,8 and 15 .The Tende River basin covers 9 sub basins including 4,6,7,11,12,13,14,16,and 17 while Riana River basin is made up of sub basin 18 and 21.

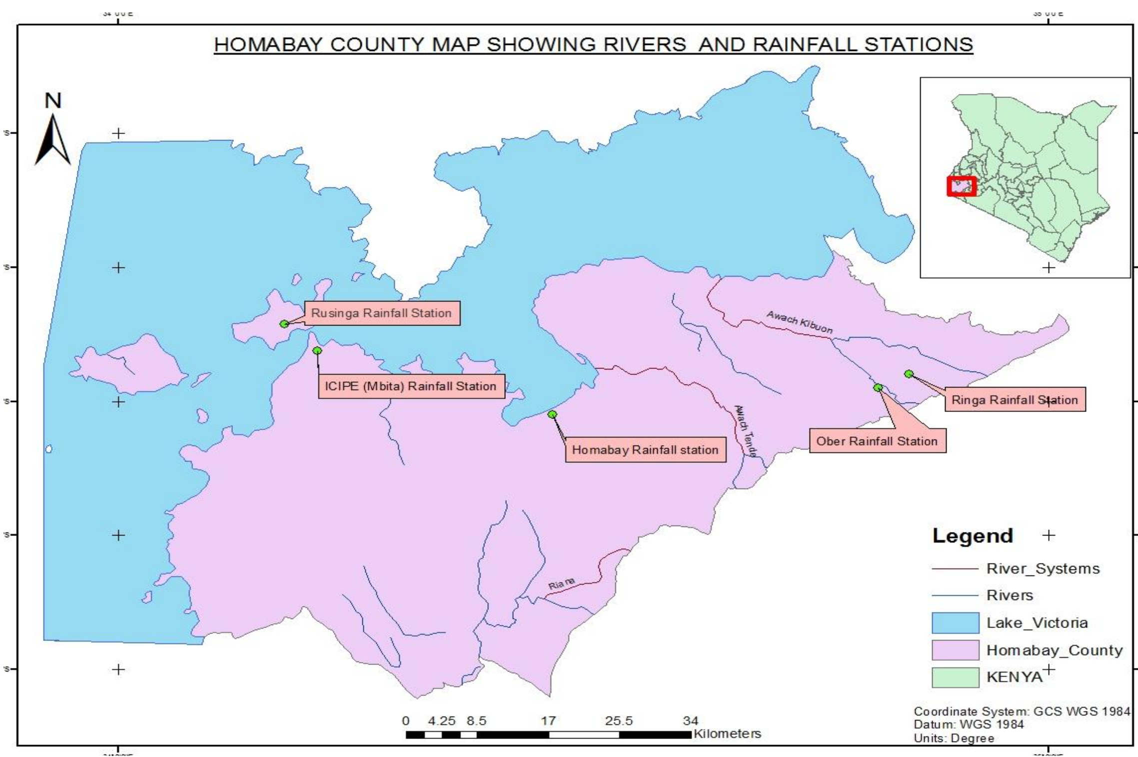

Figure 3.1: Homa Bay County Map
Source: Researcher (2018)

Table 3.1: Rainfall station arranged in terms of altitude

Station Name	Longitude	Latitude	Altitude
Ringa	34.85	0.466	1624
Awach Kasipul	34.80	-0.501	1539
Awach Tende	34.49	-0.467	1532
Ober	34.817	-0.483	1509
Kosele	34.42e	-0.26	1370
Kodera Forest	34.39	-0.31	1350
Homa Bay Dwo	34.467	-0.517	1312
Riana	34.517	-0.714	1311
Icipe Mbita	34.10	0.25	1240
Muhuru	34.07e	1.00s	1220
Awach Kibuon	34.657	-0404	1189
Awach	34.669	-0.403	1158
Opanga	34.833	-0.433	509

Source: Researcher (2018)

Table 3.2: Rainfall Stations used in the study

Station Name	Longitude	Latitude	Altitude
Ringa	34.85	-0.466	1624
Awach Tende	34.49	-0.467	1532
Ober	34.817	0.483	1509
Homa Bay Dw	34.467	-0.517	1312
Riana	34.517	-0.714	1311
Icipe Mbita	34.10	-0.25	1240
Awach Kibuon	34.657	-0.404	1189
Rusinga	34.1292	-0.4042	1143

Source: Researcher (2018)

3.2 Geology and Soil

The Predominant Soil types that occur in the Lake Victoria Basin are Cambisols, Planosols, Vertisols, Regosols, Arenosols and Ferralsols and according to Andriesse and van der Pouw, (1985) other soils in the study area are Ferrasols, Nitisols, Cambisols and Acricsols which exhibit different geological characteristics with presence of volcanic rocks, and soils derived from the Nyanzian and Kavirondo rock systems.

Ferrosols dominate the higher ground areas ,other soil types such as nitsoils, histosoils and gleisoil's also exist, along the lake literals and in the valley all the soils types affects the water balance in relation to albedo, moisture retention and carrying capacity and this eventually determines land use and vegetation cover. With a high moisture retaining capacity though deeply weathered.

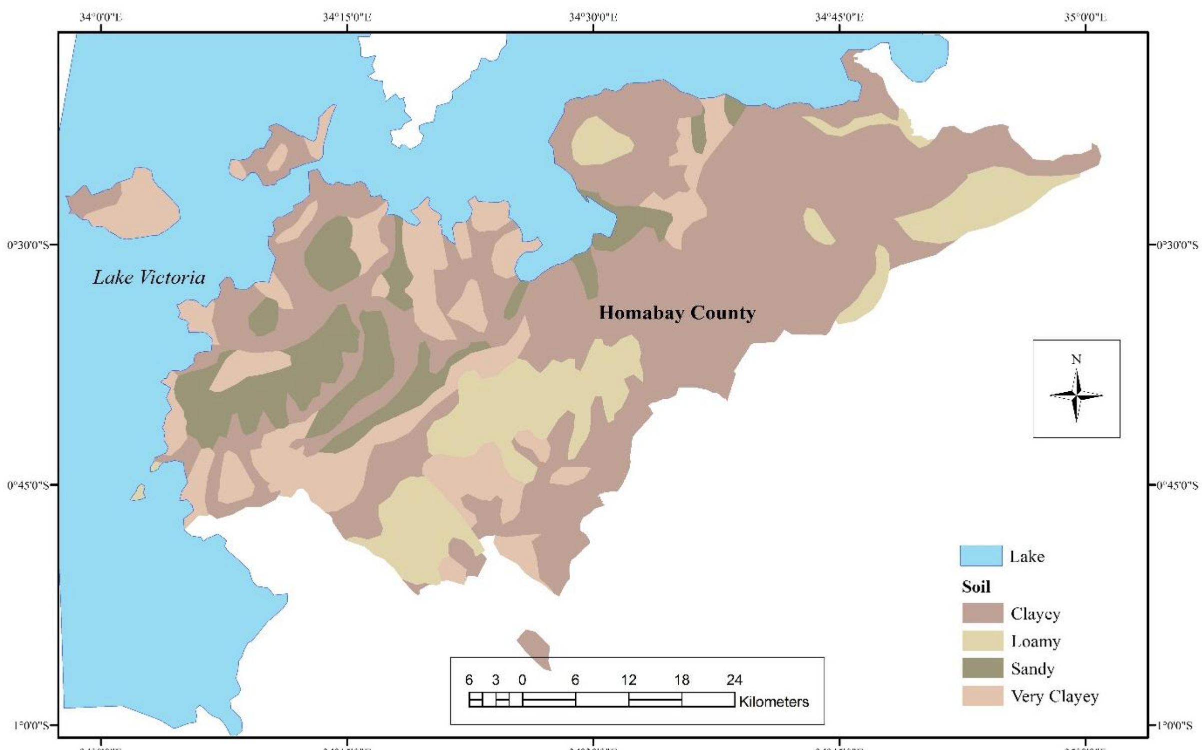

Figure 3.2: Soil Map of Homa Bay.

Source: Survey of Kenya (2011**)**

Homa Bay County lies within the Nyanzian and Kavirondian geological systems. The region is characterised by different rock and soil types which have an impact on availability and distribution of water resources. The dominant local soil types include loam, clay and sandy soils (Fig.3.2).

Depending on the geological components, the Predominant soil types found within the Lake Victoria Basin includes; Ferrosols, Arenosols, Cambisols, Vertisols and Planosols(Andriesse and Van der Pouw, 1985) other soil types include Nitisols, Cambisols and Acricsols which exhibit different geological characteristics with presence of volcanic rocks and soils derived from the Nyanzian and Kavirondo rock systems.

Ferrosols dominate the higher ground areas, soil types such as nitisols', histosoils and gleisoil's also exist, along the lake literals and in the valley all the soils types affects the water balance in relation to albedo, moisture retention and carrying capacity thus affects the distribution of land use land cover, landforms and this impacts on the hydrological system in the area by alteration the surface water channels.

3.3 Topography

Homa Bay County has a varied topography generally sloping towards Lake Victoria, there are uplands of various levels to valleys in western and central regions. The altitude of the study area ranges between approximately over 900 metres along the Lake Victoria to 1200 meters above sea on the uplands and hills. The upper zone of the area has an altitude of over 1200 m above sea level, the middle zone about an altitude of less than 1000m and the lower zone exhibit about 950 m above sea-level. The gradient increases river discharge from upstream which reflects uniform aquifer drainages systems.

The area consist of gentle undulating landscapes broken by hills ridges and even plateaus including Gwasi hills, Gembe hills, Homa hills, Wire and Ruri hills and parts of Nyabondo plateau. Steep slopes in Homa Bay enables rain water to run over the surface before infiltrating as compared to gentle slopes found in Kochia that encourages more infiltration thus affecting surface water resources and river discharges.

The valley drop in Lambwe region controls the interaction between ground water and river systems in the area. A table like environment around Kochia controls the flow from upstream Oyugis and karachuonyo, this perpetuates flooding and good yield of water table. The lakeshore lowland and the upland plateau have numerous small medium sized rivers and seasonal steams.

3.4 Climate

A number of factors contribute to the Variability in Climatic conditions in the study area including synoptic scale irregular flow of winds all year round. The common easterlies and meso-scale circulations due to the presence of Lake Victoria and highlands such as Gwasi, Wire and Homa in addition to the Kisii highlands affects the climate in the study area causing seasonal and inter annual rainfall patterns and this impacts on the availability ,distribution and quantity of water resources in Homa Bay

The climate types of the area varies spatially overtime and within short distances, Lake Victoria region has a modified equatorial climate with relatively modified temperature and fluctuating rainfall totals. The variations in temperature between the lake and the lands causes alternating land and sea breeze resulting to a convergence zone thus afternoon thunderstorms and increased rainfall amounts. A low pressure zone created at night results to warm air rising, forming clouds and fall as rainfall in some parts in the morning.

The study area experiences an annual rainfall that is relatively lower averaging to approximately 1200mm per annum than typical equatorial conditions and this classifies the region as sub-humid. Temperatures plays a vital role in influencing evapotranspiration, the study area experiences a spatial and seasonal variability in temperature in different months of the year.

The variations is between 20°C to over 35°C and from an annual Low of 17.1°C to a high of 34.8°C. Rainfall varies from 250mm to 800mm per annum and a pattern of seasonal variability of rainfall which is influenced by the movement of the ITCZ. The study area also exhibit variability in potential evapotranspiration depending on the altitude, relief and nearness to the Lake Victoria.

The area also exhibit semiarid weather conditions with daily temperatures of 26°C in cold months between April and November and 34°C in hotter months of January - March. Rainfall received is likely to be 250mm and 1200mm per year, during this period with the mean annual rainfall of 1,100mm.

There is a double rainy seasons experienced in the study area; the long rains are experienced in March-April-May while short rains starts in September to November. The variations in climate patterns could as well have an effect on surface water resources. Within the region during the hot dry season, the sandy soil is baked due to high temperature, increased temperature rates then reduces river discharge and causes surface water to evaporate.

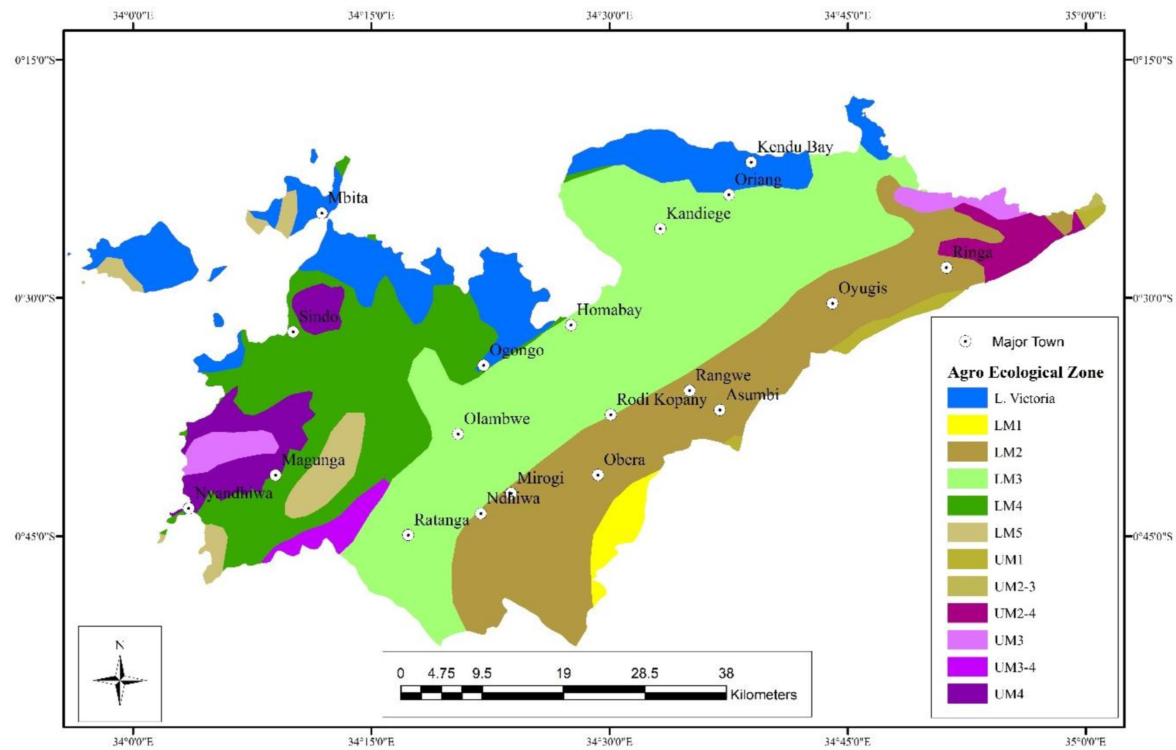

Figure 3.3: Agro Ecological Zones in Homa Bay County
Source: International Livestock Research Institute.

The various Agro ecological zones (Fig.3.3) in the study area indicates the climatic relationships with various land uses and in the Kenya soil survey climatic zoning Method ,the area falls in the zones I-IV(Sombroek et al,1982).This means that the area experiences variation in the potentiality for rainfed agriculture depending on the zones.

The study area could therefore be classified in terms of agro climatic potentiality (table 3.1) of high, medium and low potential areas in relation to rainfall amount, the low potential area are located along the lake littorals.

Table 3.3: Key to Agro Ecological Zones.

Zones	Agricultural potential	Amount of rainfall(mm)	Approximate evaporation(mm)
I	Very high	Over 1200	1200-2000
II	High	900-1600	1300-2100
III	High-medium	700-1400	1400-2200
V	Medium	600-1100	1500-2300
VI	Marginal	400-800	1600-2400

Source: Modified from Mungai (1984).

3.5 Hydrology

The hydrology of Homa Bay County is made up of underground aquifers, rivers, wells, springs and lakes. The region has a complex hydrological (figure 3.4) system originating from the Kisii highlands. The Major Rivers include; Awach Kibuon, Awach Tende and Riana which together with their tributaries drain into Lake Victoria. The area is Swampy in Lambwe valley and parts of kochia, Kabondo and Kabondo Kasipul. The only outflow from Lake Victoria is the River Nile.

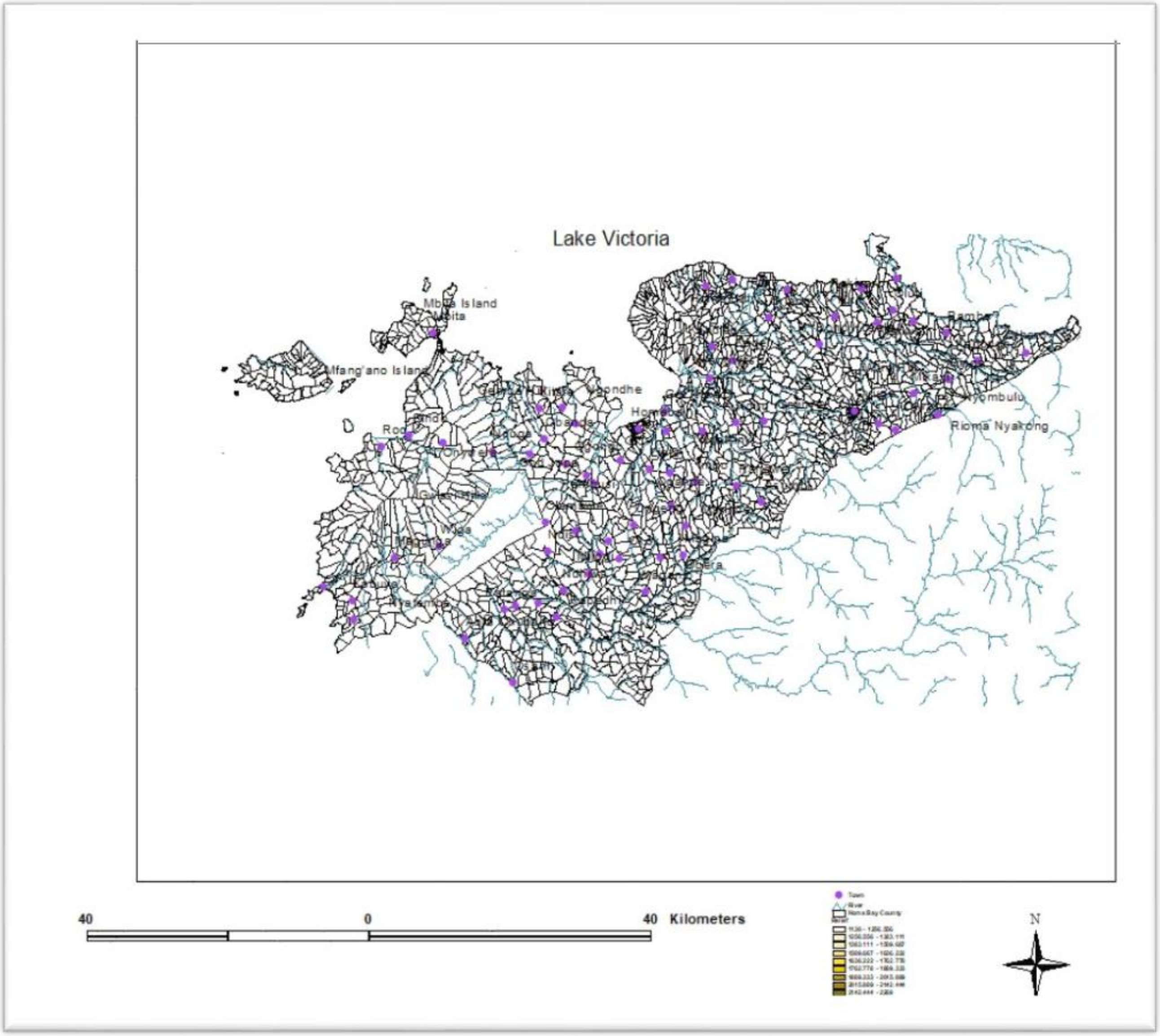

Figure 3.4: Hydrography of Homa Bay County

Source: Researcher (2018)

3.5.1 Rivers and Lakes

Homa Bay County is endowed with various rivers some of which are permanent and others seasonal (plate 3.1) . The major river include Awach Kibuon, Awach Tende, Maugo in Karchuonyo, Riana, Mirogi and a Section of Kuja, Nyakwamba and Kowuonda in Ndhiwa and Lambwe in Mbita

Plate 3.1: Section of River Kibuon

Source: Field work (May 2018)

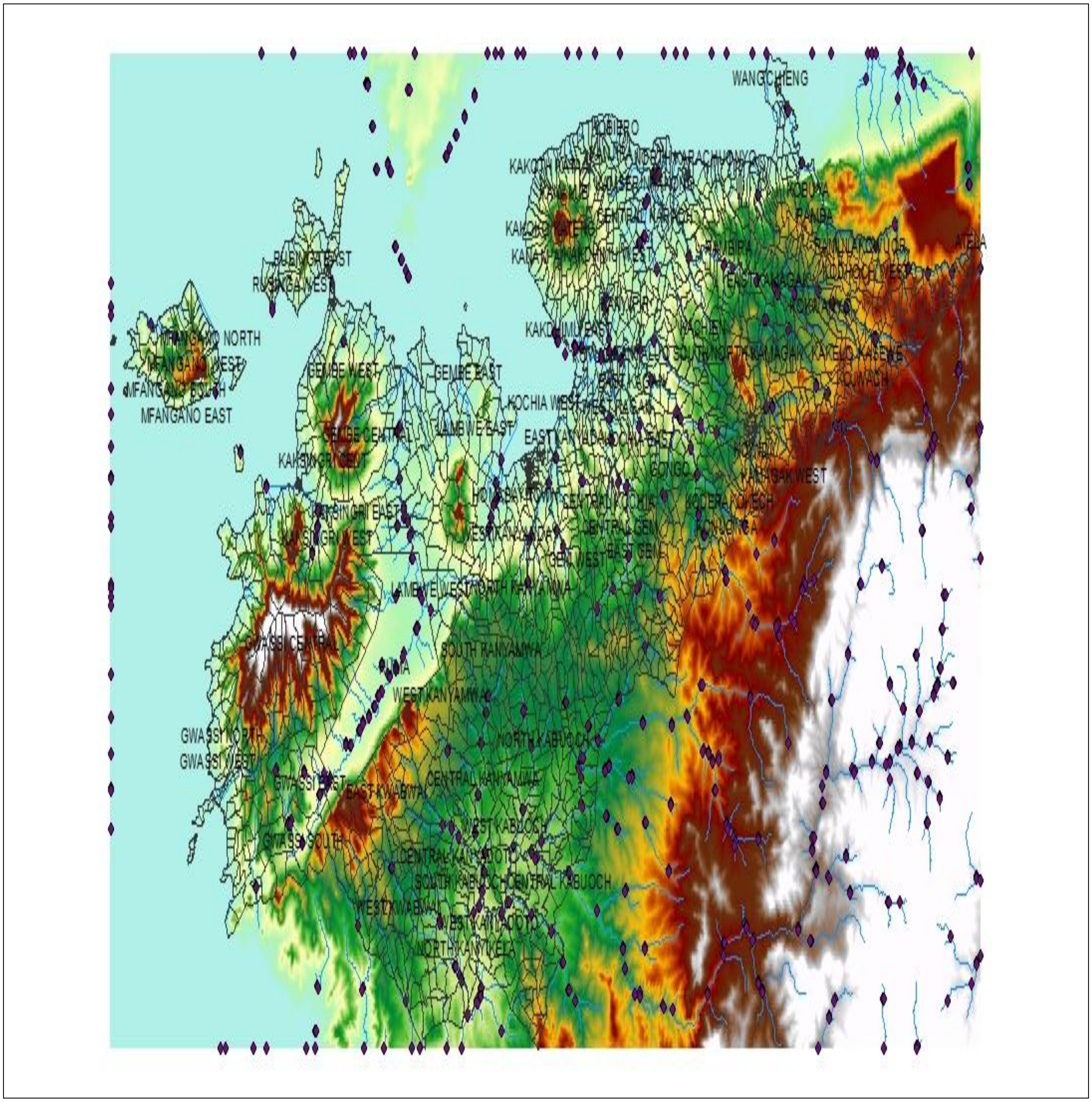

Figure 3.5: Rivers flowing through Homa Bay County

Source: Satellite image (2018)

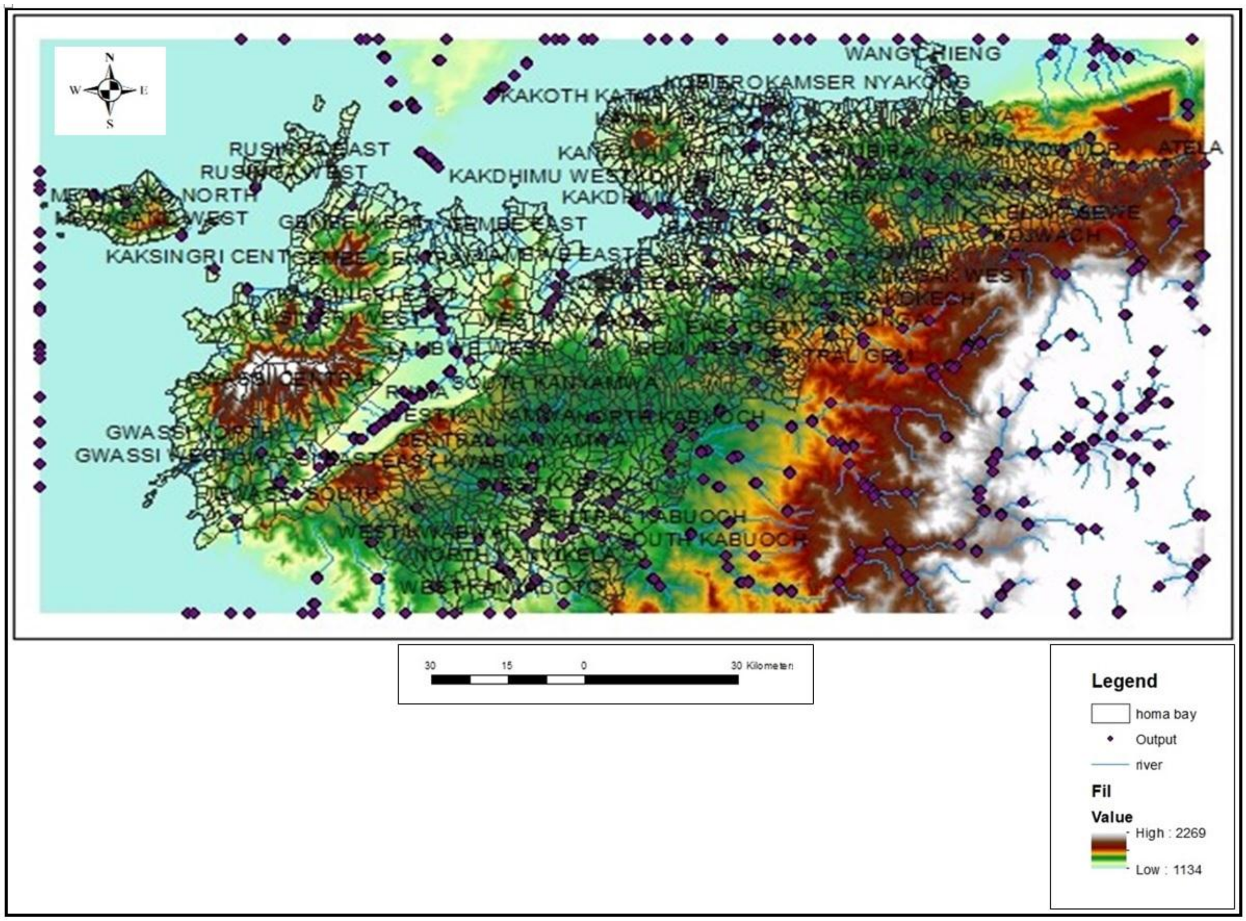

Figure 3.6: Rivers and streams in Homa Bay County

Source: Satellite Image (2018)

Lakes in the study area include Lake Victoria (plate 3.2) which is the largest surface water resource found in Homa Bay, the lake is a fishing ground and provides water for varied uses including domestic and industrial purposes. Waters found in Lake Simbi which is a volcanic crater lake in Kendu Bay is culturally believed to have medicinal value.

Plate 3.2: Lake Victoria at Mbita Point

Source: Field work (May 2018).

3.5.2 Underground Water

The hydrology of Homa Bay County also consists of underground aquifers, rivers, wells, springs and lakes. The region has a complex hydrological system originating from the Kisii highlands. The Major Rivers include; Awach Kibuon, Awach Tende and Riana which together with their tributaries drain into Lake Victoria. The area is Swampy in Lambwe valley and parts of kochia, Kabondo and Kabondo Kasipul. The only outflow from Lake Victoria is the River Nile.

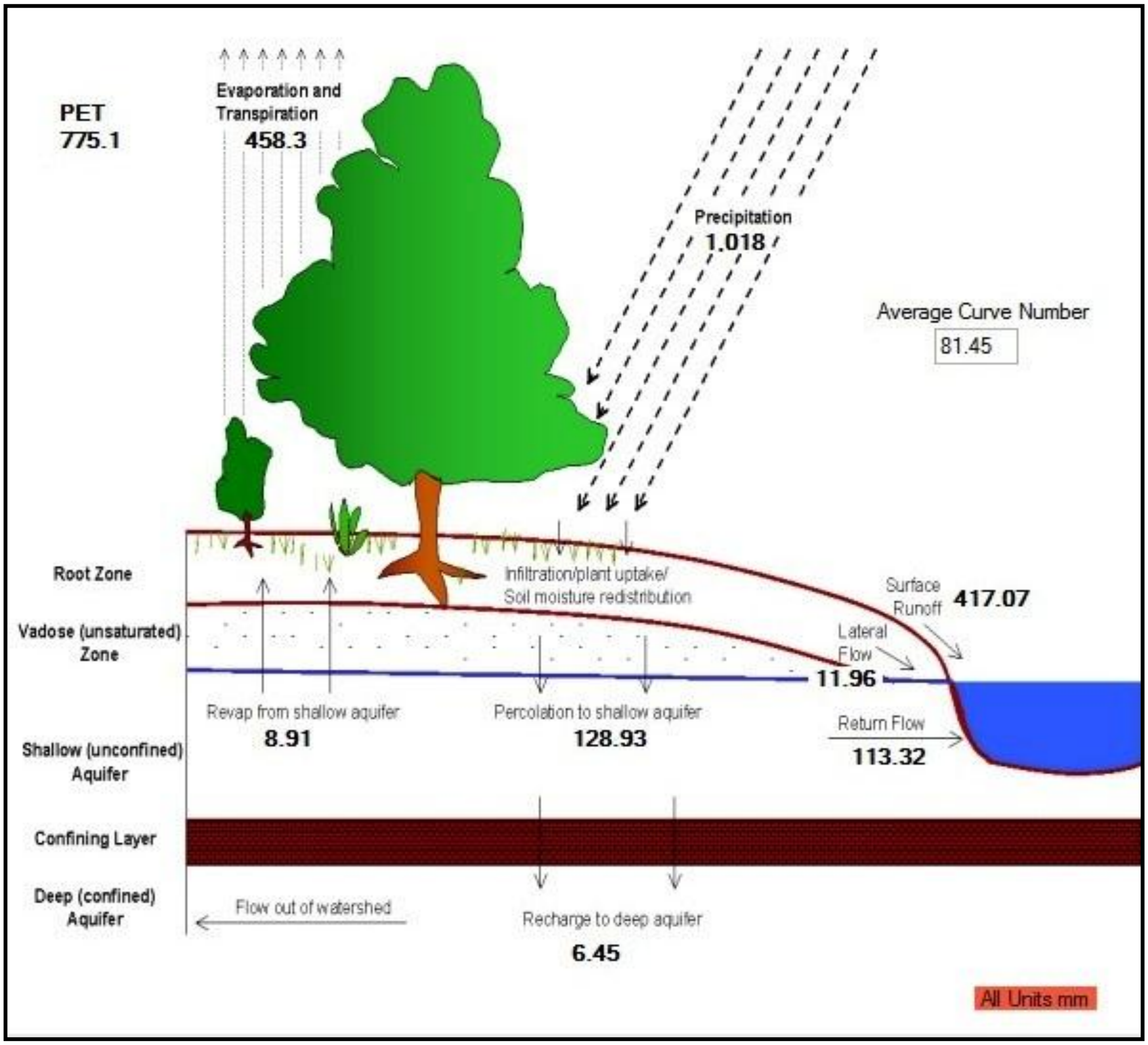

Figure 3.7: Hydrological Cycle
Source: SWAT output

3.6 Vegetation

Vegetation and land cover determines the hydrological abstraction, surface runoff volumes through different ways such as intercepting rainwater, evapotranspiration mechanisms and human activities including deforestation, ploughing along the contours. There are patches of Savanah and modified equatorial forest along Kodera, Wire, Homa, Lambwe, Gembe and Gwasi hills. Grassland cover is found in Ruma National park. Some of the Gazetted forests include Gwasi and Wire, Non Gazetted forests are found in Ruri hill, Gembe hill, Homa hill, Asego hill, Kodera and Mfangano Island. The lake shores consist of aquatic vegetation cover and play a vital role in the formation of rainfall and temperature modification; control surface runoff; and soil water infiltration which affect the water balance.

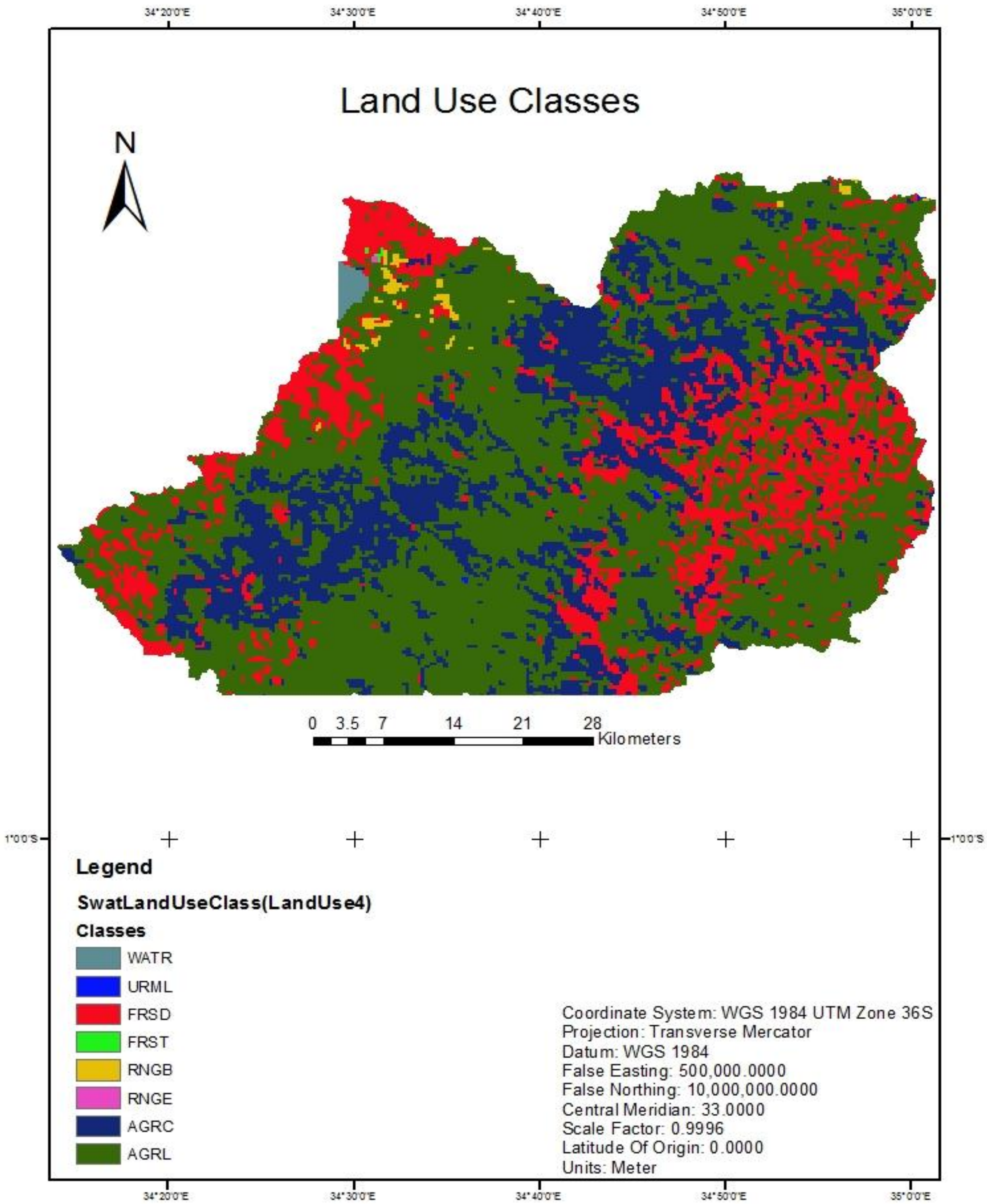

Figure 3.8: Land Use Classes
Source: SWAT output

Figure 3.8 shows the land use classes found in Homa Bay County matched with the Soil classes found in the Soil and Water Analysis Tool (SWAT) land use classes for homogeneity to avoid errors in SWAT Run (see appendix)

3.7 Socio-Economic Activities

3.7.1 Population

The population of the area based on the projection of (2009) Kenya Population and Housing Census is 1,177,181 persons of which 564,843 are males while 612,338 are females with an area of approximately 3154.7km with a population density of 373 persons per km^2. (Table 3.3) increasing population in the study area meant that there was more demand for different uses of water especially along the emerging urban centre in Homa Bay, Sindo, Mbita and Oyugis as a result of devolution.

Table 3.4: Population Density and Distribution by Sub-County projections of 2017

Constituency	**Population**	**population density (person per km^2)**
Kabondo Kasipul	77,062	441
Kasipul	192,460	430
Karachuonyo	197,922	449
Homa Bay Town	110,466	596
Ndhiwa	210,340	296
Rangwe	126,984	465
Suba North	136,075	323
Suba South	125,870	196
Total	1,177,181	387

Source: Kenya National Bureau of Statistics, Homa Bay (2013).

Rising number of days which are extremely hot and the heat index have been witnessed almost the half of the 20^{th} century (IPCC, 2001a). however, there exist a number of uncertain conditions, the IPCC (2007) findings suggests that the global warming experienced over past fifty years has been as a result of human practice.

The study region has warming accompanied with both increase and decreasing in rainfall various parts. Other studies on climate change in Africa shows a warming ranging from 0.2°C in the low scenario to over 0.5°C in high scenario per decade. These measurable outcomes and system responses to climate variability brought about an increase in rainfall and temperature totals and increasing river discharges and the associated influences on water resources. The classifications under the case studies in Homa Bay County included availability of water resources, distribution, water quantity and river discharges. The Fourth Assessment Report of the IPCC (2007) defines in detail the climate impacts and further distinguishes residual and potential impacts and variability.

This study has therefore adopted the most current definition of climate impacts in accordance with the forth assessment report by IPPC (2007), the accord of an expert panel of scientists that was backed by qualified peer review agreed that Variability is a function of the stimuli of both physical and social systems. According to IPCC (2007) climate of a region may be more variable compared to another as a consequence of ecological pressure, human activities, lack of management skills and poor regulation. The research applied Soil and Water Analysis Tool model to investigate the impact of Climate Variability on Surface water resources in Homa Bay County

3.7.2 Agriculture

Agriculture is the main economic activities in Homa Bay. Areas around Kasipul, Kabondo, Rangwe and Ndhiwa have favorable climate and fertile soils for production of maize, sugar cane (plate 3.3), Potatoes, Bananas and Pineapples. Due to variable rainfall and temperature conditions in the area that cannot support rain fed agriculture an improved household food security irrigation scheme has been established at Oluch kimira in Kochia. In Suba north and south ICIPE has also intensified programs supporting drought resistant varieties of Millet, Sorghum and Sunflower crops. This indicates the magnitude of water stress both for agricultural and household uses.

Plate 3.3: Sugarcane Plantation in Obera
Source: Field work (May 2018)

3.7.3 Fishing

Fishing is one of the main economic activities in Homa Bay County. This is carried out in the Lake Victoria. Modern fish cages have been installed across the lake to improve fish harvest. The fish caught include Nile perch, tilapia and Dagaa of which is consumed locally and exported to other countries. Fishing is also practiced by a majority of people living near and along the shores of Lake Victoria for subsistence and economic purposes.

3.7.4 Tourism

The Ruma National park, Lake Victoria, Lake Simbi, beaches in Rusinga and Mfangano Island provides good sites for tourist attraction. Other tourist attraction sites include; Archaeological sites at Rusinga, Tom Mboya Mausoleum, Homa Hills hot springs, Lake Simbi, Gwasi hills on the shores of Lake Victoria and Oyugis birds sanctuary. Tourism contributes immensely in the economic development of the study area and has also increased the demand for adequate availability of water resources.

CHAPTER FOUR

4.0 RESEARCH METHODOLOGY

4.1. Study Design

The study was based on a spatial survey design in a physically based distributed model with spatial representation of the basin hydro meteorological characteristics in the form of 45 sub basins of which the Kibuon River Basin covered five sub basins namely 2,3,5,8 and 15 .The Tende River basin consisted of 9 sub basins including 4,6,7,11,12,13,14,16, and 17 while Riana River basin was made up of sub basin 18 and 21, (Fig 5.1).

The study variables were rainfall, temperature and river discharges measured at different locations, (Appendix II). Existing daily observations of rainfall and temperature data were obtained from a list of stations provided by the Kenya Meteorological Department, spatially selected and mapped depending on the length of records for the period 1983 to 2013,(Tables 3.1; 3.2).

Data on river discharge were obtained from the records of WARMA and Ministry of water and Sanitation for the same duration of study. The spatial in situ rainfall and temperature data used in this study had challenges that arose from missing data sets and were interpolated using the inverse distance weighted method within the GIS/SWAT environment. SWAT analysis was then performed to simulate the rainfall runoff process in order to establish the spatial and temporal impacts of climate variability on water resources in the region.

4.2. Data Types and Sources

The study relied on different data types such as climate data that included Downloaded global weather data including; precipitation, temperature, wind speed, relative humidity and solar radiation for Homa Bay, observed long term daily rainfall and temperature for six (6) stations, namely Homa Bay DWO, ICIPE, Ober, Ringa, and Rusinga Island and daily river discharges at Kibuon, Tende and Riana rivers. Land controlling data were the Digital Elevation Model (Modis 80900114) from the USGS Earth explorer Shuttle Radar

Topographic Mission, Kenya FAO land use land cover data from FAO land use land cover soils website.

The above data sets were obtained from different sources including various geospatial portal websites .The terrain in the form of Digital Elevation Model was extracted from the geological Survey (USGS) site, clipped and projected to fit in Homa Bay using data transformation UTM zone 36 and WGS 84 and named and saved as Homa_Project file. LULC and soil data were retrieved from the FAO Kenya land use land cover and soils website. The Weather input data was obtained from the Global weather data and long term observed rainfall and temperature records were obtained from Kenya Meteorological department offices at Dagoreti and WRA data stores respectively. River discharge data was also obtained from WRA Headquarters at NHIF Nairobi and their regional and sub-regional offices at Kisumu and Kisii respectively.

4.3 Data Collection

4.3.1 Pilot Survey

A preliminary survey was conducted to familiarise with the study area, administrative offices in the study area, identify target population and sample size and check study instruments to fill any obstacles. This enabled identification of the location of relevant Meteorological weather stations, rain gauges both operational and non-operational and all river gauges in the study area. It was also necessary to understand and estimate the cost and challenges that would be expected during the actual study and how to overcome them including transport system, terrain and topography and the weather patterns. Pilot survey also helped in mapping of the study area.

Plate 4.1: Researcher at WRA Regional Office – Kisumu

Plate 4.2: Researcher at ICIPE Weather Station

4.3.2 Target Population and Sample Size

The target population for this study was Kenya and particularly Homa Bay County including DEM for terrain that was registered to earth explorer for Homa Bay, clipped and projected and saved in the file DEM fill. Kenya FAO land use land cover was retrieved and clipped from the FAO land cover land use geographical, projected and saved as homelandusep2.shp. Soils data was also downloaded from FAO soils clipped for Kenya and Homa Bay in particular and saved as homasoilp.shp. Global weather data section for Homa Bay was obtained from the Global Weather data base in both SWAT and CVS format which included precipitation, temperature, wind speed, relative humidity and solar radiation. Observe rainfall and temperature measurements were obtained from Water Resource Authority and Kenya Meteorogical Department, all the above dataset were spatially identified within the catchment in the study area for the period 1983-2013.

Stations with the longest period of measurements were selected for the study, this was mainly based on the daily rainfall data, temperature and river discharges from the months of January to December for the period 1983 - 2013.

The river discharge data were for many gauging stations (RGS) but stations with the longest and consistent records including Awach Kibuon, Awach Tende and Riana Rivers were selected for the study. Rainfall data were obtained from ICIPE Mbita, and other rainfall stations provided by WRA in the Ministry of Water and Sanitation including Homa Bay DWO, Awach, Riana, Ringa and Ober for the same period of study.

4.3.3 Data Collection Instruments

Data collection instruments included cameras for taking field photographs during preliminary study and actual field work, flash disks were used to retrieve and store rainfall and temperature in situ measurements from various computer data bases of WARA and Metrological department and different geospatial websites. Data sets were also accessed from different websites including Global weather database, FAO land use land cover and FAO soil databases through email and stored. Research note books, data sheets, pens and pencils were to record and other details during pilot survey and actual field work in the meteorological station.

4.3.4 Sampling Procedure

This study used purposeful sampling method, consideration was on spatial and temporal aspects. The in situ measurements for rainfall and temperature records were obtained from various relevant meteorological stations that had been mapped and marked from a list of stations obtained from the Kenya meteorological department. The reliability of a station depended on the availability of consistence records and information useful to the study which indicated altitude and their respective locations for the selected duration of study.

Due to the inhomogeneity of the study area with respect to topography, which was also considered as having influence on the amount and frequency of rainfall (Mungai 1984) a spatial sampling procedure with consideration on altitude was done in the selection of rainfall stations to account for continuity and consistency of records used in the study.

The altitude of different regions in Homa Bay had a marked relationship with rainfall distribution and patterns with level terrain in Kochia and parts of Lambwe depicting similar trends in rainfall characteristics as opposed to undulating terrain in Gwasi, Oyugis and parts of Karachuonyo that showed irregularities in trends within short distances.

The hydro meteorological data were categorised into different sets; Simulated Climate data, observed rainfall and temperature data and river discharge data. The Simulated climate data was downloaded from the Global weather geoportal and the in situ measurements obtained from lists provided by the Meteorological department and WARA respectively and recorded with respect to altitude and terrain. It was very necessary to account for the variation in altitude during the selection of rainfall station included in the study so that any inconsistencies and continuation of records was taken care of. Temporal considerations were made to account for non-functional rainfall stations for the entire period of study by listing all station and the respective years of records available.

Global weather data was downloaded from the Global weather website for Kenya and Homa Bay County in particular, this include; wind speed, ,solar radiation, relative humidity and precipitation for six different stations within the study area. Data on river discharge measurements were retrieved from the computer stores at WRA for Kibuon, Tende and

Riana rivers whose gauge stations had the longest and consistent records, these were then recorded on excel sheets for each month and corresponding years and then transferred to SPSS for analysis.

Land use land cover data was downloaded from the universal FAO land use data, land use data for Kenya was clipped and projected particularly for Homa Bay County. Land use data was then matched with FAO land use to avoid errors in SWAT RUN. The same procedure was followed for soil data and then cross matched with the SWAT soils for homogeneity.

All data used in this study were secondary and no attempt was made in collecting primary data in this study.

4.4. Data Processing and Analysis

4.4.1 Data Processing

The Hydro meteorological data for this study were form secondary sources and included long term daily rainfall and temperature and river discharge measurements, simulated precipitation, temperature, wind speed, relative humidity and solar radiation. All the observed measurement were in tab-delimited format which were transferred and recorded on excel spread sheets for each month and corresponding years from January to December of the year 1983 to 2013, all these were then customised to SWAT format and subjected to inconsistency checks and in case of missing records inbuilt interpolation procedures in SWAT were done and data calibrated where necessary. The data sets used in SWAT model were projected as different files including fill__homa_pr, Landuse_p$_{2.}$shp with lookup.dbf as its user table, Kenyap-Soil$_{2}$p.shp and faolookupnew.dbf as user table, and all the files were saved ready for analyses.

The GIS spatial overlay technique of SWAT project was set up including the major components such as automatic watershed delineation, HRU analysis and report writing, creation of various input tables, editing of input tables and saving SWAT simulation, SWAT run and finally SWAT calibration.

The model set up was a procedural process that started with the delineation of the watershed, this involved in cooperating a projected digital elevation model (DEM) that enabled complete terrain analysis, basin boundary delineation and definition of stream network .The specified DEM set up was to model water flows downstream by showing slope, aspect and altitude, this was indicated by the z direction and identification of streams starting with the flow direction, flow accumulation and final stream network definition.

Catchment boundaries, sub catchments and stream networks were clearly identified to quantify soil moisture and flow trends including the catchment responses. Streams and outlets were generated sub basin characteristics calculated. Land use, soils and slope shape files were then overlain to produce different sub basin files.

More spatial variable were added into the system including Soil types and their derived characteristic, land use land cover to help in determining the outputs in terms of stream discharge, water yield, evapotranspiration and groundwater recharge and transfer. Weather data generated from the global weather data base and observed rainfall and temperature data from six identified rainfall and meteorological stations were incorporated into SWAT to generate weather input files.

Different input tables were then successfully written including; configuration file ,Soil, weather generator, sub soil, HRU/drainage, main channel, ground water, water use, management, soil channel, pond, stream channel, septic, operations water shed and finally waste water shed file datum respectively. The SWAT input tables were edited and saved in the database ready for analysis.

4.4.1.1 Digital Elevation Model

Digital elevation model of (30m×30m) resolution was extracted from the Shuttle Radar Topographic Mission within the USGS site then projected to UTM, Spheroid WGS 84 in Zone 36 and saved as fill_homa_pr. This was necessary to account for water distribution and accumulation in the soil in relation to the topography. Slope was identified into five classes to help map depression, valley and lowlands and quantify the surface water storage, calculate the drainage network and density and their relationships to soil permeability and relief and including land use patterns. The relationship was thus compared to availability and distribution of water resources in the study area within and across the slope.

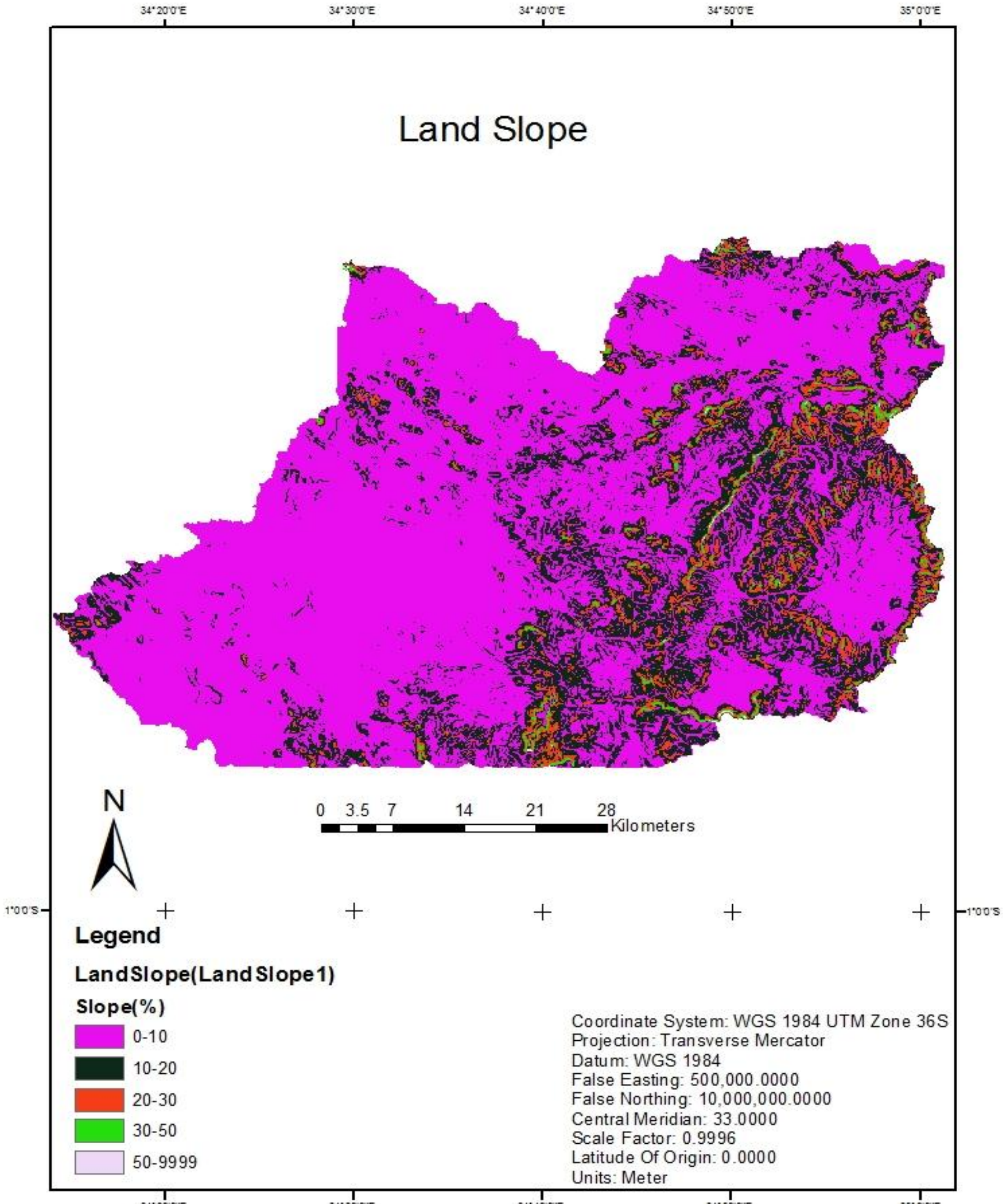

Figure 4.1: Land Slope
Source: SWAT Output

4.4.1.2 Land Use Data

Land use land cover was obtained from the universal FAO geoportal land cover database with a spatial resolution of 1km. Land use land cover was then projected and file saved as Landuse_p2shp file. The land use data was coded and a user table (lookupdbf) file created to match with the SWAT land uses and the land use patterns in Homa Bay County. The projected land use was saved as land use project file folder.

Table 4.1: Land Use Data

FAO Coding	SWAT Equivalent	Land Use Symbol	FAO Kenya Land Cover
210	11	WATR	Water Bodies
60	41	FRSD	Open Broad Leaved Decidious Forest
50	41	FRSD	Closed Broad Leaved Decidious Forest
100	43	FRST	Closed To Open Mixed Broad Leaved/Needle Leaved Forest
130	51	RNGB	Closed To Open Shrubland
14	83	AGRC	Rainfed Croplnd
30	85	AGRL	Mosaic Vegetation/Cropland
20	85	AGRL	Mosaic Cropland Vegetation
120	43	FRST	Mosaic Grassland/Forest-Shrubland/Grassland
190	21	URML	Artificial Areas
140	71	RNGE	Closed To Open Grassland
110	43	FRST	Mosaic Forest-Shrubland/Grassland
143	71	RNGE	Open Grassland
15	71	RNGE	Rainfed Herbaceous Crops
90	41	FRSD	Open Needle Leaved Decidious Forest
40	42	FRSE	Closed To Open Broadleaved Evergreen/Semi Decidious
200	31	SWRN	Open Areas

Source: Researcher (2018)

4.4.1.3 Soil Data

The land use land cover of Kenya 2015 was sourced from the universal FAO soil data and clipped to Kenya and Homa Bay in particular then projected and saved as $soil_2pshp$ file. Since the model required soil properties for the basins, a user table for soil was generated and saved as faolookupnew dbf so that the universal FAO soil types were altered to be matched with the soils in the SWAT database and the FAO Kenya soil types to avoid errors during delineation and creation of HRU in the process of modelling the watershed. Different soil classes that existed in FAO were matched with SWAT and FAO Kenya soil types (Table 4.2).

Table 4.2: FAO Soil Classification

VALUE	SNUM/FAO SOIL
1972	WATER
582	Fr9-2a
960	VP45-2/3a
960	VP45-2/3a
960	VP45-2/3a
960	VP45-2/3a
466	Bh14-3c
42	FO48-2ab

Source: Researcher (2018)

4.4.2 Data Analysis Techniques

For a successful study, variety of data sets identified and collected were subjected to spatial analysis and interpretation and included daily rainfall and temperature totals (minimum and maximum), daily river volume flows. SWAT model was used to determine river volume flows in all channels and in estimating floods and low flows from simulated and in-situ measurements.In preparation for the actual SWAT data analysis, various soft wares which were compatible with my Arc GIS 10.2.2 package were downloaded from the SWAT web portal and installed in readiness for the data analysis. Other Statistical analyses in SPSS including the Correlation and regression analysis for rainfall temperature and Water yield was also carried out.

4.4.2.1 Soil and Water Analysis Tool Procedure in Water Resource Analyses

SWAT is a hydrological model that is used to model the physical processes within a watershed to be simulated, these include precipitation, evapotranspiration surface and ground water flow to determine different scenerios affecting hydrological responses. The data sets used in SWAT then outlines different characteristics of the basin such as land use land cover, soils, topography, climate and the general hydrological scenerios within the study area.

Data used in the model are integrated within the GIS interface (Arc View \/Map Window) and are presented in tabular format map information series. The main concepts in the model processes includes simulation of the hydrological cycle and the water balance leading to the water yield.

Water balance equation

$$SW_t = SW_0 + \sum_{j=1}^{t}(R_{day} - Q_{surf} - E_a - W_{deep} - Q_{day})$$

Where:

SW_t = Final soil water content (mmH_20)

SW_0 = Initial water content on day i (mmH_20)

t = time in days

R_{day} = Amount of rainfall on day i (mmH_20)

E_a = evaporation on day i

W_{deep} = amount of water in deep aquifer on day i

Q_{day} = return flow

Calculation of precipitation based on watershed characteristics

$$W_{eff} = \frac{(W - V_i)^2}{W - V_i - V_{max}}$$

Where:-

V_i = initial abstraction

W_{eff} = event flow

The Soil and Water Assesment Tool model set up was a procedural process, the set up (Plate 4.3) begun with opening of a new Project in ArcGIS interface. After opening new project, the Digital elevation model (DEM), land use and Soils were incooperated to map the document, the specified DEM was to model water flows downstream by showing slope, aspect and altitude, this was indicated by the z direction and identification of streams starting with the flow direction, flow accumulation and final stream network definition.

This was followed by an Automatic watershed delineation to specify the DEM projection set up in order to indicate the z direction (Height). Steams were then defined beginning with the flow direction followed with flow accumulation that started with the delineation of the watershed, this involved in cooperating a projected digital elevation model (DEM) that enabled a complete terrain analysis, basin boundary delineation and a definition of stream network . More importantly, the specified DEM was to model water flows downstream by showing slope, aspect and altitude that was indicated by the z direction and identification of streams starting with the flow direction, flow accumulation and final stream network definition.

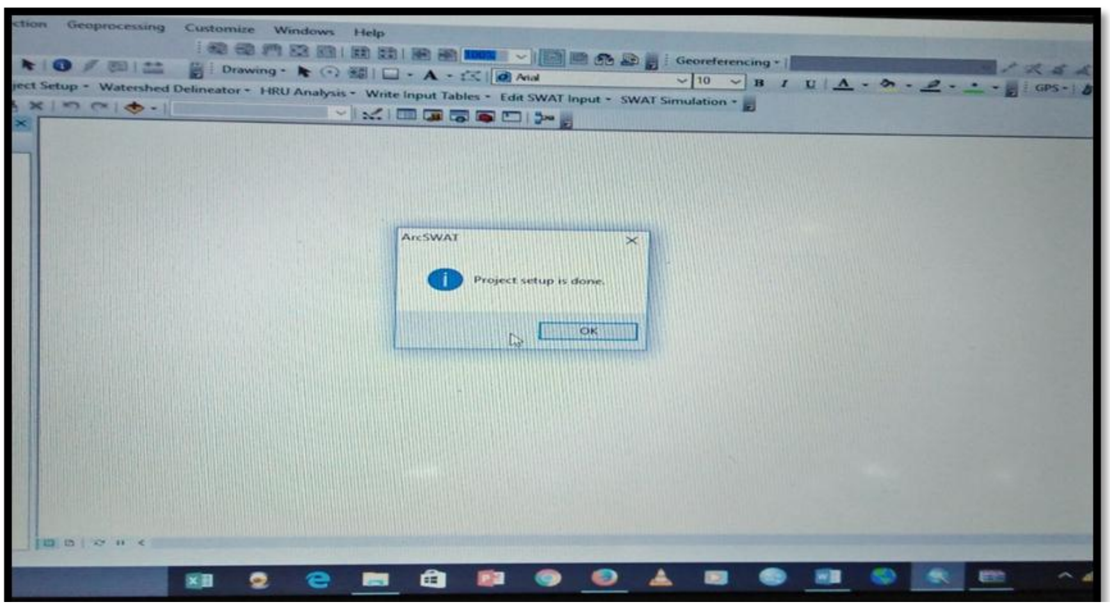

Plate 4.3: SWAT project set up.
Source: GISLab photo

This was followed by an Automatic watershed delineation (Plate 4.4) to specify the DEM projection set up in order to indicate the z direction (Height). Steams were then defined beginning with the flow direction followed with flow accumulation that started with the delineation of the watershed, this involved in cooperating a projected digital elevation model (DEM) that enabled a complete terrain analysis, basin boundary delineation and a definition of stream network . More importantly, the specified DEM was to model water flows downstream by showing slope, aspect and altitude that was indicated by the z direction and identification of streams starting with the flow direction, flow accumulation and final stream network definition.

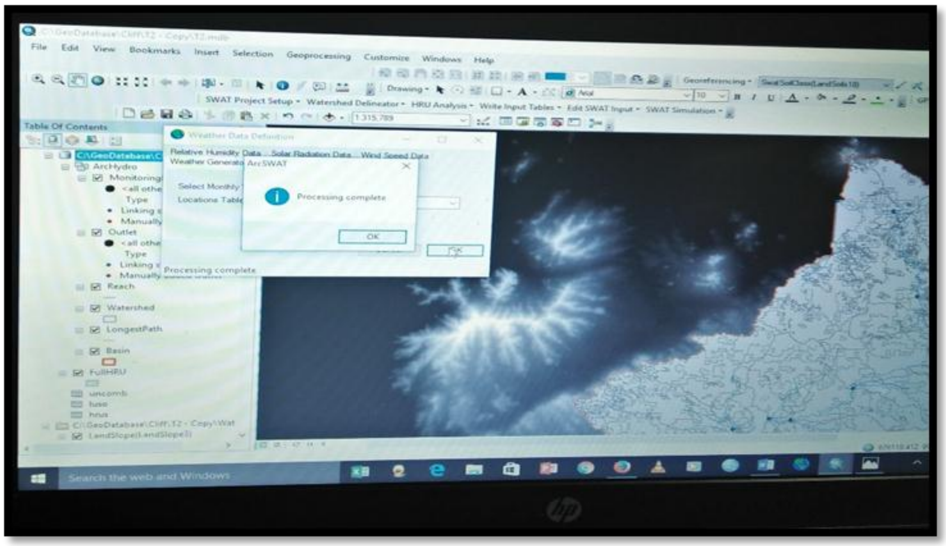

Plate 4.4: Automatic Watershed delineation
Source: GISLab photo

The stream networks helped in marking the flow points in order to effectively create streams and outlets. All the sub basins and their outlets were marked by specifying each outlet, finally the sub basin parameters were calculated and an output report generated to complete the watershed delineation.

Hydrologic Response Unit (HRU).

The Water shed was sub divided into Hydrological Response Units (Plate 4.5), the HRUs units exhibits the same land use types, management and soil characteristics and these were in cooperated into SWAT to be part of the Hydrological unit model of Homa_project. HRUs simplified the SWAT run by bringing all homogenous land uses and Soils into a single response unit since it was not practical to simulate individual sub basins. The HRU also increased the model accuracy and prediction of loadings from all the sub basins. As a rule a given sub basin should have 1-10 sub basins. (Appendix II) Catchment boundaries, sub catchments and stream networks were clearly identified to quantify soil moisture and flow trends including the catchment responses. Streams and outlets were generated and sub basin characteristics calculated. Land use, soils and slope shape files were then overlain to produce different sub basin files, finally HRU output report for land, soils and slope was generated and saved as ouputstd file.

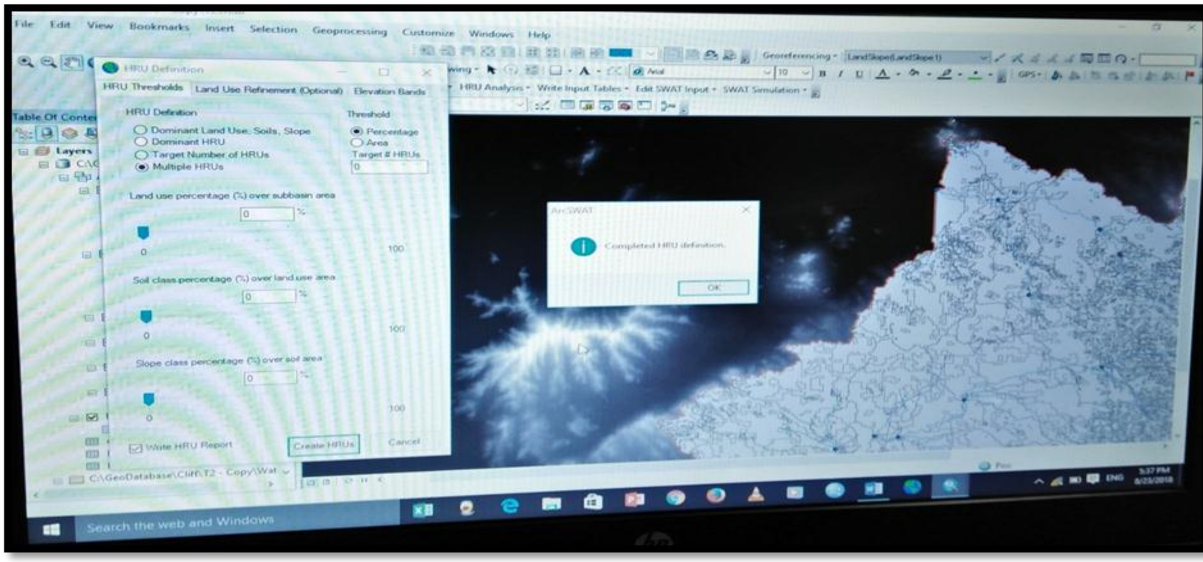

Plate 4.5: Complete HRU definition
Source: GISLab photo

Land use land cover data (land use dbf file) that had been projected was added into the model so that land use in the study area could be reclassified using a lookup user table (lookupdbf) was made to match with the SWAT land use reclassification (Plate 4.6). Land use was successfully loaded and clipped to the watershed boundary.

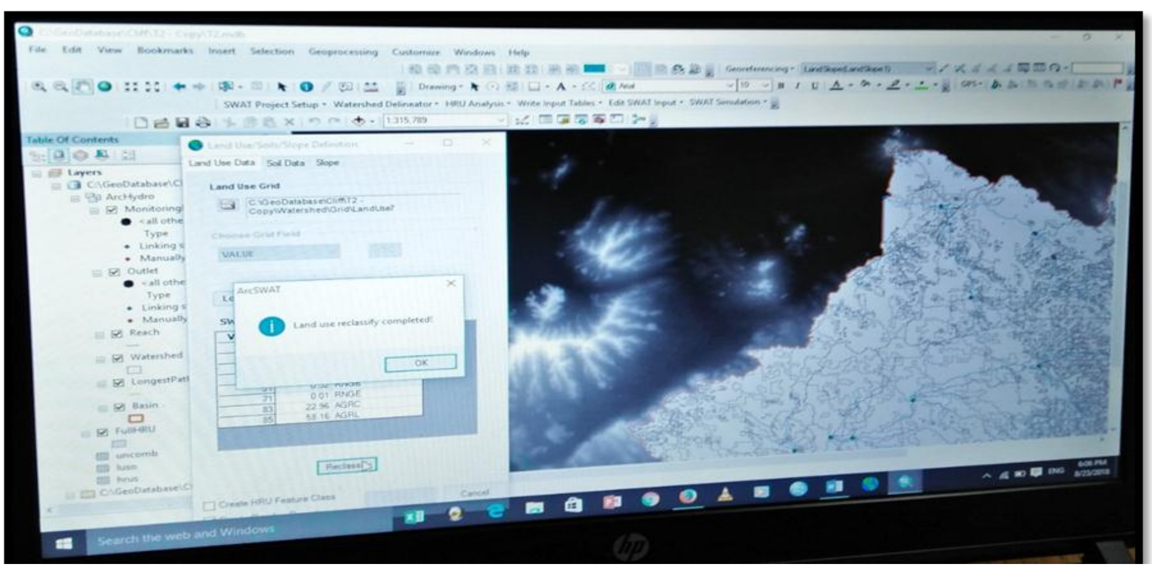

Plate 4.6: Land reclassification
Source: GISLab photo

Kenya FAO soil data was downloaded particularly for Homa Bay County and projected, it was also prudent to match the data set with SWAT classification so that errors were not encountered during modelling. A user table for the projected soil$_2$psh called faolookupnew was developed to match the soil types for successful loading and clipping with the watershed boundary (Plate 4.7).

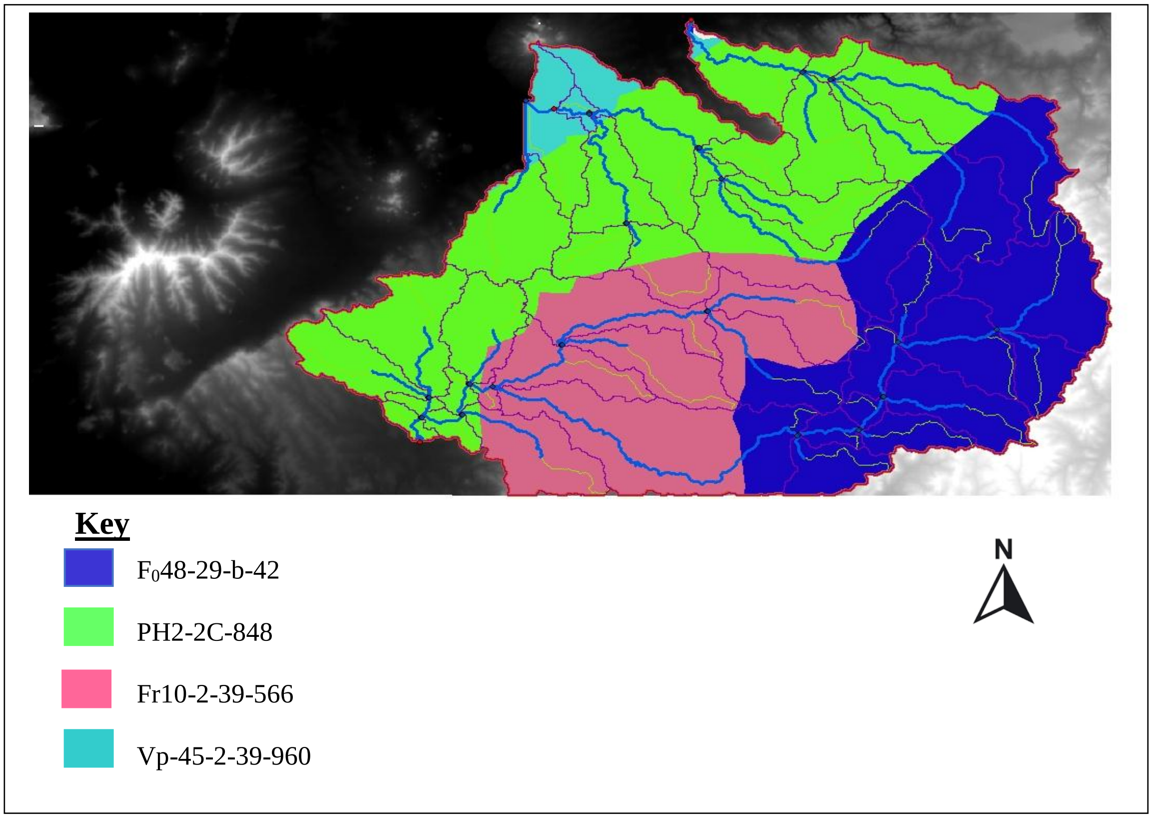

Plate 4.7: SWAT Soil layers in the study area
Source: GISLab photo

The study area was also divided into different percentage slope classes ranging from 1-10%.10-20%, 20-30%, 30-50 % and over 50%, their total areas in hectares and acres and percentage water yields per area. (See appendix II).It was established that the higher percentage of slope led to lower water yield, this was attributed to high degree of surface flows, Lateral flow, low ground water recharge and total water loss.

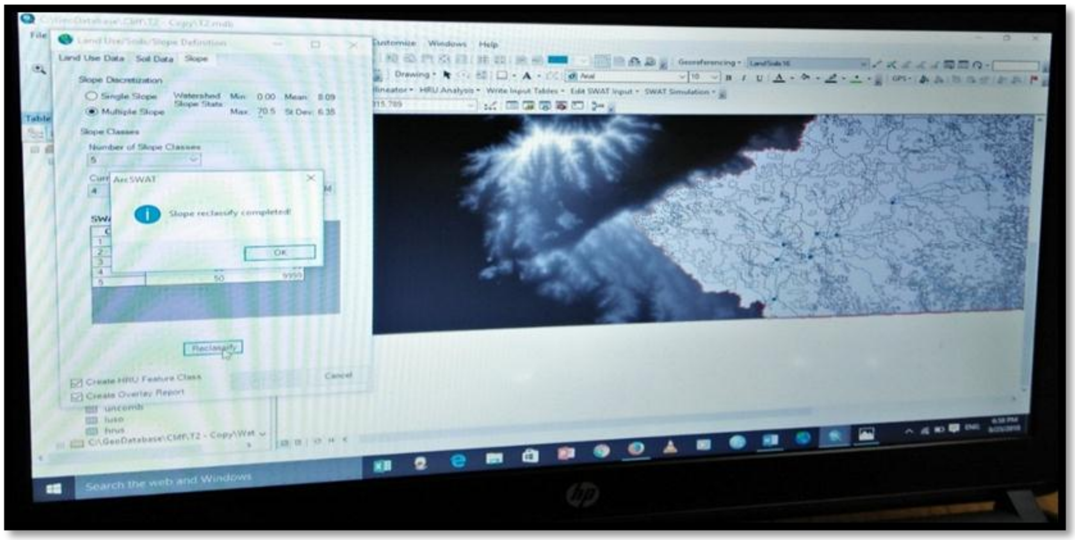

Plate 4.8: Complete slope reclassification
Source: GISLab photo

The distinctive classes of slope 1-10%, 10-20%, 20-30%, 30-50% and over 50% were necessary in creating HRU feature classes. After successful loading and clipping of the slope, an overlay of land uses, soils and the slope was successfully done.

Creation of Input Tables

More spatial variables were added into the system including Soil types and their derived characteristic, land use land cover in determining the outputs including stream discharge, water yield, evapotranspiration and groundwater recharge and transfer. Weather data generated from the global weather data base and observed rainfall and temperature data from six identified rainfall and meteorological stations were incorporated into SWAT to generate weather input files.

Different input tables (Table 4.9) were then successfully written including; configuration file ,Soil, weather generator, sub soil, HRU/drainage, main channel, ground water, water use, management, soil channel, pond, stream channel, septic, operations water shed and finally waste water shed file datum respectively. The SWAT input tables were edited and saved in the database ready for analysis.

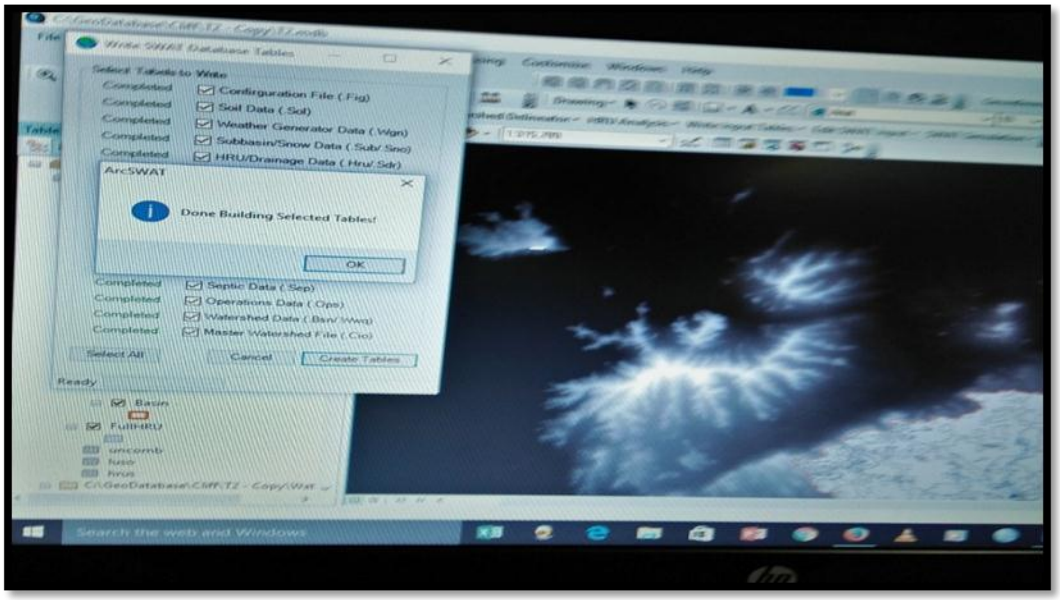

Plate 4.9: Successful building of Tables
Source: GISLab photo

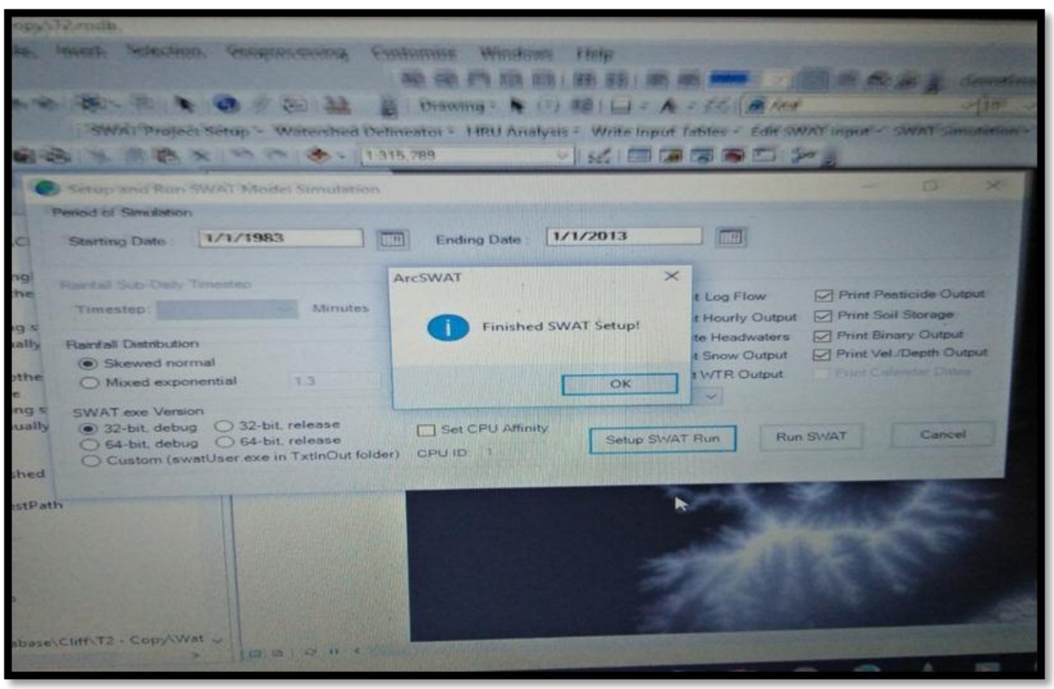

Plate 4.10: SWAT Run Setup
Source: GISLab photo

SWAT Simulation

After a successful model preparation, starting and end period (Plate 4.10) was set in the range with the Hydro meteorological data that had been in cooperated into the SWAT system in the MM/DD/YYYY format with an NYSKIP period of three (3) years to give room for model initial condition effect to check for good performance, the model was then run (Plate 4.11) on a daily, Monthly and Yearly time step for a period of thirty years (1983 - 2013).

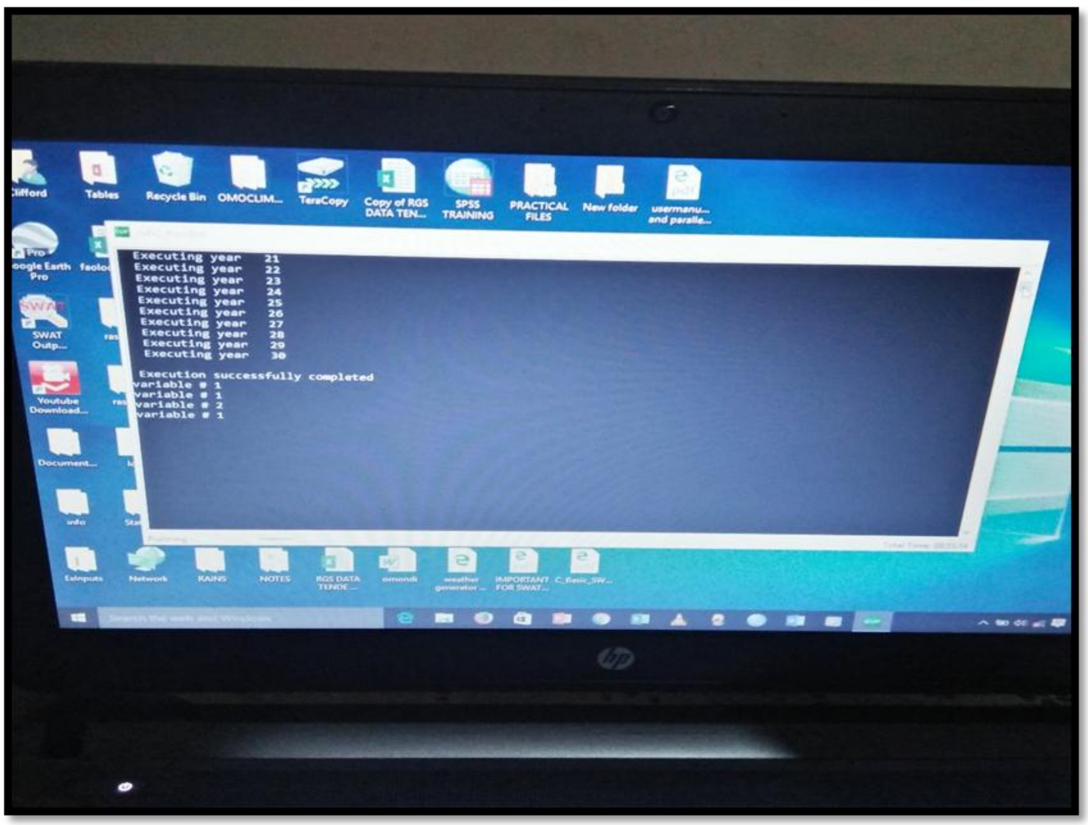

Plate 4.11: SWAT Simulation Successful
Source: GISLab photo

SWAT Calibration

The process involved the application of water balance and the modelling of river discharge and rainfall. The model parameters were adjusted to conform to the observed data within the study area basin for a period of study between the year 1983 t0 2013.

The SUFI-12 (Abbaspour, 2012) SWAT –Cup programme was applied for parameter optimization. All the uncertainties that were included and mapped into the parameter ranges were integrated with the observed data within a high prediction uncertainty range to optimise calibration. Calibration involved the observed rainfall and river discharge data for Kibuon, Tende and Riana rivers for the period (1983 t0 2013) with an NYSKP of three years (warm up).

The process of calibration for water balance and stream flow was done for average annual conditions, then monthly and finally on daily time step. This began with the Pre batch, post batch and finally SUFI2_Run batch to successful conclusion. The calibration statistics involved objective functions for simulated and observed data, slope intercept and the regression coefficient of determination and the Nash-Sutcliffe Efficiency During SWAT Run, the Watershed, HRU and Sub basin scenarios remained constant during the entire period of simulation and in the process of Calibration to estimate the coefficient of determination R^2 for discharge and simulated data in addition to the Nash-Shcliffe simulation efficiency (E) were applied to gauge the model prediction for the entire Period as illustrated herein;

Multiplicative functions:

$$R = \sum_i (Q_{.m} - Q_s)_i^2 \times \sum_1 (S_m - S_s) \times \sum_1 (N_m - N_s)_1^2 \text{ ....(4.1)}$$

Where:

Q =discharge

S=Sediment

N=Nitrate

N=Number of Observation

M=Measured Data

S=Simulated Data

For average values;

$$R^2 = \frac{\left[\sum_1 (Q_{m1} - Q_m)(q_{si} - Q_s)\right]^2}{\sum_1 \left[(M_1 - Q)^2 \sum_1 (Q_{si} - Q_s\right]^2}$$

In the coefficient of determination for R^2 for the measured and simulated discharged values, I is the i^{th} measured or simulated data.

The (R^2) - is a value that shows the magnitude of relationship existing in observed and simulated data and when R^2 estimates is near to Zero and (E) estimates are less than Zero, then the prediction is not accurate. When the value is the same as 1 the model prediction is accurate. In this study the R^2 estimate was found to be accurate.

Swat outputs were recorded in excel to show the correlations in the in situ and simulated rainfall and river discharges and their relationship to water resource availability. Calibration then compensated for error and bias in the data sets. The results of all data analysis were interpreted to show the extent of climate variability both spatially and in time and also in terms of the relationship between climate variability and quantity of water resources

The techniques used in the analysis of data included quantitative statistical analysis techniques, Measures of central tendencies, regression and correlation analysis and the Nash Sutcliffe Efficiency (NSE) descriptive analysis which provided the rate of variance of the data explained by the model (Nash and Sutcliffe, 1970), estimation of long- term means, variances and trend analysis of time series in the observed rainfall, temperature and river discharge data for the period of study. The Nash-Sutcliffe Efficiency was used to evaluate the model fit since it is the commonly recommended for hydrologic studies.

Data for this study was also converted to tab-delimited format and then transferred to excel spreadsheet. This was useful for data that were time bound such as the sequential recordings of daily rainfall, temperature and river discharges. The spread sheet made it easier to search for missing records and the determination of wrong entries. Time series analysis was done to identify trends in rainfall and stream flows and for the analysis of long term variability as a measure of trend in rainfall, temperature and river discharges.

The results of calibrating the SWAT model using river discharge indicated that there was a correlation between observed and simulated series. The difference in river discharge was very small in all time steps including annually, monthly and daily. The results also indicated that river discharge and rainfall were adequately simulated. It is important to note that the calibration process had challenges including data that were too short and small ranges for monitoring and the 30 year climatological period was essential for the procedure in calibrating overall water balance and distribution among hydrologic components (Appendix II).

Time Series Analysis of Rainfall and River Discharges

The technique was applied to analyse rainfall and river flows to show variability and distribution of rainfall and river flows for the period 1983 t0 2013.In the opinion of (Nyandega 1990), rainfall data generated depicted the annual rainfall characteristics for a Climatological period. Smoothening was undertaken to address irregular distribution of missing data. It is important to note that time series is either additive or even multiplicative and is normally divided into components such as trends, cycles, seasonality and or irregular distribution.

Time series equation

Yi=T+C+S+I or Yi=TCSI…………………… (4.2)

Where;

T….Trend

C……Cycle

S…….Seasonality

I……..Irregularity

Pearson Correlation to determine strength of relationship between Variables

This is a statistical analysis that measures the strength between variables and relationships to determine how strong the relationship is between the variables. The Pearson's correlation coefficient (r) was performed to measure the strength throughout the linear association between Rainfall and water Yield and also between temperature and Water Yield. The range of correlation coefficient is +1 to -1. The complete dependency between two variables is expressed by either +1 or -1 and 0 represents the complete independency of the variables. The calculation of the correlation coefficient was performed using Equation 4 in which x represents the independent variable and y represents the dependent variable. (4.3)

$$r = \frac{\sum_{i=1}^{n}(xj - \bar{x})(yj - \bar{y})}{\sqrt{\sum_{i=1}^{n}(xj - \bar{x})^2 (yj - \bar{y})^2}}$$

Where r is the correlation coefficient xj and yj are the jth observations for the two variables, $\bar{x}$ and $\bar{y}$ are arithmetic means of the observations of the two variables and N is the number of observations.

Regression Analysis

This is a method used to estimate the relationship between two variables and in this case a) rainfall and water yield (b) evapotranspiration and water yield

Simple linear regression was used to determine how the variables affected each other, The assumption is that a relationship exist between rainfall and water Yield and evapotranspiration and Water Yield and that this relationship is linear in a straight .The available data assist in estimating the unknown parameters and the equation obtained is fitted in straight line (linear regression).The simple linear regression applied in this study was;

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 \ldots\ldots + b_nX_n + e$$

Where;

Y is the value of the dependent variable (Water Yield);

a= Y intercept; b_1, b_2,b_3, b_4, ⋯ b_n= regression coefficients and each b represents the amount of change in Y(Water Yield) for one unit of change in the corresponding x value when the other x values are held constant; X1, X_2, X_3, X_4, ⋯ X_n= the independent variables (rainfall) and e = estimate error or residuals of the regression.

The obtained linear regression is then validated by carrying out correlation analysis in testing the goodness –of- fit of the regression equation used. This measure of association is best tested using Pearson correlation thus explaining the strength and relationships (Pearson equation above)

CHAPTER FIVE

5.0 RESULTS AND DISCUSSIONS

5.1 Introduction

This chapter is organized in four sections 5.1, 5.2.1, 5.2.2, and 5.2.3. The section 5.1 discusses the general introduction to the study in relation to sub basin, rainfall and water yield. The variability in rainfall trends is discussed briefly. Part 5.2.1 discussed the results on rainfall and river discharge, the results of the average monthly basin values is covered in 5.2.2 and the relationship between rainfall temperature and water Yield is discussed in section 5.2.3.

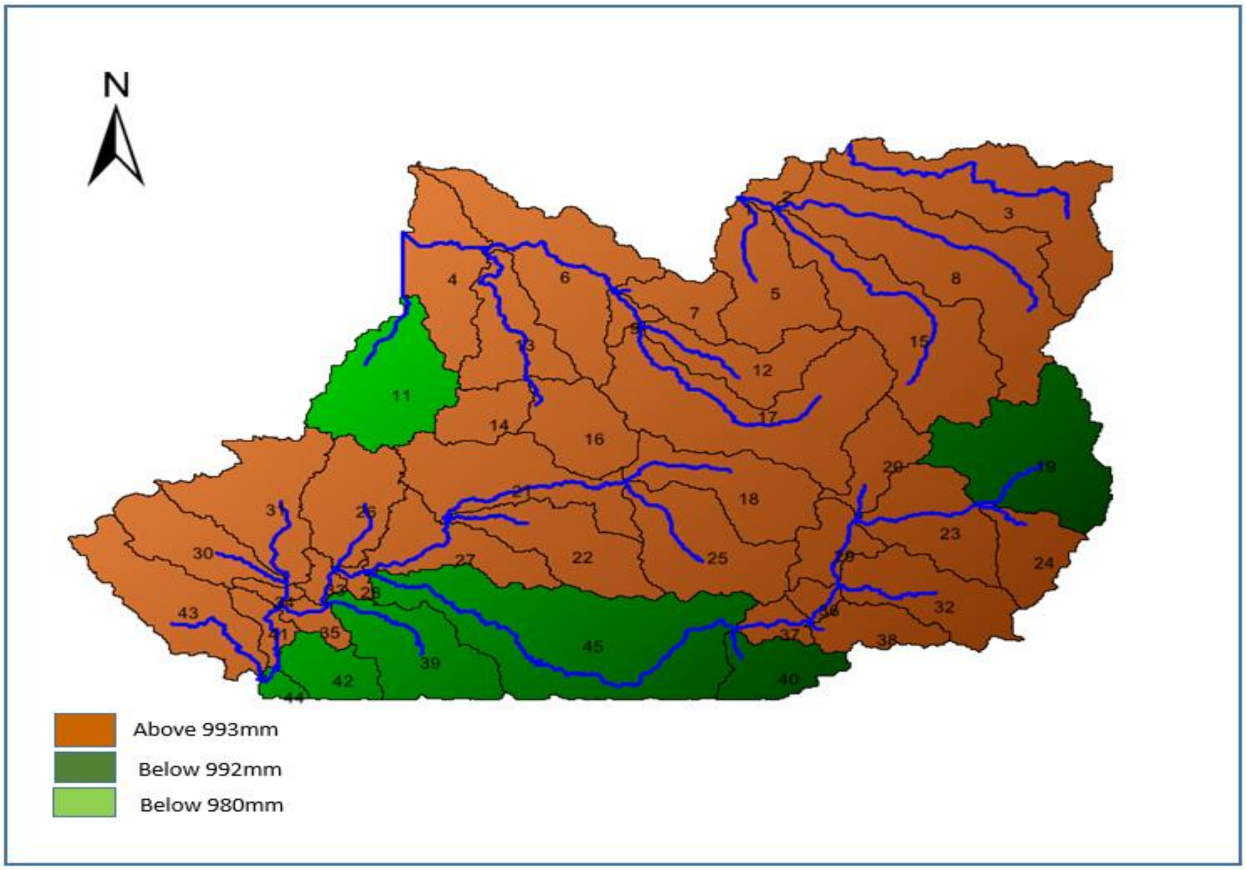

Figure 5.1: Sub-basins and annual Average rainfall
Source: SWAT Output

Figure 5.1 shows all the sub basins covered in the study area all of which are found within the same geographic environment and faces effects of climate variability in terms of rainfall and temperature trend in space and time therefore with variability trends in rainfall and river discharges.

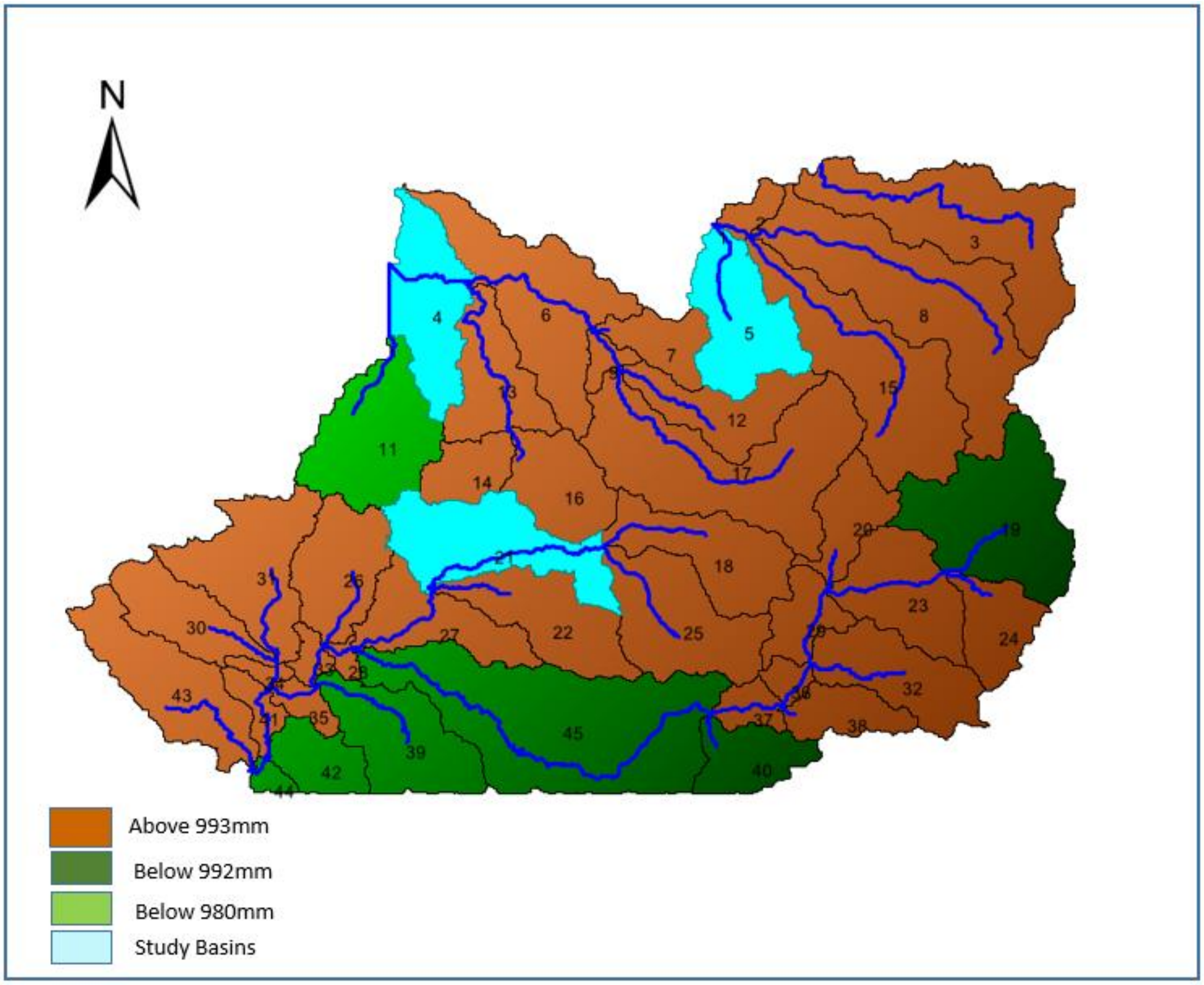

Figure 5.2: Annual average rainfall (Sub-basins 4, 5, and 21)
Source: SWAT Output

A total of 45 sub basins were considered which had an annual precipitation value of 1018.0 mm, annual total PET of 775.1mm and total annual water yield of 546mm. Approximately 82% of the basin received an annual average rainfall of above 993 mm, 13.3% below 992mm and below 980 was found to be 2.22%, Appendix II.

The **figure 5.2** shows the distribution of rainfall in terms of variability in the 45 sub basins. Rainfall was variable from below 980mm to 993mm annually, Appendix I. The varied topography generally sloping towards Lake Victoria, uplands of various levels to valleys existed in the central and western parts. The upper zone of the area had an altitude of over 1200 m above sea level, the middle zone about an altitude of less than 1000m and the lower zone exhibit about 950 m above sea-level. The gradient increased river discharge from upstream which reflected uniform aquifer drainages systems in Awach, Kibuon and Riana systems.

The area consisted of gentle undulating landscapes broken by hills ridges and even plateaus including Gwasi hills, Gembe hills, Homa hills, Wire and Ruri hills and parts of Nyabondo plateau. Steep slopes in the area enabled surface water to run downslope before infiltrating as compared to gentle slopes of kochia that would encourage more infiltration thus affecting surface water resources and river discharges.

The valley drop in Lambwe region was found to control the interaction of ground water and river systems in the area. A table like environment around Kochia affected the flow from upstream Oyugis and karachuonyo, this was expected to increase flooding and good yield of water yield in the region. The lakeshore lowland and the upland plateau witnessed numerous small medium sized rivers.

Rainfall received in Homa Bay County varied between 250mm and 1400mm of rainfall annually, with the average annual rainfall estimated at about1, 100mm. It depicted two rainy seasons; March-April-May (long rains) and September to November (short rains).Between 1986 -1988, rainfall variability showed an increase in the annual average of 1000 -900mm , a rise in rainfall between the years 1989-1990 with a sharp fall in 1991 which almost levelled through 1993(roughly 800mm).

Rainfall pattern indicated a slight rise from 1993 -1994 from 8000mm to 1000mm followed by an irregular rise and fall in rainfall up to the year 2000 (1200mm). From 2000 to 2002 there was drop in rainfall to about 1100mm,then an increase to 1200mm. Rainfall pattern indicated an increase from 2002 to 2003 then a steady fall to about 850 in 2004.The rainfall variability manifested an increase and fall through 2006, 2007 then a rise 2009 and a continuous fall in 2010 through 2012

Figure 5.3 shows rainfall variability in Homa Bay County for the period 1983 to 2013 as analyzed in the Soil and Water Assessment Tool. In the Years 1984, 1988, 1990-1993, 1996, 1998-2000, 2011-2012 Homa Bay experienced low annual average rainfall slightly below 600mm, however, there was a steady rise in the years 1985, 1989, 1990,1994,1997,2001 and 2009-2011.The lowest rainfall was recorded in the year 1992 while the year 2010 experienced the highest record of rainfall in the area, Appendix II.

Figure 5.3: Rainfall variability Trends in Homa Bay County
Source: Researcher (2018).

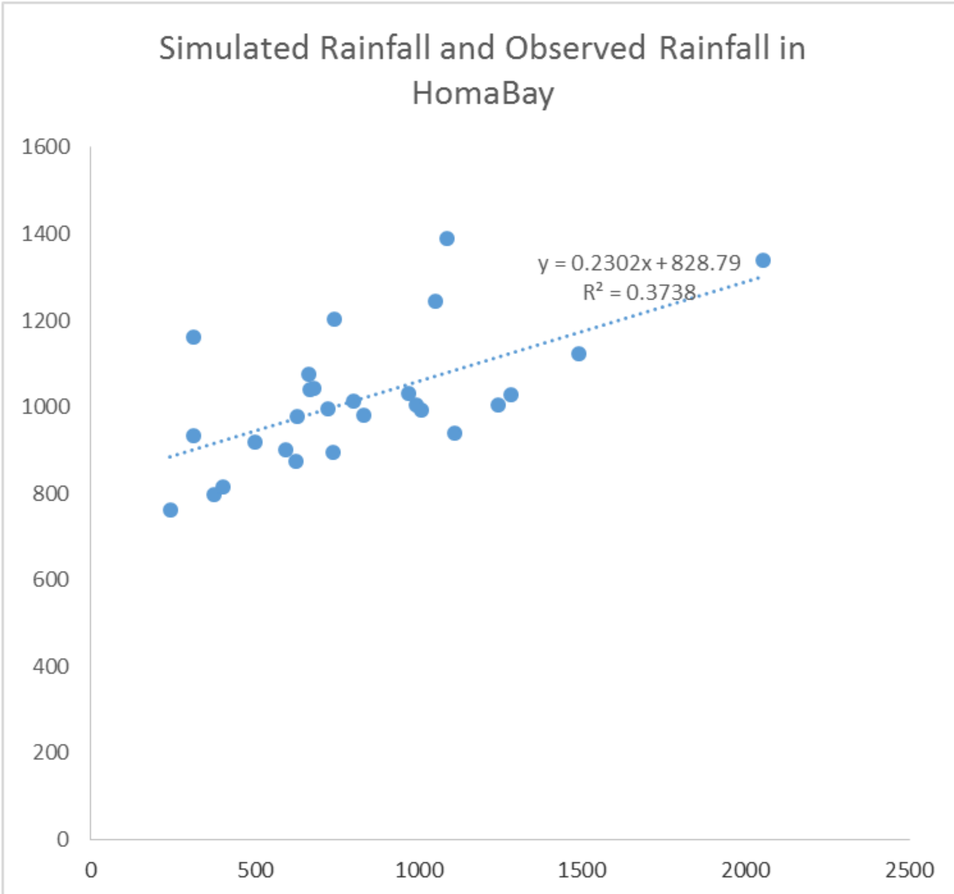

Figure 5.4: Simulated and Observed Rainfall Trends in Homa Bay County
Source: Researcher (2018)

Table 5.1: Regression Statistic of Simulated and Observed Rainfall

Multiple R	R Square	Adjusted R Square
0.611391495	0.373799561	0.348751543
	Coefficients	P-value
Intercept	828.7924143	3.4731E-14
Observed Rainfall	0.230245279	0.0007**

** Significance at 0.05 level (2 tailed)

The simulated data from the global weather data statistically explains that Observed data on annual rainfall had a strong and positive correlation coefficient 0.61. Therefore both the simulated data and observed data were found reliable in assessing the impact of climate variability on surface water in Homa-Bay County.

The variability in rainfall pattern across the entire basin and this could be attributed to relief, presence of Lake Victoria and the prevailing winds that influenced the seasonal climatic pattern. It was also established that all the sub basins had a spatial and temporal relationship in terms of rainfall and river discharge which impacted on availability and distribution of water resources in Homa Bay.

Homa Bay County exhibit quite high variability in monthly and annual rainfall especially in Kibuon, Tende and Riana basins. Rainfall amount varies from a low of 800 mm to 1400mm per annum (pa) in most stations. (5.1). Even though the rainfall patterns were very irregular, the amount varied from station to station (Table 3.2 for the stations used). The fluctuating amounts of rainfall indicated significant influence on the availability and distribution of surface water resources in terms of river flows within the county in space and time between 1990 t0 1993.

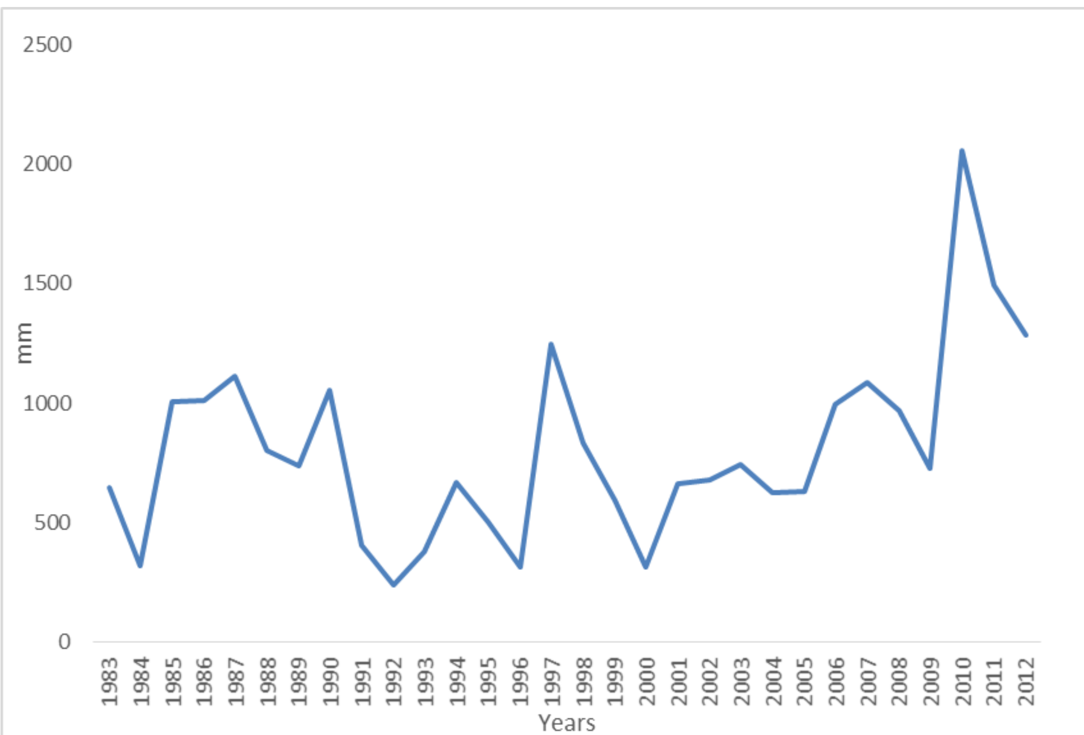

Figure 5.5: Mean annual Rainfall
Source: Researcher (2018)

Rainfall received in Homa Bay County varied between 250mm and 1400mm of rainfall annually, with the average annual rainfall estimated at 1,100mm. It depicted two rainy seasons; March-April-May (long rains) and September to November (short rains). Between 1986 -1988, rainfall variability showed an increase in the annual average of 1000 -900mm , a rise in rainfall between the years 1989-1990 with a sharp fall in 1991 which almost levelled through 1993(roughly 800mm).

Rainfall pattern indicated a slight rise from 1993 -1994 from 8000mm to 1000mm followed by an irregular rise and fall in rainfall up to the year 2000 (1200mm). From 2000 to 2002 there was drop in rainfall to about 1100mm,then an increase to 1200mm. Rainfall pattern indicated an increase from 2002 to 2003 then a steady fall to about 850 in 2004.The rainfall variability manifested an increase and fall through 2006, 2007 then a rise 2009 and a continuous fall in 2010 through 2012.

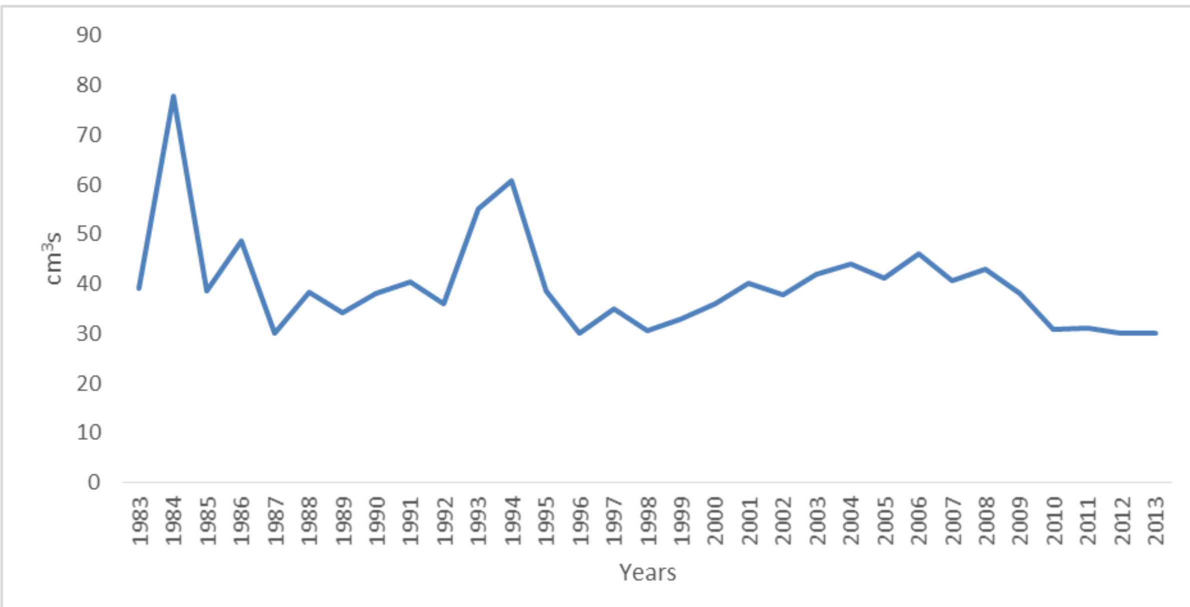

Figure 5.6: Average Annual Discharge: 1HE01 for River Tende

Source: Researcher (2018)

Figure 5.6 Shows a time series of mean annual displays of river discharge at 1HE01 (Tende River) for the period 1983 to 2013. The observed variability trends in the average river discharge across the years with some years (1983, 1992-1994) having high flow values and other years (1985, 1987, and 1996) having low flows indicated fluctuating climate variability trends. Riana sub basin river discharge variability could be attributed to temporal and spatial fluctuation of rainfall and temperature in Homa Bay. The time series analysis of to show variability in the annual distribution of rainfall and river discharges for a duration of 30 years depicted an irregular flow discharges with alternating high and low flows. During the year 1983-1984, there was a sharp rise in the discharge levels in Riana followed by a drop though 1985 and irregular patterns in 1992. The irregularities in river discharges could be due to climate variability. This also had an effect to water resources in terms of availability and distribution.

Figure 5.5 displays a spatial and temporal flow trends throughout the study period. The general increase in trends of river discharges in 1986-1988 indicated an increase in rainfall within the sub basin. The graph depicts a pattern of annual fluctuation in river discharges in few years' time ,the similarity is witnessed in rainfall variability in the same period of time and thus affects availability of water resources in the study area, arise in river discharges corresponds to an increase in rainfall and surface flows , Appendix II. This similarity in trends suggests that the study area exhibits the same Climatic variability pattern in terms of rainfall and temperature .It is a pattern that is reflected in all other rivers in the study area (Figure 5.7 1KA09 Riana River).

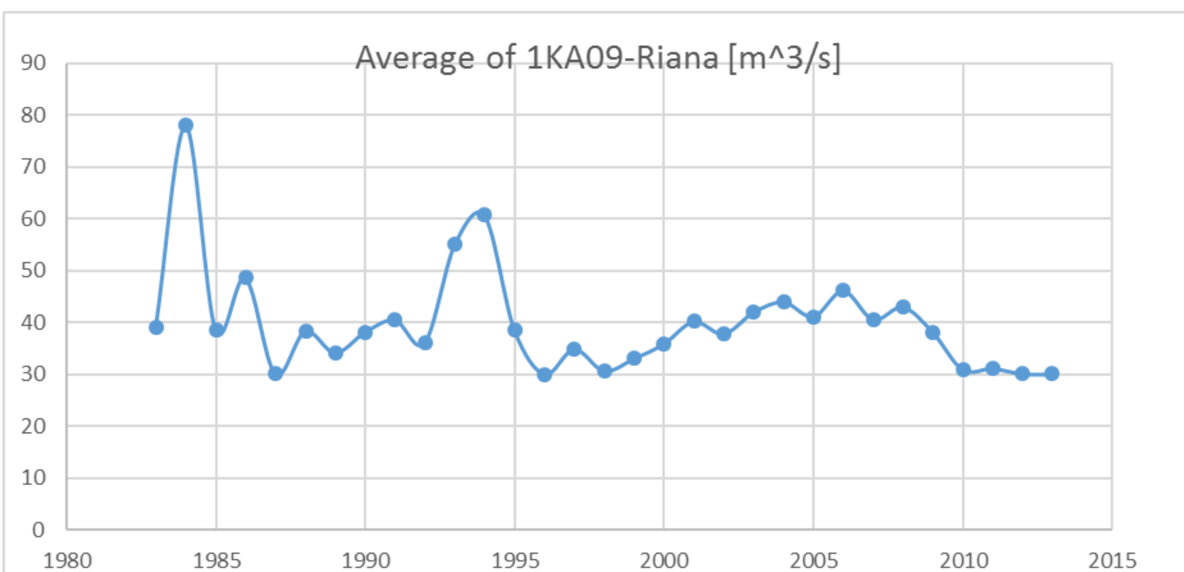

Figure 5.7: River discharge Trends for River Riana (1KA09)
Source: Researcher (2018)

It was established that Climate Variability had impact on availability of surface Water resources in Homa Bay County, though this is not uniform but depended patterns of Rainfall, Temperature and Evapotranspiration for the various Sub basins in the study. A similarity in distribution of surface water resources existed between river discharges and other environmental variables. However the close relationship with rainfall and water yield is clearly evident assuming the linear relationship depicts by the figure 5.9. An increase in rainfall rate causes the positive increase rate in water yield, which is indicated by the highest coefficient of determination R^2= 0.81. Extreme variability in rainfall regime would therefore threaten significantly the surface water resources in Homa Bay County.

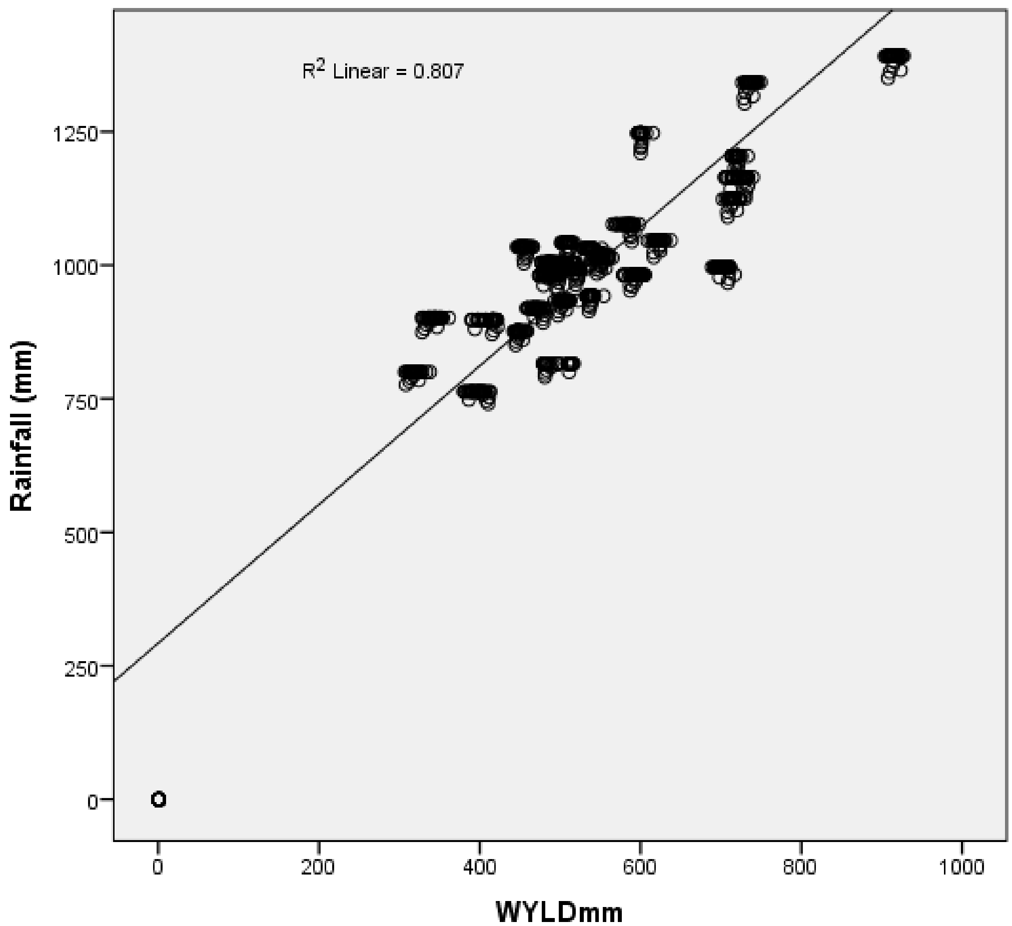

Figure 5.8: Scatterplot of Rainfall and Water Yield
Source: Researcher (2018)

Evapotranspiration is another variable playing an important role on surface water resource. An assessing of the potential association of evapotranspiration impact on water yield indicates by the figure 5.10 a positive and moderate influence of evapotranspiration variability on water resource. The coefficient of determination R^2= 0.372 show a moderate variability of evapotranspiration on water yield meaning that extreme variability of evapotranspiration may not be affecting to some extend the water yield within a different rivers due to other factors not studied in Homa-Bay County.

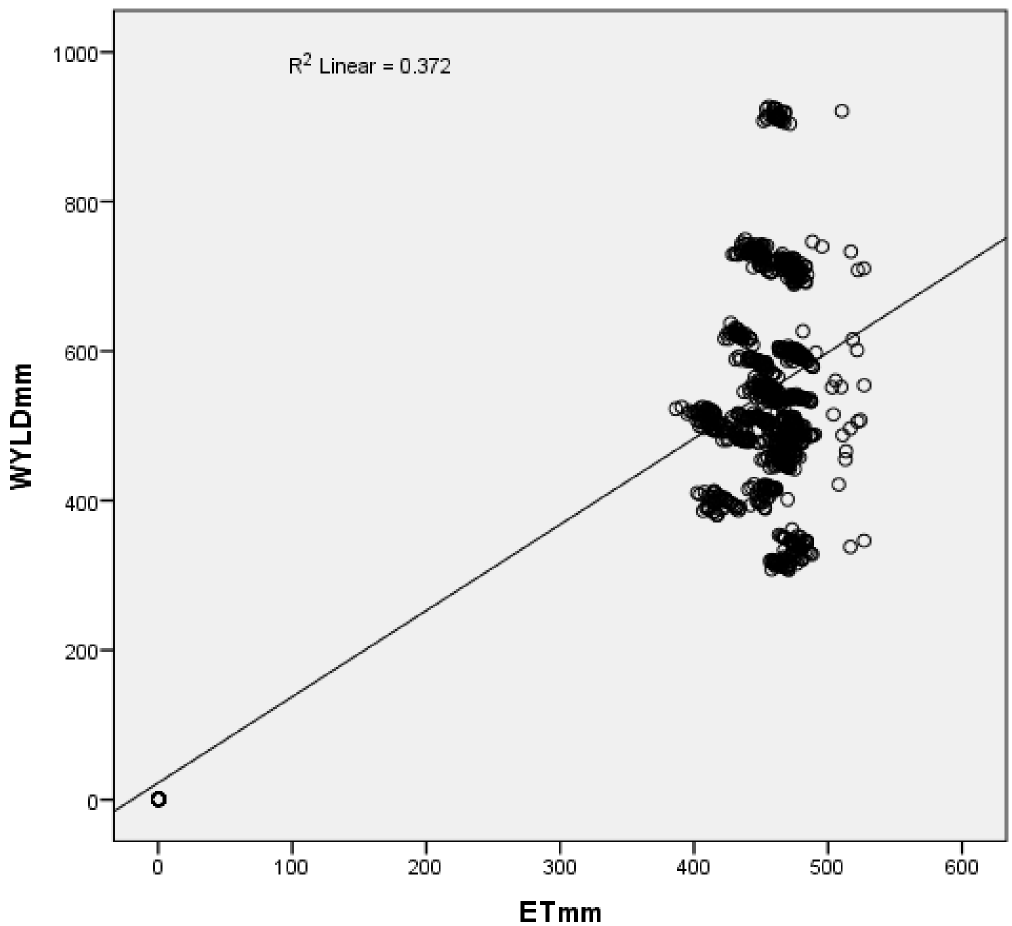

Figure 5.9: Scatterplot of Evapotranspiration and Water Yield
Source: Researcher (2018)

Table 5.2: Statistical Correlation for Rainfall, Evapotranspiration and Water Yield

	Rainfall (mm)	Water Yield (mm)	ET (mm)
Rainfall (mm)	1	.898**	.781**
Water Yield (mm)	.898**	1	.610**
ET(mm)	.781**	.610**	1

**. Correlation is significant at the 0.05

Source: Researcher (2018)

The Table 5.2 shows strength of such different association with different couple of variable affecting the surface water resources and the significance. Pearson correlation analysis output in the Table 5.3 confirm a significant impact of rainfall on water yield (Coefficient of correlation r = 0.89) than evapotranspiration influencing water yield (r = 0.61) in Homa Bay County at 95% significance level. Both variables shows a positive and strong correlation on Water Yield.

Table 5.3: Regression for Rainfall, Evapotranspiration and Water Yield

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Constant	-7.768	9.778		-.794	.427
Rainfall (mm)	.749	.013	1.082	58.808	.000**
ET (mm)	-.445	.035	-.236	-12.812	.000**

**. Significance at the 0.05

Source: Researcher (2018)

The extent of the impact of rainfall and evapotranspiration on water yield in Homa-Bay County is found statistically significant at 95% confidence level. This is implies that extreme combined effects of rainfall and Evapotranspiration could have influenced water scarcity surface water on rivers Kibuon, Tende and Riana basins within Homa-Bay County.

5.2.1 Rainfall and River Discharges

Spatial and Temporal trends existed with a regular and variable patterns between rainfall and river flows, it was evident that years 1991-1993, 2004 and 2009 had the lowest annual flows recorded. A general flow within the sub basin depicted a relationship in trend of flow with that of rainfall trends as shown in Riana, Tende and Kibuon rivers. Climate variability in terms of evaporation showed a minimal decrease in stream discharges within the watershed. This position concurs with the argument of IPCC (2007) that variability in climate is being experienced however and has impact on hydrology and surface water at a micro scale.

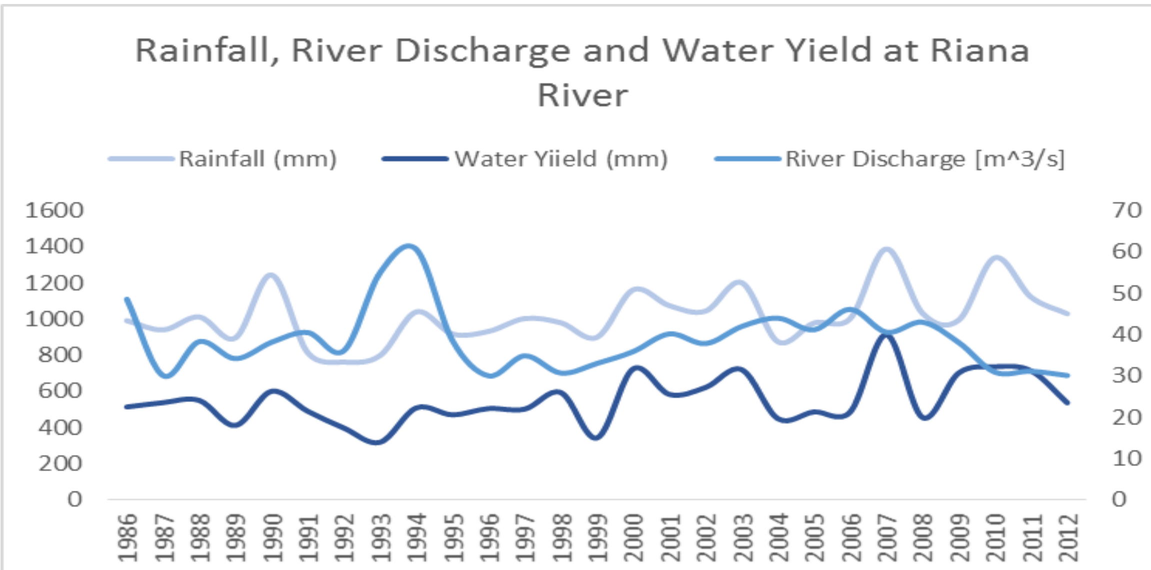

Figure 5.10: Rainfall, River discharges and Water Yield
Source: Researcher (2018)

Surface water resource availability is dictated by the hydrological cycle which is also affected by climate variability (Oki & Kane 2006) The major components of the hydrological cycle which affect the water resources includes river discharge and rainfall which was also analysed in this study due to their role in availability and replenishment of water resources (Masihet et al., 2011.The river discharge in the study area indicated a seasonal and inter annual variability. High discharge in Kibuon, Tende and Riana rivers was witnessed in (March, April and May), this was attributed to high amount of rainfall during the period. Low discharge on the other hand was experienced in the months of (October, November and December)

In all the sub basins the daily river discharge had a strong relationship with the water output, and using rainfall and discharge data was appropriate in establishing the relationship that exist between climate variability and water resources(fig 5.6).

5.2.2 Average Monthly Basin Values (mm)

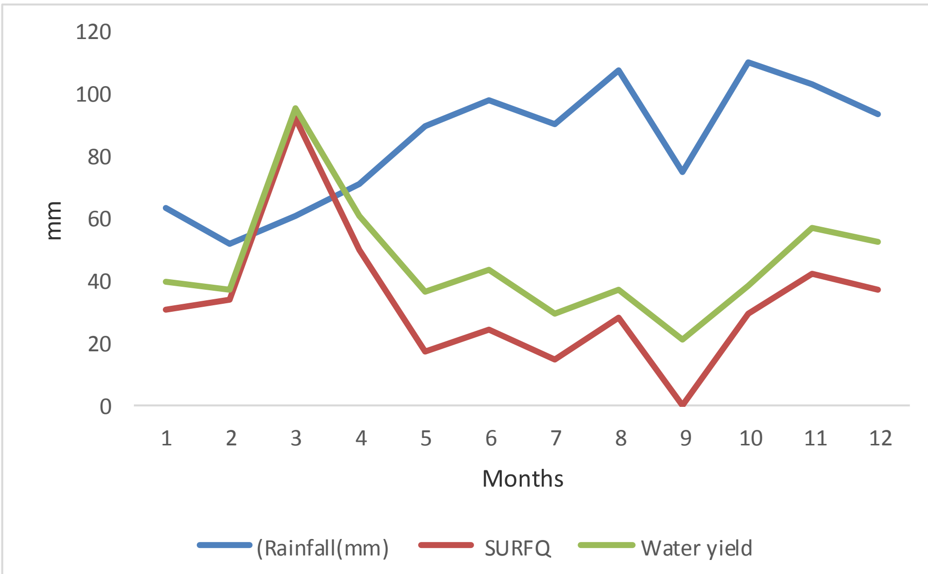

Figure 5.11: Basin values for Rainfall, SURFQ and Water Yield
Source: Researcher (2018)

WYLD =SURQ+LATQ+QWQ-TLOSS

Basin Discharge= Precipitation-Evapotranspiration +_Changes In Storage

(Appendix III for Annual Basin Values)

Figure 5.12 depicts monthly basin values for rainfall, surface flows and water yield, Appendix III. In the month of February and April, both the surface flow and water yield were observed to be high while the rainfall amount was low. This could be attributed to the fact that River Awach, River Tende and River Riana are permanent and all originate from the Kisii highlands that receives relief rainfall in most months of the year. The offset of the main rainy seasons is from mid-March to early April and continues to the month of June. However, there is no marked end of the rainy season.

Land use land cover could affect water availability and distribution in the study area across all the sub basins, Appendix II. The percentage of available water was found to be higher in area covered by agricultural land close grown and agricultural land generic. However water stress was approximately higher in the residential mid low settlement, Range-bush (RNGB) and in the Forest deciduous (FRSD) across the region which could be attributed to climate variability (Appendix II)

5.2.3 Rainfall, Temperature and Water Yield

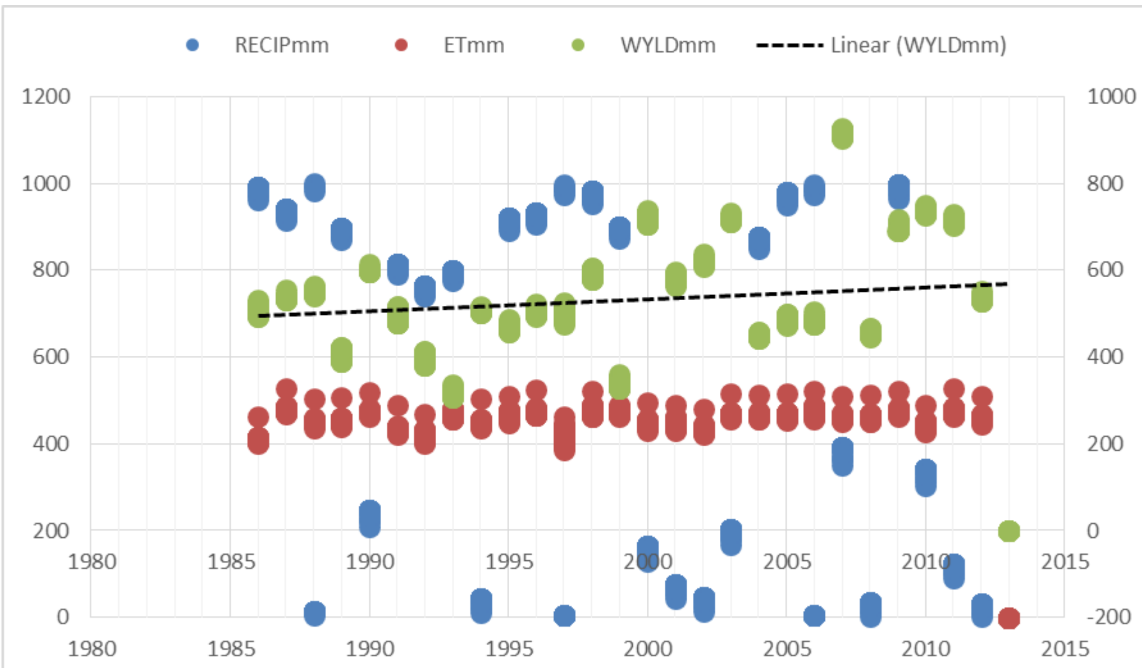

Figure 5.12: Rainfall, Temperature and Water Yield
Source: Researcher (2018)

Rainfall and temperature as shown in figure 5.13 influences the availability and distribution of surface water resources in Homa Bay .The fluctuating surface water availability and distribution in terms of river flows was due to variability in rainfall and temperature. Increased temperature had positive influence on rainfall and evapotranspiration thus affecting river discharge and distribution of surfaces water resources. This concurs with the study by Kumar et *al.* (2006) who indicated that the unpredictable nature connected with rainfall and temperature are vital components of the atmospheric systems which impact on water availability through alteration in water storage, evaporation and run-off.

High evapotranspiration led to reduction in the runoff and rainfall patterns. On the other hand rising temperature was found to increase evapotranspiration leading to a decline in soil moisture water resources in areas such as Sindo, Mbita and Magunga.

The monthly average rate of evapotranspiration in the study area depended on the trend in rainfall, evapotranspiration rate is shown to be highest with decreasing river discharges.

In the month of March, the rainfall amount was low with increased water yield due to low evapotranspiration rates. This implies that the water levels in the aquifers drained into the wells leading to high water yields. The month of June depicts a high rainfall period, high evapotranspiration and high potential evapotranspiration with low water yield. A lot of water is lost into the atmosphere through evapotranspiration. Other factors affecting water yield which were not the main items of this project include geology, soil moisture, soil chemical composition and winds and this is compares well with studies by Tao et al.., (2003, 2011) that the major climatic factor that determines the availability of water include rainfall, temperature and evaporation which is influenced by average radiation, wind speed and humidity in the atmosphere.

CHAPTER SIX

6.0 SUMMARY, CONCLUSION, RECOMMENDATIONS

6.1 Summary and findings

The results of rainfall and temperature analysis conducted in Homa Bay County established that a significant relationship existed between climate variability and water yield, this was influenced by spatial and temporal Variability in Rainfall ,temperature and River discharge Conditions within the County in the period 1983 to 2013.

6.1.1 Rainfall and Temperature Conditions in Homa Bay County.

Homa Bay County exhibited quite high variability in monthly and annual rainfall especially in Kibuon, Tende and Riana basins. Rainfall amount varied from a low of 800mm to 1400mm per annum (pa) in most stations. (Figure 5.1). The variability manifested itself in terms of fluctuating rainfall and temperature totals that led to fluctuations in in river discharges and surface flows. This could then affect water availability, distribution and quantity of water resources and Water Yield. The findings established that the inter annual and seasonal climate variability had impacts on water resources temporally and spatially in terms of availability, distribution and eventual water yield.

6.1.2 Rainfall, Temperature and Surface Water Resources in Homa Bay County

The variability in the total amounts of rainfall and temperature had a significant influence on the availability and distribution of water Yield within 0.89 as coefficient of correlation between rainfall and water yield, and 0.61 between water yield and evapotranspiration within the period 1983 to 2013. (Table: 5.10).The fluctuating rainfall and temperature trends in the study area were found to have likely caused seasonality of streams and some rivers. This would then be a cause of water stress for domestic, agricultural, urban and industrial uses. There were experiences of rainfall patterns which began late and ended early as depicted in the rainfall trends resulting to floods thus likely destruction of property and lives.

Within the study area rainfall and temperature played a major role in impacting on water yield hence needed to be addressed since climate friendly policies and mitigation strategies would help improve the water sector and the general economy.

The Study helped in the analysis of impacts to recommend for water conservation strategies, groundwater basin recharge, inter-basin water transfer from high to low potential zones, better soil and water conservation strategies, and controlling the use of products contributing to global warming in the region.

6.2 Conclusion

Using data analysis results the following conclusions were reached:

- Rainfall and Temperature variability is an environmental challenge that has impact on hydrological system which in turn affects the spatial and temporal trends in availability and distribution of Water resources.
- Variability impacts in rainfall trends caused irregular discharge levels at River Tende, Kibuon and Riana influencing the surface water availability and distribution in some sub basins in different Sub Counties including Karachuonyo, Suba north and South.
- Prolonged dry period reduced the water table hence the drying up of streams, well and springs during low rainy seasons.
- It was established that climate variability also affects other sectors of the economy that depends on water resources.
- SWAT model was found to be an effective tool to simulate the hydrological condition of an area. This involves the use of different data sets including the DEM, Soil map, Land use land cover map, Climate data and the in situ measurements.
- The outcome of this study had limitations but could be used in the management of water resources in the region since a spatial and temporal relationship exists in rainfall, temperature and river discharge trends and the availability, distribution and quantity of water resources in Homa Bay County.

6.3 Recommendations

In view of the above conclusions, the following recommendations are made on the study:

1. The County Government should put in place Water and climate Variability Policy Framework to manage and sustain available Water Resources.
2. Amore elaborate understanding of interrelationship between human and Water Resources is also important to help in addressing Policy interventions to ease Water Stress and to focus in interdisciplinary approaches while doing the same.
3. The challenge of missing and inconsistent records in Hydro climatological research should be addressed by increasing and maintaining the number and network of gauge stations.
4. Hydrologic modelling should be encouraged even at a Micro scale. More consideration should be on Data sources, Collection, retrieval and storage to avoid errors.

6.3.1 Recommendation to Policy Makers

1. A more robust Climate Variability and Water Policy framework should be designed by the County Government.
2. Proper plan of action should be put in place to address the already affected sub counties with mitigation strategies.
3. The County Government should have budgetary allocation to fund and address future Climate Variability impacts and identify critical sub Counties for conservation strategies.

6.3.2 Recommendation for Research

1. Future Research work should be focused on developing a wholesome approach to mitigate Impacts of Climate Variability on Water Resources.
2. Emphasis should be on measures to alleviate water scarcity and expand availability, distribution and supply of water resources.
3. There should be more research on mapping the population and water resources infrastructure in different sub basins to identify areas of vulnerability and plan for the future climate variability risks and uncertainties on Water resources.

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APPENDICES

APPENDIX I: OBSERVED MEAN ANNUAL RAINFALL AND RIVER DISCHARGES

DATE	Rainfall (mm)	Discharge (cms)
1986	991.58	11.93243694
1987	940.82	12.42452335
1988	1012.46	12.58003426
1989	896.22	9.514316559
1990	1245.18	13.87279224
1991	814.23	11.13933277
1992	762.13	9.128846169
1993	798.77	7.33669281
1994	1040.46	11.69888401
1995	918.1	10.85790443
1996	932.51	11.57631874
1997	1003.71	11.54048729
1998	980.08	13.73239803
1999	900.07	7.850640774
2000	1162.84	16.74140549
2001	1074.75	13.43192863
2002	1044.79	14.29457283
2003	1202.3	16.63848495
2004	875.21	10.27821732
2005	979.13	11.22549057
2006	1003.55	11.24484062
2007	1389.66	21.05078316
2008	1032.51	10.42951298
2009	994.7	16.14657974
2010	1340.28	16.98716545
2011	1122.35	16.38753128
2012	1029.88	12.36770821
2013	0	

APPENDIX II: OBSERVED RIVER DISCHARGE FOR RIANA

Year	Average of 1KA09-Riana [m^3/s]
1983	39.13872
1984	77.96049
1985	38.62272
1986	48.5747
1987	30.06477
1988	38.31085
1989	34.17404
1990	38.12961
1991	40.50038
1992	36.11351
1993	55.00227
1994	60.67232
1995	38.57282
1996	30.01307
1997	34.86754
1998	30.67842
1999	33.02543
2000	35.89951
2001	40.17656
2002	37.82732
2003	41.97639
2004	43.98146
2005	41.15773
2006	46.13772
2007	40.57867
2008	42.98835
2009	38.08405
2010	30.89519
2011	31.12672
2012	30.08761
2013	30.05723

APPENDIX III: SOIL AND WATER ANALYSIS TOOL OUTPUT

YEAR	PRECIPmm	PETmm	ETmm	SWmm	PERCmm	SURQmm	GW_Qmm	WYLDmm	LAT Q(mm)
1986	993.277	786.636	413.742	186.974	90.519	443.827	70.241	519.994	2.349
1986	993.277	786.568	413.754	187.237	91.288	442.367	70.816	519.661	2.883
1986	993.277	786.43	412.342	183.277	103.068	417.855	75.079	510.263	13.78
1986	993.277	851.828	462.755	169.101	135.162	411.471	111.067	532.444	4.461
1986	993.277	786.5	414.108	189.562	98.732	427.584	77.601	516.952	7.872
1986	993.277	786.666	406.211	177.356	114.351	427.582	91.666	525.226	1.44
1986	993.277	786.58	415.298	190.582	104.857	423.139	83.902	515.598	4.337
1986	993.277	786.369	411.73	182.357	103.043	413.52	74.366	509.079	17.716
1986	993.277	786.617	414.462	189.979	104.705	426.129	83.326	516.914	3.282
1986	993.277	786.627	414.505	191.723	113.111	414.492	90.567	515.062	5.511
1986	992.674	788.893	412.901	188.883	118.632	417.303	92.549	517.164	2.849
1986	993.277	786.44	414.393	190.917	103.866	420.312	82.364	515.846	9.053
1986	993.277	786.649	412.835	186.729	94.816	437.906	73.79	519.903	4.487
1986	993.277	786.589	414.653	188.69	99.583	433.063	78.884	517.523	1.59
1986	993.277	786.251	413.229	181.526	111.12	397.569	78.94	504.013	23.899
1986	993.277	786.532	411.969	182.265	98.583	436.702	78.062	520.945	2.234
1986	993.277	786.384	411.553	182.859	117.132	404.679	87.16	510.421	14.506
1986	993.277	786.335	409.275	178.67	99.886	428.131	77.74	520.338	10.607
1986	992.933	785.788	414.048	176.93	125.593	379.262	85.682	494.793	26.141
1986	993.277	786.126	414.247	176.923	126.669	381.864	86.375	495.213	23.226
1986	993.277	786.564	410.266	180.537	105.551	432.386	84.85	522.318	0.812
1986	993.277	786.491	409.942	178.505	100.663	435.462	80.136	522.857	3.215
1986	993.277	786.095	412.967	176.944	110.619	386.559	74.682	496.599	32.095
1986	993.277	786.069	411.231	177.054	100.217	411.821	67.836	501.57	18.862
1986	993.277	786.348	410.132	177.943	108.168	414.253	79.175	511.737	14.595
1986	993.277	786.6	414.402	188.523	104.479	429.151	83.549	517.657	0.751
1986	993.277	786.591	409.74	179.499	106.364	432.028	85.722	522.849	0.785
1986	993.277	786.641	410.344	182.02	111.177	425.902	89.98	521.262	0.886
1986	993.277	786.18	414.48	176.924	129.972	378.936	88.755	494.682	23.158
1986	993.277	786.558	413.279	188.894	102.661	430.541	80.343	517.888	3.005
1986	993.277	786.578	413.596	189.163	105.595	428.966	83.131	517.438	1.208
1986	993.277	786.102	411.611	177.043	104.726	407.573	70.899	500.598	18.965
1986	993.277	786.636	415.537	190.755	107.173	423.238	86.604	516.123	1.914
1986	993.277	786.637	414.583	191.053	112.319	418.958	90.136	515.676	2.098
1986	993.277	786.632	414.027	189.606	104.771	427.132	82.954	517.139	2.909
1986	993.277	786.211	410.832	177.332	110.161	394.026	74.458	499.977	28.24
1986	993.277	786.262	406.246	177.229	83.388	400.367	55.405	504.183	45.962
1986	993.277	786.175	409.374	176.764	107.123	399.988	73.224	502.081	25.641
1986	979.338	775.529	404.69	178.122	96.427	439.616	76.081	523.173	3.62
1986	974.271	771.172	404.191	177.147	116.796	396.979	79.552	499.314	19.294

1986	993.277	786.647	414.62	188.487	101.116	432.398	79.531	517.27	1.37
1986	971.385	769.267	402.523	184.636	101.493	433.655	79.228	520.061	3.233
1986	993.277	786.587	412.457	189.642	110.607	423.284	86.451	516.881	2.911
1986	963.509	763.073	401.232	187.475	96.176	439.64	74.893	519.131	0.827
1986	984.925	779.838	407.015	177.757	102.357	426.798	77.714	517.869	9.564
1987	942.432	801.089	482.766	175.866	67.188	466.734	63.874	536.942	2.322
1987	942.432	801.193	482.274	176.284	68.978	464.352	65.309	536.599	2.88
1987	942.432	801.4	481.335	175.056	88.969	431.759	86.17	536.788	13.696
1987	942.432	868.917	526.925	158.934	119.451	426.389	116.689	554.223	4.423
1987	942.432	801.296	477.13	179.756	89.823	442.409	82.567	537.59	7.974
1987	942.432	801.041	476.35	166.913	94.815	444.096	91.496	542.509	1.51
1987	942.432	801.176	473.724	181.517	105.1	433.193	95.099	537.875	4.494
1987	942.432	801.49	480.803	174.646	90.565	425.171	87.635	536.488	18.435
1987	942.432	801.117	475.703	180.522	99.388	438.665	91.072	538.167	3.427
1987	942.432	801.102	472.867	183.077	115.825	422.031	105.486	538.747	5.67
1987	941.86	803.429	486.736	178.47	95.177	434.385	93.3	536.06	2.845
1987	942.432	801.385	473.52	181.885	103.896	429.682	94.006	538.061	9.351
1987	942.432	801.069	481.774	175.75	73.394	458.078	69.807	536.47	4.312
1987	942.432	801.161	478.163	178.718	88.764	448.645	81.848	536.842	1.688
1987	942.432	801.656	481.276	175.078	102.393	406.463	99.052	535.328	24.025
1987	942.432	801.249	478.183	172.072	82.746	454.516	77.272	538.657	2.312
1987	942.432	801.469	478.633	175.174	108.581	413.575	103.371	537.484	14.652
1987	942.432	801.539	478.646	168.743	82.822	445.677	78.567	539.534	10.612
1987	942.105	801.639	486.726	172.601	112.854	386.567	113.5	532.563	25.7
1987	942.432	801.831	486.958	172.602	113.197	389.223	113.837	532.558	22.673
1987	942.432	801.2	474.488	170.962	96.68	444.186	89.265	539.348	0.875
1987	942.432	801.31	476.351	168.54	86.5	450.82	80.583	539.38	3.278
1987	942.432	801.872	484.673	172.378	101.289	394.745	101.573	534.045	31.601
1987	942.432	801.907	480.411	171.799	93.316	420.384	91.93	536.584	18.652
1987	942.432	801.521	478.262	170.412	97.335	424.938	93.431	538.68	14.806
1987	942.432	801.144	475.559	178.992	98.327	441.347	90.164	537.316	0.815
1987	942.432	801.159	473.77	170.015	98.37	442.846	90.714	539.511	0.87
1987	942.432	801.081	471.406	172.991	108.422	435.618	99.353	541.339	0.974
1987	942.432	801.756	487.388	172.717	115.907	385.964	116.783	532.438	22.705
1987	942.432	801.209	481.168	178.553	85.217	448.143	80.581	536.419	2.965
1987	942.432	801.18	480.747	178.985	89.729	444.847	84.692	535.698	1.243
1987	942.432	801.862	481.53	171.974	96.618	415.74	95.678	536.024	18.782
1987	942.432	801.089	471.462	181.929	110.89	431.153	99.862	538.348	2.069
1987	942.432	801.086	474.07	182.067	111.716	428.307	102.294	538.237	2.155
1987	942.432	801.095	477.75	179.814	94.832	441.795	87.981	537.658	2.929
1987	942.432	801.713	479.255	172.418	106.516	398.29	103.721	536.749	28.615
1987	942.432	801.641	473.402	171.551	87.81	403.724	84.183	541.392	48.502
1987	942.432	801.763	478.686	171.217	102.263	405.706	100.106	538.343	26.557

1987	929.206	789.95	471.761	167.658	76.309	458.82	72.101	538.937	3.612
1987	924.399	786.366	472.655	172.372	108.318	403.098	106.887	535.609	19.236
1987	942.432	801.072	478.415	178.328	85.29	451.524	79.869	537.463	1.401
1987	921.661	783.481	471.567	173.956	78.721	454.198	75.699	537.696	3.178
1987	942.432	801.165	482.571	179.384	91.641	439.944	87.905	535.882	2.893
1987	914.187	777.061	468.895	176.525	72.843	460.841	69.694	535.715	0.859
1987	934.507	794.63	474.001	168.658	87.057	440.965	82.608	538.215	9.716
1988	1014.189	747.826	449.13	182.951	94.592	466.824	73.553	546.528	2.278
1988	1014.189	747.815	449.404	183.219	95.526	465.628	74.569	546.914	2.783
1988	1014.189	747.788	451.345	178.866	114.222	437.172	95.295	551.244	13.637
1988	1014.189	815.597	503.07	163.56	141.26	423.95	116.594	551.349	4.445
1988	1014.189	747.803	452.119	185.533	106.415	448.349	86.722	547.262	7.544
1988	1014.189	747.83	449.348	173.004	118.265	446.289	95.983	548.877	1.436
1988	1014.189	747.817	453.126	186.544	115.161	442.787	95.939	548.043	4.153
1988	1014.189	747.774	451.246	178.008	114.673	433.541	96.13	552.491	17.617
1988	1014.189	747.823	452.82	185.944	113.274	445.328	93.335	546.836	3.154
1988	1014.189	747.825	455.542	187.687	123.421	431.019	103.892	545.904	5.35
1988	1013.574	750.208	459.782	184.809	120.232	434.022	97.303	539.455	2.821
1988	1014.189	747.791	453.638	186.884	113.923	439.067	94.915	547.763	8.658
1988	1014.189	747.828	450.094	182.47	99.235	460.817	78.028	547.331	4.344
1988	1014.189	747.819	451.431	184.664	106.994	454.545	86.781	547.494	1.54
1988	1014.189	747.745	454.304	177.214	123.516	416.485	105.316	551.053	23.505
1988	1014.189	747.809	449.157	178.285	104.315	458.353	83.417	548.383	2.174
1988	1014.189	747.778	454.485	178.605	125.343	422.553	106.097	548.567	14.116
1988	1014.189	747.766	449.546	174.672	105.484	448.692	84.867	548.434	10.322
1988	1013.837	747.431	457.324	172.601	140.46	396.043	121.726	550.423	25.974
1988	1014.189	747.71	457.356	172.605	141.297	398.115	122.62	550.594	23.142
1988	1014.189	747.815	449.511	176.573	112.705	452.431	92.215	550.386	0.801
1988	1014.189	747.801	448.42	174.54	106.571	456.673	85.786	550.146	3.112
1988	1014.189	747.701	454.147	172.548	129.447	404.004	111.895	554.144	32.132
1988	1014.189	747.693	448.14	172.421	123.55	428.788	107.721	561.391	19.091
1988	1014.189	747.769	450.291	173.636	119.128	432.783	100.505	553.211	14.476
1988	1014.189	747.821	452.079	184.493	112.891	449.988	92.77	548.47	0.733
1988	1014.189	747.819	449.232	175.542	113.715	452.082	93.26	551.122	0.783
1988	1014.189	747.826	450.461	178.044	118.949	444.959	99.105	550.261	0.864
1988	1014.189	747.726	458.253	172.642	143.672	394.923	124.624	549.496	23.106
1988	1014.189	747.814	452.973	184.884	107.385	450.982	86.31	544.861	2.94
1988	1014.189	747.817	453.585	185.153	110.778	449.645	89.583	545.226	1.184
1988	1014.189	747.703	449.773	172.47	126.468	424.053	110.163	559.454	19.293
1988	1014.189	747.826	452.818	186.689	118.518	442.994	99.354	549.538	1.836
1988	1014.189	747.826	454.895	187.01	121.769	436.754	101.819	546.149	2.06
1988	1014.189	747.825	453.142	185.576	111.86	446.605	91.4	545.766	2.845
1988	1014.189	747.735	451.605	172.612	128.559	411.298	112.649	558.307	28.194

1988	1014.189	747.748	445.344	172.307	108.011	419.593	94.155	565.021	46.14
1988	1014.189	747.725	449.48	172.051	126.596	417.63	110.663	559.779	25.46
1988	999.956	737.321	441.174	174.151	100.984	462.607	79.593	549.939	3.511
1988	994.783	733.428	443.984	172.591	134.471	413.15	117.55	556.519	19.414
1988	1014.189	747.827	450.987	184.46	105.151	457.68	84.644	548.16	1.322
1988	991.836	731.339	441.524	180.649	104.706	454.153	82.94	544.686	3.152
1988	1014.189	747.818	455.646	185.652	114.117	442.092	92.37	542.305	2.843
1988	983.794	725.415	437.2	183.464	100.088	462.257	78.565	545.801	0.814
1988	1005.661	741.505	445.06	173.616	109.326	448.656	89.373	552.156	9.325
1989	897.753	824.198	453.082	176.436	78.747	364.386	46.808	416.7	1.928
1989	897.753	824.329	452.981	176.495	79.603	363.354	47.721	417.101	2.383
1989	897.753	824.589	452.038	172.151	101.471	331.646	58.511	407.33	13.096
1989	897.753	891.276	508.053	155.544	105.539	346.239	66.436	421.422	3.661
1989	897.753	824.458	457.211	176.98	85.739	350.365	55.881	417.258	6.683
1989	897.753	824.138	450.08	165.201	94.144	354.115	57.762	417.488	1.202
1989	897.753	824.307	460.467	177.255	91.965	344.767	62.77	416.071	3.667
1989	897.753	824.703	452.387	171.519	102.845	325.278	59.337	406.387	17.676
1989	897.753	824.234	458.656	177.071	91.068	348.005	60.352	415.764	2.745
1989	897.753	824.215	461.38	177.374	97.589	338.306	66.962	414.969	4.502
1989	897.208	826.49	457.074	175.463	96.235	347.691	58.237	412.704	2.346
1989	897.753	824.57	460.164	177.293	90.188	342.881	61.46	416.859	7.719
1989	897.753	824.173	452.915	175.525	81.559	360.288	49.319	417.107	3.731
1989	897.753	824.289	457.23	176.657	86.992	354.154	56.178	416.009	1.356
1989	897.753	824.915	454.512	170.613	111.985	308.535	66.068	402.295	23.211
1989	897.753	824.399	453.846	170.793	81.506	361.938	51.472	419.358	1.884
1989	897.753	824.676	456.442	170.926	108.116	320.997	66.667	406.132	13.708
1989	897.753	824.765	452.004	166.794	81.361	356.577	50.75	420.604	9.29
1989	897.442	824.972	452.437	166.893	133.605	285.581	75.095	391.09	25.683
1989	897.753	825.144	452.591	166.863	134.629	287.501	75.426	390.446	22.768
1989	897.753	824.337	455.845	168.344	87.421	356.056	57.568	418.873	0.707
1989	897.753	824.475	453.449	166.846	81.046	362.152	52.046	421.057	2.691
1989	897.753	825.198	449.744	166.819	123.544	292.293	68.231	396.734	31.915
1989	897.753	825.244	446.963	166.648	118.262	313.232	62.836	399.069	19.035
1989	897.753	824.742	452.061	166.854	103.109	329.053	60.848	408.333	14.125
1989	897.753	824.267	458.598	175.94	90.535	350.571	59.779	415.618	0.645
1989	897.753	824.286	455.695	167.254	87.746	355.956	58.101	419.354	0.702
1989	897.753	824.189	458.349	169.067	92.976	348.672	63.256	417.656	0.775
1989	897.753	825.046	453.099	166.876	136.845	284.81	77	389.419	22.759
1989	897.753	824.349	455.425	176.722	87.622	354.288	54.439	415.357	2.463
1989	897.753	824.312	456.57	176.773	89.843	352.719	56.388	414.437	1.011
1989	897.753	825.186	447.777	166.679	121.159	309.339	65.073	397.741	19.229
1989	897.753	824.198	461.252	177.318	94.525	343.67	65.278	415.67	1.662
1989	897.753	824.195	460.625	177.242	96.998	342.133	65.567	414.492	1.729

1989	897.753	824.206	457.431	176.927	90.392	350.086	58.403	415.39	2.407
1989	897.753	824.99	451.129	166.922	122.429	295.395	68.64	396.931	28.502
1989	897.753	824.895	446.299	166.891	102.203	301.548	56.239	408.567	47.152
1989	897.753	825.055	448.916	166.764	120.274	302.128	66.235	398.284	25.704
1989	885.154	812.761	444.685	167.166	75.958	368.652	46.768	422.16	2.952
1989	880.575	809.195	442.25	166.811	128.374	298.881	71.082	393.847	19.376
1989	897.753	824.177	456.544	176.772	85.687	356.052	54.33	415.721	1.159
1989	877.967	806.093	442.879	173.016	82.971	360.803	50.043	417.354	2.609
1989	897.753	824.294	455.997	176.733	92.127	350.051	56.946	413.757	2.406
1989	870.848	799.473	440.244	176.467	82.535	361.691	49.241	415.386	0.694
1989	890.204	817.616	448.347	166.768	88.332	349.164	53.714	415.671	8.726
1990	1247.313	773.517	477.378	196.611	97.088	485.637	106.897	600.916	2.845
1990	1247.313	773.652	476.841	196.833	98.672	483.837	108.256	601.145	3.468
1990	1247.313	773.922	475.822	194.341	123.088	446.076	132.175	600.887	16.076
1990	1247.313	840.786	518.303	178.332	154.265	439.903	162.209	615.462	5.314
1990	1247.313	773.786	474.464	198.737	114.438	463.592	120.593	599.182	9.108
1990	1247.313	773.456	470.282	186.74	127.76	461.668	136.638	606.953	1.783
1990	1247.313	773.629	473.218	199.544	126.067	456.581	130.712	598.614	5.107
1990	1247.313	774.041	476.097	193.765	123.488	440.575	132.546	600.386	20.704
1990	1247.313	773.554	473.847	199.066	123.295	460.154	129.185	599.51	3.932
1990	1247.313	773.535	472.433	200.52	137.695	443.545	141.526	598.303	6.586
1990	1246.556	775.848	479.012	198.19	132.656	447.352	140.941	598.752	3.422
1990	1247.313	773.902	472.87	199.835	125.033	452.498	129.218	598.37	10.535
1990	1247.313	773.491	475.985	196.284	103.709	477.499	112.879	601.417	5.267
1990	1247.313	773.61	475.237	197.973	114.109	470.473	121.209	599.593	1.932
1990	1247.313	774.262	477.1	193.826	135.426	419.855	143.505	597.958	27.621
1990	1247.313	773.725	473.692	191.863	107.92	477.715	114.825	600.929	2.688
1990	1247.313	774.013	474.925	193.988	137.954	430.585	145.294	599.631	16.742
1990	1247.313	774.106	472.582	188.582	109.214	467.501	115.007	600.527	12.34
1990	1246.88	774.347	480.342	191.254	155.858	392.127	165.533	595.995	30.25
1990	1247.313	774.499	480.292	191.12	156.887	394.661	166.83	596.658	27.018
1990	1247.313	773.66	471.996	189.957	117.489	470.909	123.231	601.078	0.977
1990	1247.313	773.804	472.25	188.142	109.058	476.751	114.88	601.028	3.767
1990	1247.313	774.555	478.496	190.77	141.825	401.482	151.025	597.224	37.325
1990	1247.313	774.602	475.117	189.464	132.725	430.186	142.767	602.179	22.194
1990	1247.313	774.082	473.453	189.291	127.593	442.625	135.284	601.638	17.137
1990	1247.313	773.588	474.205	197.695	121.536	464.594	127.781	599.489	0.922
1990	1247.313	773.607	471.346	188.921	118.36	470.653	123.828	601.398	0.951
1990	1247.313	773.508	470.747	191.185	126.297	462.796	131.111	601.187	1.061
1990	1247.313	774.398	480.63	191.259	160.117	390.996	170.088	596.388	27
1990	1247.313	773.673	476.314	198.247	115.118	466.606	123.227	599.577	3.583
1990	1247.313	773.634	476.428	198.47	119.326	464.115	127.139	599.035	1.466
1990	1247.313	774.542	475.736	189.709	136.955	424.858	147.004	601.578	22.487

1990	1247.313	773.517	472.216	199.652	130.303	455.972	134.732	599.34	2.28
1990	1247.313	773.514	473.254	199.969	134.877	449.751	139.764	598.668	2.515
1990	1247.313	773.525	474.887	198.792	121.247	461.684	128.015	599.415	3.453
1990	1247.313	774.34	475.187	190.367	141.317	410.092	150.511	600.934	33.055
1990	1247.313	774.242	470.959	189.78	115.789	419.701	123.331	602.698	53.709
1990	1247.313	774.407	474.712	189.963	138.227	417.351	147.753	601.875	29.571
1990	1229.809	762.795	466.259	187.977	101.978	483.212	108.641	601.558	4.27
1990	1223.446	759.514	467.398	190.265	148.07	412.302	158.163	600.927	22.756
1990	1247.313	773.495	475.781	197.846	111.388	473.154	119.193	599.913	1.635
1990	1219.822	756.531	465.308	194.254	109.88	472.413	118.01	600.215	3.827
1990	1247.313	773.615	476.769	198.928	124.484	456.236	132.34	598.603	3.45
1990	1209.931	750.31	463.529	197.058	104.103	479.413	113.731	600.017	1.026
1990	1236.824	767.373	469.19	188.341	113.683	463.7	120.546	601.327	11.149
1991	815.628	767.944	433.185	175.076	79.324	406.902	68.413	482.049	2.096
1991	815.628	768.104	433.541	175.201	80.22	405.261	69.475	482.026	2.581
1991	815.628	768.425	435.095	169.625	79.71	398.159	80.431	495.977	11.695
1991	815.628	834.979	488.484	154.453	114.188	378.178	98.573	487.224	3.953
1991	815.628	768.261	437.492	175.997	90.08	388.041	80.655	481.204	7.045
1991	815.628	767.87	432.024	163.973	97.648	391.717	84.671	483.401	1.331
1991	815.628	768.077	439.944	176.435	98.552	380.587	89.729	480.292	3.921
1991	815.628	768.568	436	168.526	78.018	396.209	80.008	496.882	14.957
1991	815.628	767.988	438.541	176.322	96.126	385.01	86.517	480.351	2.975
1991	815.628	767.964	441.39	176.888	104.892	372.359	95.684	479.372	4.863
1991	815.133	770.265	440.195	174.079	98.057	385.506	84.824	478.605	2.518
1991	815.628	768.401	439.951	176.712	96.883	378.004	88.236	480.389	8.173
1991	815.628	767.913	433.721	174.193	82.889	401.483	71.922	482.229	3.953
1991	815.628	768.055	437.152	175.543	90.719	393.022	80.777	480.737	1.48
1991	815.628	768.835	438.895	167.913	80.814	386.453	86.347	498.693	19.674
1991	815.628	768.19	434.327	170.053	87.819	397.581	76.979	481.813	2.058
1991	815.628	768.534	439.467	169.262	90.553	382.576	89.564	490.497	12.044
1991	815.628	768.646	434.029	165.33	86.299	393.684	76.758	484.847	9.198
1991	815.345	769.002	439.428	162.859	80.663	386.981	94.61	509.649	21.106
1991	815.628	769.124	439.189	163.531	80.96	388.784	95.133	509.505	18.591
1991	815.628	768.114	435.934	168.08	94.45	390.656	84.289	481.406	0.781
1991	815.628	768.283	434.073	166.432	89.261	395.415	78.56	482.201	2.93
1991	815.628	769.192	436.604	161.866	73.757	392.339	87.832	512.766	26.144
1991	815.628	769.251	432.152	162.579	69.548	409.5	84.324	515.666	15.653
1991	815.628	768.617	435.337	165.005	82.236	394.349	83.685	496.286	12.308
1991	815.628	768.029	438.071	175.236	95.78	387.821	85.994	480.327	0.71
1991	815.628	768.052	435.877	167.065	95.205	389.947	85.106	481.564	0.778
1991	815.628	767.933	437.91	168.947	99.861	383.531	90.641	481.126	0.848
1991	815.628	769	439.815	163.557	82.547	386.69	96.555	508.928	18.581
1991	815.628	768.129	436.536	175.589	89.829	393.6	78.834	480.413	2.638

1991	815.628	768.083	437.33	175.687	92.607	391.688	81.491	479.793	1.097
1991	815.628	769.176	433.259	162.679	71.565	406.434	86.206	514.704	15.735
1991	815.628	767.944	440.164	176.858	101.646	379.089	93.015	480.166	1.792
1991	815.628	767.94	440.586	176.635	103.345	377.434	93.729	479.35	1.861
1991	815.628	767.953	437.83	176.011	94.359	387.948	84.078	480.28	2.567
1991	815.628	768.929	436.903	163.316	73.279	393.487	87.413	510.692	23.311
1991	815.628	768.81	432.98	158.597	61.503	397.179	74.603	516.75	39.451
1991	815.628	769.011	434.787	161.046	72.875	399.445	86.373	513.928	21.756
1991	804.182	757.326	425.73	166.622	84.776	401.516	73.067	482.762	3.25
1991	800.021	754.205	428.046	163.792	76.747	397.463	91.125	511.117	15.807
1991	815.628	767.918	436.104	175.743	88.852	395.839	78.568	480.968	1.248
1991	797.651	751.092	424.629	171.934	86.972	398.252	74.953	481.14	2.856
1991	815.628	768.061	437.932	175.535	94.385	388.443	82.584	479.197	2.567
1991	791.184	744.899	421.372	175.1	83.255	403.518	71.774	480.923	0.763
1991	808.769	761.914	430.298	165.874	83.418	396.814	77.969	488.435	8.243
1992	763.437	792.436	414.802	135.732	36.845	375.422	33.66	412.891	1.423
1992	763.437	792.559	414.883	136.622	37.273	373.845	34.225	412.233	1.733
1992	763.437	792.8	414.513	146.035	36.47	353.373	34.016	398.25	8.38
1992	763.437	861.669	469.861	145.131	47.673	346.363	48.813	401.577	2.579
1992	763.437	792.679	424.381	143.707	38.532	354.018	38.294	399.732	4.583
1992	763.437	792.38	410.29	139.652	42.201	360.11	41.48	405.62	0.904
1992	763.437	792.538	431.955	146.409	39.85	344.94	41.546	392.19	2.558
1992	763.437	792.907	414.946	146.15	35.76	349.71	33.435	396.684	11.105
1992	763.437	792.47	427.558	146.013	39.795	350.26	40.767	396.039	1.952
1992	763.437	792.452	433.139	153.069	41.236	335.642	44.511	386.71	3.137
1992	762.974	794.839	415.295	154.921	42.431	351.505	42.709	399.08	1.679
1992	763.437	792.783	430.985	147.641	39.644	342.439	41.261	392.099	5.283
1992	763.437	792.413	414.452	138.806	37.917	369.534	35.381	410.097	2.635
1992	763.437	792.521	424.153	141.42	38.882	359.306	38.402	401.539	0.998
1992	763.437	793.103	419.957	149.752	36.812	336.12	35.429	388.585	14.443
1992	763.437	792.625	418.41	135.477	39.347	364.633	38.075	406.867	1.404
1992	763.437	792.882	421.917	150.181	39.404	338.259	39.928	389.883	8.732
1992	763.437	792.965	414.154	136.331	39.051	358.62	37.498	405.251	6.409
1992	763.172	793.137	416.816	155.234	37.456	326.528	35.739	380.69	15.812
1992	763.437	793.31	416.931	154.964	37.939	329.067	36.039	381.498	13.762
1992	763.437	792.566	423.81	136.717	40.431	355.792	40.946	400.316	0.547
1992	763.437	792.695	418.926	133.162	39.887	361.701	39.079	405.595	1.979
1992	763.437	793.359	413.987	152.34	34.022	331.059	31.294	384.23	19.577
1992	763.437	793.4	409.857	147.969	32.911	349.151	28.49	391.51	11.772
1992	763.437	792.944	415.927	143.253	37.486	348.651	36.021	396.179	8.877
1992	763.437	792.501	427.301	143.614	39.844	353.206	40.628	397.359	0.487
1992	763.437	792.519	424.051	136.238	40.64	354.821	41.376	399.82	0.555
1992	763.437	792.428	429.4	140.224	40.859	347.138	42.894	393.855	0.581

1992	763.437	793.222	417.514	155.724	38.418	327.332	36.945	380.683	13.709
1992	763.437	792.578	418.572	144.658	39.4	360.407	38.49	403.468	1.747
1992	763.437	792.543	420.394	145.763	39.957	358.013	39.632	401.314	0.742
1992	763.437	793.348	410.983	148.78	33.611	346.726	29.657	390.235	11.668
1992	763.437	792.436	434.376	147.016	40.36	343.198	42.771	390.419	1.189
1992	763.437	792.433	431.042	150.961	41.244	341.44	43.821	389.827	1.221
1992	763.437	792.443	423.919	146.192	39.747	353.692	40.16	398.532	1.686
1992	763.437	793.171	415.349	151.334	33.893	334.679	31.665	385.871	17.193
1992	763.437	793.086	408.694	147.125	26.483	335.72	23.521	390.709	29.688
1992	763.437	793.23	411.395	150.078	33.055	339.008	30.561	388.449	16.619
1992	752.723	781.437	407.886	131.315	39.239	369.372	37.23	411.445	2.192
1992	748.829	777.986	406.73	151.815	35.904	338.914	33.361	386.341	11.614
1992	763.437	792.416	422.121	140.882	38.483	362.594	37.62	403.811	0.837
1992	746.611	775.027	404.314	140.587	39.404	365.783	37.718	408.138	1.911
1992	763.437	792.526	417.478	150.18	40.805	354.575	40.722	400.015	1.698
1992	740.557	768.664	402.31	139.317	38.024	371.63	35.562	410.268	0.528
1992	757.017	786.097	412.404	136.194	38.564	358.647	36.908	403.957	5.753
1993	800.137	775.897	470.717	193.689	30.136	281.814	22.45	307.168	2.11
1993	800.136	776.086	469.983	193.876	32.217	280.631	23.976	308.089	2.643
1993	800.136	776.467	471.821	190.034	42.144	272.541	32.098	318.08	12.26
1993	800.137	841.072	516.716	174.569	97.965	250.595	80.204	338.049	4.193
1993	800.136	776.275	463.572	195.277	56.073	263.901	41.458	314.351	7.688
1993	800.136	775.81	466.478	183.373	65.515	265.696	52.145	321.069	1.306
1993	800.137	776.054	459.204	195.857	71.141	258.86	52.346	316.972	4.201
1993	800.136	776.634	471.716	189.363	41.811	270.262	31.632	318.825	15.771
1993	800.137	775.949	462.032	195.505	65.819	262.32	48.867	315.86	3.156
1993	800.137	775.921	458.917	196.579	85.004	250.062	63.318	320.651	5.33
1993	799.651	778.132	476.918	194.556	68.62	256.843	54.328	315.839	2.642
1993	800.136	776.439	459.358	196.085	71.28	254.797	52.492	317.831	8.955
1993	800.137	775.86	469.587	193.18	38.582	276.085	29.246	310.499	4.128
1993	800.137	776.027	464.745	194.642	53.238	270.107	39.395	312.219	1.477
1993	800.137	776.944	472.01	189.299	50.983	259.424	38.47	320.097	20.808
1993	800.137	776.189	465.28	188.542	47.276	275.06	35.468	313.722	2.025
1993	800.136	776.595	468.134	189.62	65.769	256.561	49.788	320.932	12.857
1993	800.136	776.726	466.123	184.941	48.611	269.698	37.113	317.712	9.605
1993	799.859	777.172	480.184	185.928	51.668	258.013	40.545	322.184	21.988
1993	800.137	777.276	480.339	186.169	51.252	260.532	40.075	321.617	19.39
1993	800.137	776.098	461.12	186.413	62.536	268.737	46.799	317.733	0.717
1993	800.137	776.3	463.186	184.692	51.781	273.237	38.935	316.429	2.984
1993	800.136	777.355	477.969	185.258	40.451	264.399	31.418	324.082	26.99
1993	800.136	777.421	474.856	184.059	28.928	287.037	22.046	325.803	15.86
1993	800.137	776.692	468.568	185.099	49.292	270.179	37.326	321.681	12.849
1993	800.137	775.996	462.516	194.195	63.615	265.449	47.218	314.819	0.687

1993	800.137	776.024	460.24	185.336	64.425	268.348	48.239	318.781	0.675
1993	800.136	775.883	457.41	187.47	75.286	262.102	56.063	320.699	0.819
1993	800.137	777.134	480.751	186.409	54.209	257.679	42.508	321.3	19.391
1993	800.137	776.115	469.05	194.928	52.119	268.529	39.527	312.187	2.78
1993	800.137	776.061	468.819	195.086	56.844	266.692	43.174	312.435	1.105
1993	800.137	777.336	475.486	184.531	32.567	283.003	24.932	324.878	15.959
1993	800.137	775.897	457.11	195.926	76.667	258.334	56.377	318.235	1.863
1993	800.136	775.892	460.742	196.171	79.893	255.026	59.73	318.6	1.988
1993	800.137	775.907	465.088	195.304	61.629	264.231	46.219	314.684	2.744
1993	800.136	777.052	472.801	185.411	43.691	267.948	32.737	326.195	24.291
1993	800.137	776.916	467.177	182.262	28.604	270.498	20.774	333.445	41.434
1993	800.137	777.147	473.077	182.802	40.524	273.489	30.953	328.606	22.984
1993	788.907	765.196	459.602	184.672	40.977	278.903	31.195	314.488	3.309
1993	784.826	762.171	466.608	185.556	44.545	272.491	34.084	324.184	16.291
1993	800.137	775.866	466.212	194.596	49.377	272.251	36.669	311.365	1.267
1993	782.501	758.883	460.514	190.969	45.691	272.778	35.317	312.334	2.959
1993	800.137	776.035	471.456	195.431	61.562	261.748	47.574	313.724	2.718
1993	776.156	752.608	457.906	194.019	37.273	277.991	28.336	308.076	0.731
1993	793.408	769.88	462.734	184.709	45.615	273.236	34.435	317.575	8.703
1994	1042.238	857.479	448.912	188.968	95.716	425.66	77.365	509.568	2.462
1994	1042.237	857.449	448.834	189.096	97.055	423.861	78.693	509.776	3.052
1994	1042.237	857.386	449.416	185.28	99.101	409.948	80.225	508.899	14.336
1994	1042.238	924.15	504.008	169.806	139.972	391.472	112.59	515.069	4.686
1994	1042.237	857.418	452.407	189.998	109.134	403.115	91.562	508.295	8.524
1994	1042.237	857.493	444.322	178.579	119.926	407.008	97.128	510.984	1.526
1994	1042.238	857.454	455.381	190.252	118.409	394.892	101.485	506.868	4.728
1994	1042.237	857.357	449.742	184.517	97.44	407.333	79.005	509.051	18.378
1994	1042.238	857.471	453.646	190.111	116.627	399.404	98.645	507.153	3.569
1994	1042.238	857.475	455.826	190.867	128.36	383.328	109.986	505.568	5.955
1994	1041.605	859.751	451.714	189.676	126.051	394.607	101.552	504.716	3.017
1994	1042.237	857.391	454.708	190.485	117.396	391.393	100.354	507.376	9.917
1994	1042.238	857.485	448.601	188.372	100.896	418.589	81.777	509.477	4.735
1994	1042.238	857.459	452.451	189.434	109.356	409.596	91.538	507.91	1.728
1994	1042.238	857.3	453.254	184.269	101.062	394.436	82.68	506.089	24.323
1994	1042.238	857.433	448.427	183.507	106.067	416.114	87.123	510.392	2.383
1994	1042.237	857.364	451.744	184.449	114.518	391.966	94.845	507.041	14.896
1994	1042.237	857.34	446.005	179.957	105.545	410.307	85.917	512.025	11.092
1994	1041.876	856.905	454.869	181.186	101.568	390.264	81.004	501.911	26.065
1994	1042.238	857.236	454.83	181.19	102.569	392.686	81.765	502.134	23.071
1994	1042.238	857.448	447.402	181.119	115.943	408.975	97.067	512.323	0.877
1994	1042.238	857.414	446.297	179.578	108.496	414.833	89.38	512.569	3.429
1994	1042.237	857.22	452.032	180.786	91.276	397.052	72.702	506.116	32.281
1994	1042.237	857.207	446.8	179.62	87.349	419.103	69.709	511.949	19.328

1994	1042.238	857.347	447.901	180.045	103.15	406.812	84.091	510.762	15.19
1994	1042.238	857.464	452.984	188.848	116.053	403.384	98.021	507.698	0.819
1994	1042.238	857.459	446.724	180.011	116.718	408.911	97.853	513.078	0.853
1994	1042.237	857.481	448.277	181.921	123.028	401.087	104.822	512.799	0.976
1994	1042.238	857.264	455.57	181.356	104.557	390.039	83.322	501.138	23.063
1994	1042.238	857.445	450.75	189.916	110.842	408.227	91.023	507.39	3.179
1994	1042.238	857.453	451.555	190.02	114.396	405.807	94.34	506.604	1.292
1994	1042.238	857.224	447.98	179.897	89.943	415.372	71.762	510.558	19.479
1994	1042.238	857.479	455.892	190.252	122.037	393.404	105.277	506.81	2.122
1994	1042.237	857.48	455.12	190.597	126.438	389.583	107.745	505.7	2.257
1994	1042.238	857.477	452.54	190.067	115.397	402.104	96.464	507.034	3.109
1994	1042.237	857.28	449.967	180.447	94.19	399.824	76.483	509.65	29.046
1994	1042.238	857.306	444.454	178.241	74.783	404.534	60.877	517.072	48.261
1994	1042.238	857.262	447.906	178.594	91.671	405.967	73.887	510.715	26.752
1994	1027.611	845.416	439.943	179.806	101.959	420.892	82.229	511.393	3.802
1994	1022.295	840.879	442.041	180.467	98.428	404.4	79.155	507.679	19.707
1994	1042.238	857.484	451.681	189.517	107.339	412.547	89.205	508.104	1.471
1994	1019.266	838.567	438.271	186.155	107.423	413.891	86.528	508.465	3.382
1994	1042.237	857.457	450.778	190.418	118.942	400.199	97.158	505.766	3.095
1994	1011.002	831.786	435.953	189.272	101.852	420.654	82.28	508.181	0.874
1994	1033.473	850.186	443.529	179.669	102.506	413.208	83.35	511.162	10.016
1995	919.669	743.169	459.923	171.534	122.774	359.451	111.674	479.741	2.757
1995	919.669	743.454	460.884	171.945	123.427	356.92	112.428	478.636	3.388
1995	919.669	744.027	467.017	168.245	130.197	332.084	119.315	472.817	15.179
1995	919.669	808.654	510.939	153.611	167.803	313.805	160.063	487.36	5.143
1995	919.669	743.736	470.485	175.597	132.804	329.423	122.234	467.2	9.173
1995	919.669	743.039	460.853	162.059	146.578	334.762	137.119	480.794	1.741
1995	919.669	743.405	475.289	177.734	142.157	317.409	131.385	460.759	5.154
1995	919.669	744.284	468.913	167.821	127.959	327.773	117.247	470.646	19.482
1995	919.669	743.246	472.157	176.45	140.748	324.316	130.187	465.207	3.935
1995	919.669	743.205	478.854	178.76	150.372	303.91	140.316	458.007	6.502
1995	919.111	745.427	470.95	171.941	148.672	324.155	140.226	475.073	3.323
1995	919.669	743.984	476.398	177.996	139.595	313.324	129.192	459.9	10.676
1995	919.669	743.114	461.551	171.213	127.017	350.889	116.386	478.513	5.139
1995	919.669	743.365	468.324	174.661	134.74	337.219	123.841	469.456	1.942
1995	919.669	744.759	474.66	167.777	133.46	309.97	122.538	464.746	25.852
1995	919.669	743.607	463.361	167.847	132.093	344.992	121.35	475.365	2.677
1995	919.669	744.223	474.95	169.33	141.697	310.14	131.666	464.501	15.811
1995	919.669	744.424	464.404	163.677	130.079	337.359	119.987	475.608	11.96
1995	919.35	745.273	475.781	162.344	143.012	299.629	131.624	465.759	27.678
1995	919.669	745.274	475.258	162.334	144.333	302.096	132.789	466.365	24.592
1995	919.669	743.47	467.32	167.051	140.394	332.762	129.945	470.491	1
1995	919.669	743.774	463.725	164.389	133.809	341.31	123.283	474.831	3.785

1995	919.669	745.396	472.342	162.027	131.949	307.676	120.212	468.336	34.21
1995	919.669	745.5	465.535	162.016	126.98	332.188	114.916	473.409	20.301
1995	919.669	744.371	468.339	164.002	133.402	325.616	122.673	470.871	16.156
1995	919.669	743.318	470.929	175.012	140.717	328.674	130.028	466.399	0.932
1995	919.669	743.36	467.283	166.152	141.498	331.495	131.063	470.385	0.986
1995	919.669	743.149	471.672	169.348	146.616	320.616	136.244	465.053	1.101
1995	919.669	745.053	475.977	162.381	146.853	298.959	135.351	465.935	24.612
1995	919.669	743.497	466.963	173.687	135.323	337.913	125.133	473.076	3.48
1995	919.669	743.415	468.366	174.119	138.863	334.644	128.775	471.599	1.444
1995	919.669	745.367	467.124	162.057	129.945	327.641	117.899	472.228	20.537
1995	919.669	743.169	476.031	178.44	145.974	314.909	135.116	459.366	2.345
1995	919.669	743.161	476.34	177.774	149.507	311.955	139.316	460.986	2.479
1995	919.669	743.185	470.245	175.332	139.682	328.872	129.308	468.317	3.395
1995	919.669	744.927	473.548	163.966	129.587	310.088	118.31	465.269	30.678
1995	919.669	744.716	469.75	163.103	106.552	315.674	95.714	467	50.577
1995	919.669	745.073	470.037	162.326	128.294	317.754	117.297	468.781	27.597
1995	906.762	733.022	452.73	163.243	128.575	352.046	117.923	480.372	4.219
1995	902.071	730.654	462.664	163.018	137.318	314.983	125.703	468.119	20.876
1995	919.669	743.122	466.437	174.16	133.115	341.587	122.236	471.831	1.629
1995	899.399	726.92	452.383	168.81	132.754	345.741	122.692	478.607	3.731
1995	919.669	743.376	469.292	173.788	142.155	329.247	132.782	472.367	3.377
1995	892.106	720.843	447.842	171.813	128.451	353.742	117.809	478.734	1.003
1995	911.935	737.682	460.281	163.604	130.408	338.14	119.717	474.918	10.786
1996	934.107	799.367	482.251	194.755	65.148	442.344	50.232	498.731	2.254
1996	934.107	799.328	480.697	194.956	68.041	440.53	52.576	499.955	2.846
1996	934.107	799.244	476.465	191.076	76.202	426.268	60.604	504.685	13.414
1996	934.107	866.796	524.259	175.755	126.678	396.666	99.716	507.52	4.587
1996	934.107	799.287	472.513	196.493	94.54	418.879	74.298	506.479	8.307
1996	934.107	799.384	473.46	184.512	98.566	418.957	77.287	503.054	1.478
1996	934.107	799.334	468.081	197.084	112.612	410.436	89.277	510.057	4.636
1996	934.107	799.205	475.618	190.373	75.994	423.509	60.315	505.638	17.462
1996	934.107	799.356	470.853	196.744	105.314	415.236	82.961	507.12	3.476
1996	934.107	799.362	465.784	197.918	125.919	398.437	99.418	509.957	5.854
1996	933.54	801.707	481.87	195.834	99.87	408.572	76.49	493.318	2.875
1996	934.107	799.25	467.228	197.387	112.055	406.642	88.643	510.72	9.78
1996	934.107	799.374	479.846	194.296	73.295	434.329	56.692	499.642	4.395
1996	934.107	799.34	474.932	195.78	91.91	425.48	72.221	504.306	1.672
1996	934.107	799.135	473.575	190.507	86.266	409.549	68.854	506.288	23.114
1996	934.107	799.306	475.911	189.674	84.393	430.743	65.521	503.182	2.276
1996	934.107	799.214	471.529	190.9	101.625	406.253	80.173	506.015	14.232
1996	934.107	799.183	474.73	185.985	83.785	423.771	65.143	504.059	10.533
1996	933.783	798.738	477.283	186.98	84.277	404.398	67.792	501.563	24.506
1996	934.107	799.057	477.517	187.425	84.16	406.938	67.834	501.229	21.569

1996	934.107	799.325	471.794	187.596	100.823	420.989	79.169	506.313	0.863
1996	934.107	799.282	474.208	185.843	88.767	427.293	69.082	504.499	3.316
1996	934.107	799.037	475.873	185.957	73.14	412.188	59.578	506.276	30.142
1996	934.107	799.02	474.954	184.684	62.423	437.411	52.25	511.383	17.758
1996	934.107	799.191	472.922	186.209	84.275	421.545	66.925	507.426	14.26
1996	934.107	799.346	472.043	195.411	103.14	418.6	81.288	506.063	0.799
1996	934.107	799.341	470.994	186.521	102.828	419.91	80.789	506.924	0.852
1996	934.107	799.369	467.555	188.693	115.177	412.105	91.258	510.196	0.983
1996	934.107	799.091	477.783	187.774	86.762	403.786	69.676	500.028	21.561
1996	934.107	799.322	477.65	196.107	88.043	423.958	68.353	500.139	3.012
1996	934.107	799.333	477.34	196.286	92.99	421.224	72.336	499.812	1.23
1996	934.107	799.042	475.149	185.277	66.149	432.884	54.964	509.806	17.832
1996	934.107	799.367	466.243	197.205	118.934	408.959	94.553	511.58	2.107
1996	934.107	799.367	468.352	197.473	120.087	404.772	94.822	507.85	2.209
1996	934.107	799.365	473.683	196.525	99.471	417.811	77.92	503.983	3.007
1996	934.107	799.11	471.406	186.382	78.04	416.25	63.696	511.593	27.167
1996	934.107	799.141	466.885	182.281	61.055	422.386	50.458	522.209	45.767
1996	934.107	799.088	472.504	183.547	72.657	423.761	59.441	512.588	25.106
1996	920.998	788.11	470.726	185.787	76.082	435.308	58.275	501.497	3.599
1996	916.233	783.822	465.353	186.734	78.237	420.684	63.949	507.447	18.207
1996	934.107	799.373	476.397	195.75	86.998	428.581	68.06	502.79	1.402
1996	913.519	781.731	469.474	192.119	79.401	429.214	60.839	497.733	3.187
1996	934.107	799.338	478.283	196.664	95.743	415.165	73.979	497.258	2.955
1996	906.112	775.417	467.786	195.124	71.796	436.913	55.173	497.088	0.813
1996	926.252	792.536	470.973	185.89	80.955	427.2	63.163	504.422	9.54
1997	1005.427	710.403	396.869	181.003	150.147	388.552	122.299	519.703	2.582
1997	1005.427	710.679	399.367	181.034	148.965	386.998	121.471	517.818	3.079
1997	1005.427	711.23	410.278	176.624	155.293	358.525	125.238	505.06	14.824
1997	1005.427	777.034	461.753	160.244	176.675	355.556	148.909	517.57	4.758
1997	1005.427	710.951	424.895	181.248	138.294	368.732	113.528	496.311	7.787
1997	1005.427	710.278	405.848	169.773	162.09	370.018	134.322	513.215	1.587
1997	1005.427	710.632	438.189	181.341	135.549	362.294	111.831	484.773	4.235
1997	1005.427	711.473	413.32	175.956	154.717	352.105	124.071	501.42	18.846
1997	1005.427	710.478	430.491	181.273	140.83	365.357	116.281	491.411	3.252
1997	1005.427	710.438	448.574	181.417	136.845	350.122	114.221	476.433	5.391
1997	1004.817	712.73	422.466	180.037	163.481	353.636	137.463	501.597	3.062
1997	1005.427	711.19	440.684	181.38	132.27	358.772	109.038	482.857	8.756
1997	1005.427	710.351	402.255	180.073	150.043	381.786	122.888	515.907	4.823
1997	1005.427	710.593	418.924	180.966	144.001	374.836	118.275	501.193	1.65
1997	1005.427	711.922	425.276	174.942	154.688	335.099	124.599	491.197	24.962
1997	1005.427	710.827	406.865	175.208	146.02	383.706	121.361	513.96	2.394
1997	1005.427	711.416	430.558	175.2	154.215	340.5	126.065	488.277	14.876
1997	1005.427	711.605	406.959	171.224	144.593	376.594	120.615	514.674	10.988

1997	1005.078	712.407	422.25	171.332	172.51	317.403	139.879	492.266	27.831
1997	1005.427	712.409	420.97	171.307	174.541	320.05	141.561	493.87	25.037
1997	1005.427	710.695	418.173	172.627	143.643	377.028	120.207	504.775	0.881
1997	1005.427	710.988	407.982	171.224	144.276	383.649	120.76	514.296	3.348
1997	1005.427	712.525	416.36	171.28	161.542	326.521	129.166	496.953	34.729
1997	1005.427	712.624	401.767	171.163	161.448	353.869	126.619	507.713	20.946
1997	1005.427	711.556	413.459	171.236	154.489	355.709	125.429	503.46	15.738
1997	1005.427	710.547	425.455	180.169	140.769	373.022	117.347	497.712	0.785
1997	1005.427	710.587	419.107	171.519	143.664	376.191	120.27	504.017	0.872
1997	1005.427	710.384	431.326	173.204	140.445	367.412	117.295	492.307	0.9
1997	1005.427	712.198	422.786	171.311	176.603	316.514	143.713	492.613	25.033
1997	1005.427	710.72	415.319	181.164	149.9	371.138	123.802	504.766	3.184
1997	1005.427	710.641	416.716	181.186	147.877	374.022	123.994	506.05	1.29
1997	1005.427	712.498	404.768	171.181	163.711	348.713	129.171	505.716	21.397
1997	1005.427	710.404	441.347	181.35	135.553	361.829	112.05	482.246	1.87
1997	1005.427	710.396	441.44	181.359	141.385	355.782	117.77	482.458	2.126
1997	1005.427	710.419	424.95	181.228	145.255	366.631	120.134	496.378	2.992
1997	1005.427	712.079	420.666	171.282	159.609	328.572	125.126	490.792	30.723
1997	1005.427	711.881	415.052	171.241	135.35	335.619	102.791	493.06	49.483
1997	1005.427	712.217	412.722	171.203	159.454	337.466	125.699	496.694	27.183
1997	991.317	700.706	390.663	171.672	147.162	391.54	123.366	525.273	3.862
1997	986.188	698.436	407.246	171.239	169.249	334.148	134.506	496.836	21.373
1997	1005.427	710.358	412.528	181.142	142.357	383.063	118.554	509.466	1.433
1997	983.267	694.872	394.986	177.568	153.393	378.29	127.649	516.121	3.459
1997	1005.427	710.603	420.572	181.203	154.986	361.541	129.148	500.736	3.054
1997	975.294	689.061	386.364	181.035	148.528	390.988	124.331	522.748	0.928
1997	996.972	705.165	402.524	171.186	149.701	373.688	123.503	513.755	10.053
1998	981.76	726.991	483.324	176.767	111.995	467.152	115.065	591.914	2.766
1998	981.76	727.119	481.964	177.102	114.155	465.447	117.025	592.829	3.377
1998	981.76	727.378	481.302	173.943	135.462	431.274	135.697	590.271	15.608
1998	981.76	795.52	521.633	159.003	175.125	413.297	173.105	601.251	5.318
1998	981.759	727.248	472.364	180.045	135.286	445.608	136.19	598.223	8.958
1998	981.759	726.933	476.345	167.299	145.743	439.523	146.336	595.93	1.775
1998	981.76	727.098	465.963	181.604	150.573	439.141	150.683	602.786	5.035
1998	981.759	727.491	480.587	173.662	136.84	425.55	137.267	590.803	20.236
1998	981.76	727.026	469.715	180.668	145.977	442.025	146.491	600.268	3.869
1998	981.76	727.008	464.057	182.726	164.101	424.995	163.05	603.015	6.564
1998	981.164	729.404	485.666	178.142	151.037	424.598	150.415	586.903	3.402
1998	981.76	727.36	465.838	181.897	149.378	434.94	149.197	602.318	10.363
1998	981.76	726.967	481.215	176.49	119.829	458.409	122.043	592.77	5.133
1998	981.76	727.08	474.221	179.142	134.177	452.455	135.654	597.551	1.896
1998	981.76	727.698	479.91	173.857	148.766	406.334	147.725	589.161	27.004
1998	981.76	727.189	475.358	172.539	127.892	457.72	128.138	595.82	2.656

1998	981.759	727.465	475.089	174.693	156.506	413.465	155.994	594.3	16.413
1998	981.759	727.553	476.523	168.919	128.51	446.295	127.114	592.724	12.079
1998	981.419	727.772	488.325	169.919	161.701	382.675	158.323	579.137	29.423
1998	981.76	727.917	488.44	169.75	162.501	385.197	159.021	579.287	26.298
1998	981.76	727.127	469.049	171.289	140.12	452.061	139.558	600.238	0.974
1998	981.76	727.265	472.62	168.942	130.456	456.447	129.741	597.21	3.708
1998	981.76	727.968	486.688	169.366	147.18	392.703	144.307	581.255	36.216
1998	981.759	728.011	483.327	167.977	137.202	422.214	135.76	586.981	21.315
1998	981.76	727.53	476.764	169.323	143.092	426.329	142.077	593.005	16.701
1998	981.76	727.059	470.509	179.2	143.939	446.485	143.366	598.518	0.908
1998	981.76	727.077	467.71	170.325	141.546	451.843	140.965	601.455	0.956
1998	981.76	726.982	463.479	173.172	150.944	445.416	150.494	604.93	1.052
1998	981.76	727.823	488.715	169.919	165.937	381.33	162.267	578.809	26.29
1998	981.76	727.139	478.998	178.849	133.575	447.166	134.821	593.172	3.538
1998	981.76	727.102	478.326	179.182	138.546	444.587	137.531	591.26	1.442
1998	981.76	727.956	483.944	168.261	141.665	416.571	139.907	585.972	21.612
1998	981.76	726.992	463.206	181.972	156.107	438.711	156.173	605.248	2.244
1998	981.759	726.988	466.843	181.871	159.892	431.14	159.456	601.474	2.515
1998	981.76	726.999	473.562	179.966	142.34	442.858	143.059	597.203	3.436
1998	981.76	727.769	479.465	169.915	151.95	398.625	151.026	590.109	32.187
1998	981.76	727.679	473.675	169.387	128.069	408.63	127.975	596	52.326
1998	981.76	727.832	480.183	168.782	146.99	407.393	145.703	589.885	28.725
1998	967.982	716.915	470.625	168.147	121.852	461.128	120.993	593.412	4.215
1998	962.974	713.836	473.811	169.282	155.55	402.174	153.774	586.494	22.05
1998	981.76	726.97	476.098	178.782	130.616	454.948	130.165	594.027	1.595
1998	960.121	711.027	471.353	174.293	127.457	451.043	127.863	590.151	3.784
1998	981.759	727.084	480.705	179.345	143.275	435.414	143.575	590.467	3.409
1998	952.336	705.18	469.284	177.175	119.786	460.198	118.969	587.207	1
1998	973.504	721.223	472.27	168.598	132.165	444.215	131.434	594.041	10.928
1999	901.608	791.886	488.138	179.379	89.27	250.672	70.275	327.919	2.534
1999	901.608	792.003	486.889	179.529	91.513	249.245	72.375	329.324	3.148
1999	901.608	792.232	482.089	174.798	93.528	242.371	78.139	340.035	14.417
1999	901.608	860.037	526.868	159.168	141.875	218.11	116.35	346.364	4.921
1999	901.608	792.116	474.568	180.561	115.082	234.221	94.176	342.989	8.834
1999	901.608	791.833	477.707	168.52	119.197	233.52	96.282	337.252	1.595
1999	901.608	791.983	468.015	180.896	132.05	228.951	109.638	350.1	4.899
1999	901.608	792.332	481.065	174.055	92.523	240.917	77.761	342.154	18.365
1999	901.608	791.918	471.648	180.813	125.879	231.837	103.628	345.442	3.698
1999	901.608	791.901	463.461	181.534	144.861	219.853	120.718	353.99	6.201
1999	901.06	794.244	483.336	178.9	123.29	224.807	99.189	333.144	3.137
1999	901.608	792.215	466.722	181.308	130.86	225.921	108.672	351.444	10.289
1999	901.608	791.864	484.993	178.615	96.381	244.85	76.644	331.173	4.891
1999	901.608	791.966	477.576	179.908	113.777	239.327	92.684	339.465	1.782

1999	901.608	792.518	477.988	173.473	99.948	231.407	85.396	346.707	24.307
1999	901.608	792.065	479.97	173.976	106.721	242.612	85.983	336.36	2.467
1999	901.608	792.309	473.544	174.279	117.635	227.546	98.804	347.478	14.917
1999	901.607	792.387	479.292	169.373	104.618	237.472	84.625	338.668	11.336
1999	901.295	792.551	483.79	168.947	94.906	229.46	83.102	344.172	25.947
1999	901.608	792.723	484.213	169.515	95.015	231.339	83.256	343.251	22.968
1999	901.608	792.009	473.337	171.918	121.902	236.463	99.73	343.146	0.911
1999	901.608	792.132	477.587	170.113	110.47	240.415	89.392	338.86	3.573
1999	901.608	792.772	483.249	167.57	84.368	235.369	74.07	346.672	32.108
1999	901.608	792.814	484.189	168.186	74.846	254.943	66.474	345.27	19.111
1999	901.608	792.367	477.56	169.766	100.586	239.42	84.637	344.755	15.217
1999	901.608	791.948	473.226	179.608	124.136	234.635	101.949	343.605	0.845
1999	901.608	791.964	472.285	170.824	123.718	235.844	101.372	344.236	0.887
1999	901.608	791.878	467.163	172.914	134.873	230.442	111.71	349.867	1.014
1999	901.608	792.634	483.894	169.584	97.825	228.937	85.564	343.295	22.977
1999	901.608	792.02	480.814	180.112	110.623	237.235	89.206	335.214	3.299
1999	901.608	791.987	479.788	180.224	115.592	235.501	93.57	336.115	1.335
1999	901.608	792.76	483.995	168.246	78.617	251.397	69.602	345.218	19.305
1999	901.608	791.886	465.295	181.327	138.153	228.224	115.149	352.478	2.192
1999	901.608	791.883	467.196	181.229	139.879	224.446	116.033	349.778	2.345
1999	901.608	791.893	475.182	180.524	120.92	233.343	98.785	341.361	3.228
1999	901.608	792.583	477.041	168.857	88.973	239.502	78.666	352.397	28.829
1999	901.608	792.501	473.19	164.633	72.221	244.466	64.463	361.596	48.158
1999	901.608	792.642	479.289	166.895	84.31	245.183	74.533	351.264	26.395
1999	888.955	780.888	475.643	170.244	99.142	245.592	78.821	333.277	3.962
1999	884.356	777.41	471.878	169.525	90.004	242.429	79.372	346.81	19.535
1999	901.608	791.867	479.596	180.124	109.373	241.429	88.536	336.923	1.518
1999	881.736	774.487	473.517	176.163	103.108	240.535	82.008	331.142	3.525
1999	901.608	791.971	480.055	180.214	118.671	230.436	95.849	335.328	3.212
1999	874.586	768.132	472.686	179.486	96.13	246.632	76.029	328.305	0.899
1999	894.026	785.536	475.442	170.071	100.475	241.598	82.188	339.202	10.202
2000	1164.83	755.417	443.121	201.51	104.329	639.901	86.657	733.844	2.53
2000	1164.83	755.566	443.678	201.673	104.836	636.811	87.357	732.045	3.077
2000	1164.83	755.864	448.622	198.341	122.936	601.312	100.778	722.068	14.659
2000	1164.83	823.329	495.54	182.788	156.081	590.568	136.754	739.62	4.878
2000	1164.83	755.712	448.577	203.035	111.865	619.938	96.273	729.735	8.177
2000	1164.83	755.348	442.026	191.385	130.619	611.865	112.582	732.217	1.608
2000	1164.83	755.541	450.785	203.56	118.308	614.64	103.793	728.773	4.543
2000	1164.83	755.996	449.645	197.786	123.08	595.332	100.596	720.065	18.857
2000	1164.83	755.458	449.385	203.262	118.598	617.773	103.279	730.266	3.471
2000	1164.83	755.436	452.972	204.359	127.341	603.278	113.009	728.479	5.882
2000	1164.123	757.784	452.026	202.74	134.922	597.43	116.646	723.577	3.115
2000	1164.83	755.842	451.48	203.79	116.729	610.967	102.319	728.393	9.39

2000	1164.83	755.388	444.208	201.071	108.963	628.928	91.468	730.181	4.759
2000	1164.83	755.52	447.369	202.4	113.279	625.446	97.24	729.791	1.714
2000	1164.83	756.24	453.858	197.742	132.086	576.073	108.361	715.515	25.434
2000	1164.83	755.646	444.296	196.356	111.813	630.032	95.216	732.93	2.425
2000	1164.83	755.965	452.822	197.98	134.125	585.962	113.399	720.761	15.342
2000	1164.83	756.068	445.154	192.876	113.611	618.154	96.199	730.859	11.224
2000	1164.426	756.366	457.163	194.93	152.562	547.68	123.144	705.035	27.993
2000	1164.83	756.5	456.793	194.766	153.971	550.6	124.022	705.961	25.076
2000	1164.83	755.575	445.688	194.217	118.24	622.164	102.637	731.387	0.898
2000	1164.83	755.732	443.947	192.509	113.291	626.818	97.004	732.599	3.419
2000	1164.83	756.561	454.215	194.273	138.205	558.137	110.137	708.333	34.495
2000	1164.83	756.613	448.375	192.455	129.115	588.827	101.307	715.546	20.313
2000	1164.83	756.041	448.604	193.137	127.063	597.293	104.897	723.396	15.666
2000	1164.83	755.496	448.536	201.948	118.404	619.072	102.905	728.517	0.822
2000	1164.83	755.517	445.723	193.149	118.804	621.114	103.379	731.11	0.885
2000	1164.83	755.407	447.837	195.241	122.499	617.103	107.875	731.943	0.961
2000	1164.83	756.389	457.45	194.978	157.138	546.924	127.004	705.383	25.039
2000	1164.83	755.589	447.547	202.799	116.826	619.869	99.8	728.413	3.241
2000	1164.83	755.546	448.141	202.965	120.212	616.542	103.289	726.844	1.318
2000	1164.83	756.547	449.683	192.804	133.139	583.172	104.912	713.965	20.587
2000	1164.83	755.417	450.748	203.594	121.103	613.514	106.906	728.415	2.017
2000	1164.83	755.413	451.718	203.963	126.9	606.946	111.983	727.44	2.274
2000	1164.83	755.426	448.66	203.132	119.13	617.39	103.055	729.285	3.129
2000	1164.83	756.325	453.072	193.726	135.646	568.206	108.36	712.476	30.413
2000	1164.83	756.218	448.76	192.811	107.733	579.038	84.466	716.329	48.528
2000	1164.83	756.399	450.994	192.834	132.599	575.131	105.923	713.243	26.826
2000	1148.483	744.963	435.425	192.535	109.883	631.839	92.698	733.514	3.877
2000	1142.542	741.844	444.103	193.595	143.837	570.244	114.997	712.015	20.959
2000	1164.83	755.393	446.406	202.379	112.449	626.457	96.021	729.25	1.46
2000	1139.157	738.836	435.095	198.916	115.956	623.949	98.193	731.005	3.475
2000	1164.83	755.526	449.368	203.424	125.582	608.266	108.182	725.523	3.124
2000	1129.92	732.749	431.197	201.903	110.647	631.042	92.837	729.888	0.918
2000	1155.035	749.462	441.476	192.606	117.769	614.068	98.32	727.851	10.166
2001	1076.591	722.949	441.8	168.082	196.659	398.657	177.806	589.227	3.456
2001	1076.591	723.157	441.48	168.692	197.95	397.472	179.194	590.258	4.198
2001	1076.591	723.57	446.058	168.194	198.496	374.766	184.126	587.398	18.592
2001	1076.591	788.616	490.803	150.055	242.836	355.326	224.411	598.075	6.402
2001	1076.591	723.361	452.592	174.551	201.322	371.409	184.967	577.279	10.963
2001	1076.591	722.854	441.941	158.735	221.111	376.617	202.44	591.926	2.144
2001	1076.591	723.122	458.144	178.104	208.696	360.387	193.159	570.146	6.089
2001	1076.591	723.752	447.954	167.963	195.314	371.36	182.109	586.564	23.241
2001	1076.591	723.006	454.951	175.877	209.209	365.932	192.931	573.947	4.665
2001	1076.591	722.976	462.832	179.516	215.393	345.911	200.508	565.092	7.689

2001	1075.938	725.235	454.194	168.525	222.059	364.946	204.343	584.252	4.109
2001	1076.591	723.54	459.447	178.397	204.77	356.387	189.858	569.192	12.594
2001	1076.591	722.909	442.722	168.052	200.556	392.211	182.118	590.37	6.466
2001	1076.591	723.093	450.536	173.217	205.38	379.22	188.152	579.75	2.316
2001	1076.591	724.086	453.616	169.683	197.359	353.494	186.144	580.796	30.937
2001	1076.591	723.268	444.348	165.594	204.675	386.312	186.764	586.249	3.269
2001	1076.591	723.709	455.588	170.07	207.997	352.656	195.317	577.522	18.868
2001	1076.591	723.85	444.042	161.558	201.349	378.795	184.203	587.362	14.561
2001	1076.217	724.374	452.811	165.967	206.275	343.682	196.555	584.609	33.524
2001	1076.591	724.444	452.309	165.963	208.045	345.867	198.137	584.89	29.958
2001	1076.591	723.169	449.497	166.033	210.29	376.108	193.153	580.84	1.2
2001	1076.591	723.389	444.611	162.485	205.453	383.895	187.815	586.323	4.612
2001	1076.591	724.53	449.072	165.717	193.144	352.026	183.066	586.819	41.634
2001	1076.591	724.603	441.248	165.012	191.188	377.902	179.572	592.235	24.965
2001	1076.591	723.813	447.068	164.567	200.538	368.537	187.305	585.598	19.587
2001	1076.591	723.059	453.604	174.236	210.086	371.92	193.364	576.803	1.103
2001	1076.591	723.089	449.267	165.307	211.277	375.324	194.174	581.117	1.174
2001	1076.591	722.935	454.624	169.568	213.897	363.825	197.58	573.424	1.279
2001	1076.591	724.291	453.41	166.055	210.387	342.387	200.689	584.103	29.946
2001	1076.591	723.188	448.925	171.235	207.648	379.056	189.939	583.386	4.301
2001	1076.591	723.129	451.152	171.868	210.654	376.713	193.127	581.895	1.762
2001	1076.591	724.51	442.904	165.188	194.096	372.954	182.803	591.115	25.367
2001	1076.591	722.949	458.852	179.199	212.439	359.075	196.963	569.509	2.722
2001	1076.591	722.944	459.593	177.904	216.834	354.758	201.127	569.789	2.957
2001	1076.591	722.961	452.877	174	209.644	370.359	192.775	577.589	4.108
2001	1076.591	724.203	450.777	167.491	190.393	354.999	181.971	584.141	37.061
2001	1076.591	724.056	446.817	166.129	163.615	362.674	155.474	587.321	60.531
2001	1076.591	724.305	446.852	165.363	191.132	363.773	181.332	588.27	33.188
2001	1061.482	713.01	433.526	160.158	202.388	393.845	184.033	592.812	5.25
2001	1055.991	710.332	439.986	166.367	200.943	359.435	191.09	586.559	25.502
2001	1076.591	722.915	448.894	172.248	204.367	383.987	186.76	582.675	1.984
2001	1052.863	707.111	434.68	165.419	206.473	385.686	188.12	588.381	4.663
2001	1076.591	723.1	452.348	171.129	214.19	370.44	196.723	581.79	4.147
2001	1044.326	701.244	430.918	168.323	202.417	394.457	183.695	589.037	1.242
2001	1067.538	717.423	440.23	162.301	200.672	381.252	185.029	589.251	13.066
2002	1046.583	723.462	434.014	177.943	196.527	466.029	142.161	618.142	3.291
2002	1046.583	723.656	433.988	178.114	198.433	464.267	143.82	618.917	4.092
2002	1046.583	724.041	434.415	174.337	204.626	445.346	150.078	622.077	19.638
2002	1046.583	790.353	481.218	158.349	260.71	410.564	199.987	626.565	6.568
2002	1046.583	723.846	433.713	179.595	219.904	439.77	162.25	621.128	11.654
2002	1046.583	723.373	431.557	167.422	231.632	436.851	173.055	620.047	2.022
2002	1046.583	723.623	432.494	180.359	237.637	431.398	177.077	622.881	6.341
2002	1046.583	724.209	434.677	173.821	202.244	442.731	148.085	622.554	24.835

2002	1046.583	723.515	433.371	179.876	232.476	435.268	172.776	620.711	4.749
2002	1046.583	723.487	434.164	180.881	251.028	414.962	188.629	620.238	8.069
2002	1045.948	725.8	443.788	177.928	235.254	420.059	176.007	608.408	4.127
2002	1046.583	724.013	433.101	180.517	234.983	426.36	175.021	622.825	13.487
2002	1046.583	723.424	434.204	177.3	203.617	457.077	148.538	619.075	6.51
2002	1046.583	723.596	433.483	179.022	220.625	448.22	162.538	620.489	2.236
2002	1046.583	724.52	437.124	173.382	210.125	425.747	155.061	621.313	33.308
2002	1046.583	723.76	431.502	172.877	213.305	454.835	156.508	621.744	3.119
2002	1046.583	724.17	436.034	173.887	227.447	422.37	169.279	619.619	20.152
2002	1046.583	724.301	431.828	169.042	209.912	445.402	154.337	621.941	15.009
2002	1046.22	724.765	441.349	169.643	212.693	416.275	157.756	617.452	35.988
2002	1046.583	724.851	441.285	169.539	214.218	418.861	158.935	617.439	32.15
2002	1046.583	723.667	430.53	170.907	228.284	445.975	169.297	624.189	1.11
2002	1046.583	723.872	430.207	169.072	216.257	452.781	159.176	623.947	4.595
2002	1046.583	724.93	438.07	169.366	197.449	426.334	145.301	623.037	44.567
2002	1046.583	724.996	430.534	168.686	192.388	457.242	140.418	630.773	26.508
2002	1046.583	724.267	432.137	169.283	210.931	441.274	155.465	624.679	20.703
2002	1046.583	723.564	432.803	178.625	231.467	441.147	171.79	621.857	1.035
2002	1046.583	723.592	429.928	169.864	229.968	445.382	170.787	625.094	1.052
2002	1046.583	723.448	429.796	172.086	241.089	435.681	180.26	625.417	1.233
2002	1046.583	724.709	442.246	169.604	217.246	414.822	161.475	616.059	32.147
2002	1046.583	723.685	436.298	178.955	218.582	443.454	161.095	616.384	4.35
2002	1046.583	723.63	436.45	179.12	224.589	440.867	166.168	616.439	1.706
2002	1046.583	724.911	432.37	168.806	196.029	451.342	143.533	628.54	26.911
2002	1046.583	723.462	431.254	180.546	244.302	430.976	182.679	624.721	2.759
2002	1046.583	723.457	434.244	180.473	247.487	423.005	185.604	620.123	3.041
2002	1046.583	723.473	434.852	179.52	228.257	437.323	169.275	618.638	4.241
2002	1046.583	724.628	433.51	169.611	201.639	432.87	148.408	627.966	39.798
2002	1046.583	724.492	427.389	169.45	171.627	443.019	124.228	637.53	64.567
2002	1046.583	724.722	431.721	169.243	197.239	442.061	144.907	628.997	35.257
2002	1031.895	713.501	424.391	168.942	205.189	460.943	149.763	622.86	5.13
2002	1026.557	710.75	426.749	169.278	208.248	436.536	153.693	624.696	27.267
2002	1046.583	723.43	433.481	178.954	216.767	451.969	159.295	620.58	1.951
2002	1023.516	707.606	425.842	174.909	211.411	449.088	155.187	616.164	4.623
2002	1046.583	723.603	439.213	179.167	228.169	430.939	169.54	612.583	4.233
2002	1015.217	701.743	422.735	178.127	204.68	459.263	149.096	616.47	1.133
2002	1037.782	717.894	427.429	168.914	208.113	451.018	152.616	624.392	13.638
2003	1204.36	817.906	471.659	178.659	121.713	575.463	133.412	720.129	3.014
2003	1204.359	818.03	471.191	178.831	124.446	572.459	135.807	720.373	3.76
2003	1204.359	818.276	469.096	174.678	132.255	554.464	139.796	719.029	16.325
2003	1204.36	885.625	517.066	158.849	187.392	524.188	191.699	733.031	5.815
2003	1204.359	818.151	469.448	180.084	153.105	538.937	161.54	720.573	10.587
2003	1204.359	817.849	464.428	167.992	157.718	547.806	166.097	725.839	1.981

2003	1204.359	818.009	469.019	180.689	172.643	524.569	179.838	720.806	6.009
2003	1204.359	818.384	468.69	174.143	130.836	551.326	138.21	719.152	21.277
2003	1204.359	817.94	469.095	180.283	165.53	532.97	173.446	721.102	4.57
2003	1204.359	817.921	467.779	181.127	188.801	508.142	194.67	721.576	7.661
2003	1203.628	820.229	471.907	178.489	165.743	532.805	173.535	720.343	3.754
2003	1204.359	818.258	468.518	180.853	171.935	519.35	178.643	720.752	12.461
2003	1204.36	817.882	470.365	177.962	130.761	565.15	141.408	720.792	5.613
2003	1204.359	817.991	470.376	179.535	150.671	548.714	160.016	720.456	2.239
2003	1204.36	818.582	469.251	173.535	142.408	532.345	147.57	716.928	28.291
2003	1204.359	818.096	469.849	173.424	140.741	558.394	150.83	721.327	3.04
2003	1204.359	818.359	468.561	174.114	159.699	526.496	165.78	719.499	17.537
2003	1204.359	818.443	468.598	169.593	138.955	551.297	148.001	721.49	13.298
2003	1203.942	818.616	470.381	169.597	142.931	529.236	145.661	713.22	29.712
2003	1204.359	818.792	470.637	169.484	143.273	532.377	146.163	713.339	26.145
2003	1204.359	818.037	468.443	171.285	158.752	543.736	167.512	722.256	1.156
2003	1204.36	818.168	468.978	169.559	144.677	554.135	154.287	721.917	4.281
2003	1204.359	818.842	468.413	169.341	128.555	539.121	131.791	715.118	36.309
2003	1204.359	818.886	466.949	168.747	114.505	569.752	120.046	718.337	21.104
2003	1204.359	818.421	467.855	169.539	138.708	548.335	145.728	720.165	17.381
2003	1204.359	817.971	469.303	179.041	162.968	538.688	171.538	721.352	1.087
2003	1204.359	817.989	468.1	170.21	160.684	542.194	169.26	722.543	1.155
2003	1204.359	817.897	467.237	172.335	174.711	528.958	182.159	722.96	1.308
2003	1204.359	818.703	470.935	169.525	146.851	528.52	149.472	712.957	26.152
2003	1204.36	818.049	470.325	179.545	148.248	549.446	157.719	720.48	3.914
2003	1204.36	818.013	470.45	179.673	154.21	545.62	163.326	720.276	1.641
2003	1204.359	818.83	467.343	168.844	119.612	564.222	124.664	717.69	21.157
2003	1204.359	817.906	467.818	180.823	179.472	522.165	186.545	722.199	2.77
2003	1204.359	817.903	468.064	180.774	182.77	518.455	189.582	721.834	2.904
2003	1204.359	817.913	469.333	179.982	160.088	538.717	168.641	721.17	3.909
2003	1204.359	818.651	466.709	169.578	130.179	542.893	134.577	718.159	32.625
2003	1204.359	818.565	461.692	169.443	106.016	549.934	111.054	722.516	54.732
2003	1204.359	818.711	466.067	169.213	124.275	552.224	129.229	719.119	29.839
2003	1187.458	806.55	462.941	169.531	130.589	567.219	141.422	721.936	4.675
2003	1181.314	802.979	459.282	169.25	133.524	548.785	137.941	716.867	21.854
2003	1204.359	817.885	470.407	179.494	145.55	554.138	155.474	720.733	1.837
2003	1177.815	799.936	460.103	175.544	138.251	559.065	148.453	720.637	4.131
2003	1204.359	817.996	470.175	179.723	159.021	538.93	167.507	720.159	3.82
2003	1168.265	793.37	457.571	178.812	130.3	568.661	141.445	719.874	1.117
2003	1194.232	811.358	464.929	169.357	135.189	556.205	144.186	720.96	11.878
2004	876.712	743.952	469.915	177.983	84.008	352.185	84.464	445.345	2.43
2004	876.712	743.995	469.888	178.557	85.067	350.202	85.837	445.385	2.982
2004	876.712	744.075	468.077	175.828	84.447	341.32	88.866	449.603	12.833
2004	876.712	809.692	512.965	161.466	126.835	314.858	126.991	455.295	4.552

2004	876.712	744.035	468.07	183.941	98.01	329.944	101.609	447.03	8.049
2004	876.712	743.932	465.943	169.402	106.638	332.206	107.368	448.871	1.595
2004	876.712	743.988	467.006	186.962	108.241	321.918	113.609	448.308	4.551
2004	876.712	744.108	468.204	175.471	82.629	339.232	87.26	449.402	16.418
2004	876.712	743.964	467.816	185.137	105.169	326.658	109.46	447.547	3.481
2004	876.712	743.958	467.223	188.713	116.318	311.23	122.379	448.15	5.723
2004	876.18	746.246	475.151	180.151	107.292	322.746	108.733	442.307	2.95
2004	876.712	744.069	467.003	187.387	106.732	318.356	112.196	448.065	9.368
2004	876.712	743.944	469.522	178.102	88.498	345.136	89.368	445.576	4.484
2004	876.712	743.982	468.608	182.605	98.215	336.261	101.316	446.745	1.767
2004	876.712	744.167	468.703	176.594	86.848	327.593	93.1	449.257	21.656
2004	876.712	744.017	467.759	175.163	94.459	341.551	96.344	447.387	2.44
2004	876.712	744.1	468.497	178.336	99.066	322.751	104.336	448.135	13.416
2004	876.712	744.125	467.167	171.29	92.721	336.016	94.614	447.943	10.392
2004	876.407	744.011	470.229	171.343	85.718	326.956	93.685	450.591	22.998
2004	876.712	744.234	470.271	171.454	86.029	329.307	94.064	450.583	20.231
2004	876.712	743.997	466.094	175.195	103.808	333.101	107.072	448.898	0.956
2004	876.712	744.04	466.624	171.906	96.726	338.81	98.89	448.326	3.408
2004	876.712	744.25	467.849	170.466	76.863	333.621	84.721	453.009	28.328
2004	876.712	744.264	464.251	169.185	70.556	355.685	78.695	457.08	16.789
2004	876.712	744.119	466.288	172.056	87.995	337.56	92.952	450.912	13.545
2004	876.712	743.975	467.752	183.48	104.645	330.143	108.594	447.492	0.867
2004	876.712	743.981	465.69	174.363	104.885	332.181	108.286	449.291	0.974
2004	876.712	743.949	464.989	178.33	111.31	324.608	116.023	450.049	1.043
2004	876.712	744.205	470.766	171.692	88.028	326.64	96.065	450.038	20.218
2004	876.712	744.001	470.306	181.429	97.179	335.455	99.247	445.027	3.064
2004	876.712	743.989	470.364	182.064	100.597	333.139	102.998	444.949	1.304
2004	876.712	744.246	465.165	169.61	73.179	351.783	81.355	456.073	16.842
2004	876.712	743.952	466.212	187.837	111.954	320.647	117.803	449.089	2.126
2004	876.712	743.951	467.953	187.247	114.016	317.317	119.303	447.445	2.214
2004	876.712	743.955	469.02	183.685	102.774	329.433	106.139	446.301	3.001
2004	876.712	744.189	465.948	172.566	76.837	336.734	85.005	453.41	25.291
2004	876.712	744.161	461.668	169.81	61.912	340.995	69.453	458.569	42.834
2004	876.712	744.207	465.001	169.57	75.4	343.409	83.192	456.411	23.604
2004	864.408	733.554	460.78	169.937	90.049	346.312	90.811	447.547	3.755
2004	859.936	729.946	457.982	171.526	80.414	341.106	88.652	453.438	17.07
2004	876.712	743.945	468.791	181.769	95.876	339.394	98.345	446.396	1.457
2004	857.389	727.575	459.926	175.9	93.2	340.758	93.987	444.932	3.292
2004	876.712	743.983	471.823	181.926	102.89	327.977	105.029	443.632	2.98
2004	850.437	721.648	456.631	178.549	88.867	347.555	89.473	444.542	0.913
2004	869.339	737.806	463.051	171.063	89.236	340.636	92.035	448.69	9.238
2005	980.806	792.042	468.602	160.539	68.204	433.121	60.454	499.768	2.116
2005	980.806	792.145	468.858	161.515	69.196	430.982	61.168	498.883	2.603

2005	980.806	792.35	467.619	167.727	80.425	401.992	69.232	488.342	12.607
2005	980.806	862.028	516.692	155.731	106.439	394.743	91.442	496.463	4.035
2005	980.805	792.247	470.572	174.243	78.448	408.066	67.478	487.322	7.103
2005	980.805	791.994	463.447	158.203	88.053	413.02	76.312	495.883	1.356
2005	980.806	792.128	472.085	180.929	86.397	398.054	73.191	480.3	3.944
2005	980.805	792.439	467.889	167.574	80.956	397.059	69.438	487.536	16.554
2005	980.806	792.07	471.111	177.569	84.188	403.742	71.805	483.534	2.996
2005	980.806	792.055	472.183	187.094	92.432	386.456	77.61	474.475	4.938
2005	980.211	794.478	471.498	173.19	87.278	402.408	75.391	485.575	2.574
2005	980.806	792.335	471.685	182.38	84.705	394.823	72.004	480.103	8.226
2005	980.806	792.022	468.392	162.654	72.089	425.626	63.24	497.148	3.99
2005	980.806	792.113	470.713	171.266	79.075	414.603	68.197	488.983	1.493
2005	980.806	792.601	469.78	172.369	87.607	379.607	74.413	480.539	21.731
2005	980.806	792.201	468.668	162.05	76.053	420.901	66.273	493.778	2.076
2005	980.806	792.418	469.911	173.721	91.96	384.075	77.577	479.927	13.144
2005	980.805	792.487	467.209	159.185	76.906	412.936	66.77	493.833	9.599
2005	980.465	792.596	470.048	171.828	96.104	364.155	81.721	474.531	23.565
2005	980.806	792.781	470.19	171.834	96.702	366.394	82.245	474.616	20.856
2005	980.806	792.151	469.123	165.604	83.112	411.144	70.959	487.794	0.79
2005	980.806	792.26	468.133	159.771	77.738	417.907	67.363	492.844	2.957
2005	980.806	792.824	467.526	169.463	87.37	371.432	74.339	479.608	29.211
2005	980.806	792.86	463.863	167.204	81.33	393.923	70.081	485.8	17.455
2005	980.806	792.469	467.03	165.104	85.087	395.85	72.52	486.595	13.514
2005	980.806	792.096	471.081	174.807	83.864	407.575	71.607	484.861	0.718
2005	980.806	792.111	469.047	165.107	83.943	410.083	71.486	487.301	0.789
2005	980.806	792.034	470.078	171.851	88.864	401.159	74.634	481.854	0.859
2005	980.806	792.703	470.693	172.279	98.791	363.571	83.819	473.48	20.868
2005	980.806	792.161	470.025	169.975	78.547	414.758	68.064	490.18	2.685
2005	980.806	792.132	470.474	171.803	81.118	412.185	70.114	488.238	1.114
2005	980.806	792.814	465.034	167.502	84.201	389.829	72.184	484.106	17.62
2005	980.806	792.042	472.075	182.91	89.347	396.19	75.248	478.507	1.802
2005	980.805	792.039	471.916	183.397	91.245	393.244	76.94	477.468	1.899
2005	980.806	792.048	470.602	175.012	82.627	407.335	70.83	485.681	2.614
2005	980.806	792.658	466.417	170.537	90.19	373.702	75.509	480.117	26.232
2005	980.806	792.587	461.87	165.763	73.754	379.29	61.57	488.313	43.65
2005	980.806	792.71	465.018	167.936	86.283	380.963	73.181	482.586	23.908
2005	967.041	781.029	460.256	155.354	72.573	426.581	64.035	498.243	3.277
2005	962.038	777.484	458.14	170.361	92.597	378.215	78.397	479.279	17.808
2005	980.806	792.025	470.145	169.454	77.159	418.364	66.831	491.039	1.258
2005	959.188	774.633	457.846	162.835	75.51	421.068	66.244	494.72	2.892
2005	980.806	792.117	470.099	173.275	83.259	407.253	71.859	486.681	2.612
2005	951.411	768.285	455.16	163.059	71.92	428.185	63.485	496.749	0.774
2005	972.558	785.656	463.447	159.782	78.837	410.97	68.196	492.465	8.772

2006	1005.264	779.237	468.326	192.597	95.294	403.976	75.153	485.695	2.674
2006	1005.263	779.35	468.876	192.764	97.455	401.325	77.235	485.88	3.339
2006	1005.263	779.581	472.923	185.932	122.813	372.139	91.692	484.646	16.215
2006	1005.264	849.629	522.03	173.719	158.993	357.991	135.728	505.615	5.195
2006	1005.263	779.465	480.044	194.21	119.961	372.886	99.2	486.45	9.446
2006	1005.263	779.184	467.683	182.396	129.585	378.61	107.82	493.508	1.677
2006	1005.264	779.331	486.562	194.722	136.025	360.639	114.752	486.261	5.276
2006	1005.263	779.682	474.481	184.662	123.014	366.3	90.778	482.943	21.313
2006	1005.263	779.268	482.464	194.476	131.084	367.909	109.859	487.141	3.983
2006	1005.264	779.251	489.986	195.626	150.389	346.777	128.669	488.333	6.682
2006	1004.653	781.696	477.791	193.793	135.928	366.453	114.152	489.574	3.31
2006	1005.263	779.564	487.015	195.053	135.115	356.417	113.67	486.693	11.072
2006	1005.264	779.215	469.628	192.154	103.116	394.506	82.901	486.781	5.136
2006	1005.264	779.315	478.266	193.494	118.819	380.988	97.976	485.749	1.905
2006	1005.264	779.866	480.841	183.232	136.1	346.221	100.377	479.922	28.348
2006	1005.264	779.413	472.586	187.402	112.739	388.942	91.845	488.01	2.606
2006	1005.263	779.658	482.482	185.567	142.555	348.302	112.152	483.14	17.172
2006	1005.263	779.736	472.363	183.241	113.84	379.594	92.028	488.701	12.439
2006	1004.915	779.89	480.081	177.082	153.488	332.851	108.044	476.766	30.535
2006	1005.264	780.062	479.411	177.034	154.773	335.842	108.743	477.113	27.156
2006	1005.264	779.357	477.667	185.312	127.441	376.215	106.449	488.866	0.953
2006	1005.264	779.48	473.014	183.524	116.631	384.862	95.661	489.088	3.783
2006	1005.263	780.109	476.189	176.914	139.169	341.952	95.784	480.119	37.619
2006	1005.263	780.148	467.721	176.457	132.612	370.522	88.549	485.679	22.191
2006	1005.264	779.716	474.477	180.277	130.56	364.69	98.158	485.174	17.44
2006	1005.264	779.297	481.49	193.137	129.175	372.058	108.047	486.319	0.9
2006	1005.263	779.313	477.733	184.233	129.254	374.823	108.251	489.321	0.921
2006	1005.263	779.229	483.334	186.394	139.323	363.999	118.391	489.231	1.079
2006	1005.264	779.979	480.441	177.079	157.65	332.337	111.434	476.432	27.162
2006	1005.264	779.368	475.309	193.92	118.018	381.389	97.183	486.922	3.487
2006	1005.264	779.335	477.164	194.094	123.207	377.778	102.065	486.336	1.413
2006	1005.264	780.098	469.496	176.54	135.972	365.374	91.766	484.164	22.448
2006	1005.264	779.237	487.806	194.868	141.76	358.175	120.374	486.747	2.363
2006	1005.263	779.234	487.126	195.2	145.794	355.014	124.223	487.771	2.51
2006	1005.263	779.243	479.757	194.306	127.367	372.436	106.263	487.385	3.441
2006	1005.263	779.93	477.219	176.835	140.9	344.155	97.569	480.38	33.819
2006	1005.263	779.849	472.543	176.617	113.244	350.36	75.826	485.365	55.382
2006	1005.264	779.986	472.917	176.364	137.331	353.339	94.845	483.219	30.34
2006	991.156	768.414	460.934	183.568	106.143	395.882	85.182	489.569	4.176
2006	986.028	764.999	465.921	176.755	147.43	350.565	102.246	480.852	22.979
2006	1005.263	779.218	476.226	193.534	114.722	385.273	93.996	485.586	1.61
2006	983.107	762.114	460	189.979	111.583	389.461	90.668	488.43	3.712
2006	1005.263	779.319	477.161	194.531	128.142	372.059	106.85	487.615	3.399

2006	975.136	755.862	455.964	192.985	103.359	397.809	82.729	485.717	0.946
2006	996.81	772.991	467.977	181.766	117.506	379.028	91.262	486.266	11.387
2007	1392.041	744.285	464.002	193.995	254.696	674.313	223.167	911.349	4.127
2007	1392.04	744.372	463.375	194.331	256.659	670.715	225.052	910.627	5.036
2007	1392.04	744.543	463.086	191.18	262.6	643.986	238.604	916.115	22.957
2007	1392.041	813.153	510.403	176.092	332.652	601.26	298.51	921.062	8.045
2007	1392.04	744.456	462.83	197.258	275.222	643.157	243.233	910.516	13.551
2007	1392.04	744.244	460.436	184.453	296.928	634.481	264.006	912.656	2.558
2007	1392.04	744.357	461.691	198.67	291.192	633.458	258.68	910.827	7.462
2007	1392.04	744.618	462.894	190.796	259.881	640.065	237.113	916.309	28.636
2007	1392.04	744.308	462.464	197.809	288.476	638.359	256.173	911.343	5.675
2007	1392.04	744.296	462.934	199.897	306.833	615.13	274.327	911.037	9.678
2007	1391.196	746.705	471.623	195.837	304.72	615.055	272.032	904.071	5.088
2007	1392.04	744.53	462.113	199.03	288.263	627.974	255.888	910.505	15.541
2007	1392.041	744.268	463.551	193.806	262.992	660.616	231.214	909.814	7.879
2007	1392.04	744.345	462.682	196.288	277.087	651.911	244.871	910.173	2.733
2007	1392.041	744.756	464.469	191.129	268.024	619.269	247.689	916.692	38.764
2007	1392.041	744.418	461.091	189.676	270.787	659.622	238.917	912.835	3.858
2007	1392.04	744.6	463.889	192.009	286.574	618.088	261.872	915.049	23.57
2007	1392.04	744.659	461.252	186.171	268.08	648.065	237.387	913.712	17.859
2007	1391.557	744.712	467.413	187.372	276.501	601.622	262.844	918.569	42.327
2007	1392.041	744.9	467.378	187.136	278.148	604.919	264.704	919.372	37.886
2007	1392.04	744.377	459.747	188.302	284.885	647.562	252.892	912.863	1.37
2007	1392.041	744.467	459.682	186.023	273.381	655.845	241.671	913.58	5.497
2007	1392.04	744.933	464.829	186.63	256.78	614.874	242.483	920.521	52.27
2007	1392.04	744.962	459.415	184.702	246.27	652.889	230.683	924.948	30.927
2007	1392.04	744.644	460.739	186.393	268.003	639.611	245.218	919.783	24.096
2007	1392.041	744.33	462.598	196.317	287.215	642.282	254.879	909.535	1.285
2007	1392.04	744.343	459.085	187.304	286.416	646.371	254.448	913.239	1.309
2007	1392.04	744.278	459.393	190.109	295.671	637.294	263.48	913.738	1.483
2007	1392.04	744.839	468.061	187.342	282.444	600.064	269.353	919.292	37.819
2007	1392.041	744.385	465.095	196.188	279.102	645.381	246.982	908.454	5.319
2007	1392.041	744.36	465.686	196.519	285.212	641.01	252.883	907.033	2.116
2007	1392.04	744.926	460.716	185.059	251.741	645.624	236.572	924.225	31.337
2007	1392.04	744.285	460.72	198.979	297.236	631.55	264.664	910.943	3.243
2007	1392.04	744.282	463.214	199.066	304.381	622.323	271.731	909.564	3.703
2007	1392.04	744.29	463.699	197.208	286.616	639.345	254.386	909.937	5.132
2007	1392.04	744.803	461.34	186.837	256.28	625.256	242.061	924.135	45.964
2007	1392.04	744.744	455.873	186.236	219.714	639.846	204.443	927.227	73.792
2007	1392.04	744.844	459.763	185.973	252.693	635.532	238.018	924.879	40.636
2007	1372.505	733.926	453.577	185.314	264.015	664.63	232.553	913.659	6.292
2007	1365.404	730.546	453.797	186.215	266.494	628.269	252.503	923.804	31.686
2007	1392.04	744.27	463.574	195.953	273.445	654.663	241.39	908.931	2.363

2007	1361.359	727.921	454.521	191.673	273.489	652.119	241.659	910.027	5.683
2007	1392.04	744.348	467.521	196.847	292.484	629.34	260.051	905.863	5.126
2007	1350.321	721.962	451.675	194.482	265.074	663.026	233.214	907.874	1.45
2007	1380.335	738.256	456.463	185.736	265.425	651.371	238.166	915.978	15.966
2008	1034.281	821.908	463.198	183.358	133.898	333.074	109.571	453.774	2.934
2008	1034.281	822.035	463.273	183.517	135.885	331.734	111.375	455.063	3.652
2008	1034.281	822.284	463.279	181.424	135.862	317.617	114.64	457.113	16.256
2008	1034.281	888.824	513.432	164.207	187.39	291.283	157.851	466.109	5.693
2008	1034.281	822.158	466.98	184.828	156.526	301.981	129.72	451.353	10.281
2008	1034.281	821.85	458.702	173.021	163.518	312.469	136.188	460.468	1.916
2008	1034.281	822.013	469.602	185.406	172.382	289.017	143.699	448.648	5.732
2008	1034.281	822.393	463.91	181.046	134.141	314.413	113.611	457.497	20.934
2008	1034.281	821.943	467.914	185.053	167.427	295.903	139.1	449.292	4.332
2008	1034.281	821.924	470.304	186.022	184.849	273.813	154.225	446.124	7.205
2008	1033.653	824.195	466.546	183.844	168.661	300.356	139.544	453.73	3.655
2008	1034.281	822.266	469.553	185.599	170.606	284.597	142.205	448.917	12.016
2008	1034.281	821.884	462.704	182.773	140.614	326.908	115.686	456.759	5.596
2008	1034.281	821.995	466.753	184.244	156.303	310.883	129.412	451.802	2.136
2008	1034.281	822.591	466.728	180.908	140.624	297.87	120.011	454.538	27.689
2008	1034.281	822.102	463.383	178.2	149.505	319.118	123.36	454.433	2.94
2008	1034.281	822.367	467.081	180.528	158.669	291.214	133.982	452.046	17.06
2008	1034.281	822.452	461.754	174.761	145.737	313.716	120.86	456.427	12.965
2008	1033.922	822.621	466.313	178.663	137.018	298.872	118.734	455.831	29.131
2008	1034.281	822.802	466.338	178.574	137.799	301.297	119.356	455.584	25.792
2008	1034.281	822.042	464.78	176.102	163.821	307.403	135.859	454.142	1.127
2008	1034.281	822.175	462.807	174.376	152.673	316.361	126.074	455.805	4.197
2008	1034.281	822.852	463.706	178.418	124.207	307.067	108.044	459.297	35.851
2008	1034.281	822.894	460.011	177.806	116.069	333.1	101.231	463.293	21.119
2008	1034.281	822.43	463.044	176.377	141.551	310.638	119.709	456.522	17.262
2008	1034.281	821.975	467.67	183.792	166.174	302.676	138.002	451.589	1.028
2008	1034.281	821.993	464.468	175.04	165.543	306.457	137.384	454.809	1.13
2008	1034.281	821.899	466.569	177.15	175.888	292.965	146.554	451.131	1.245
2008	1034.281	822.712	466.818	178.628	140.691	297.818	121.721	454.679	25.83
2008	1034.281	822.054	465.214	184.429	154.453	312.383	127.516	453.028	3.817
2008	1034.281	822.018	466.175	184.581	159.403	309.952	131.822	452.938	1.583
2008	1034.281	822.84	460.917	177.913	119.846	328.231	104.405	462.045	21.341
2008	1034.281	821.908	470.039	185.506	178.264	287.179	148.786	449.096	2.63
2008	1034.281	821.905	469.521	185.651	181.042	283.932	150.934	448.31	2.753
2008	1034.281	821.915	466.873	184.831	163.483	301.751	135.509	450.795	3.765
2008	1034.281	822.66	464.019	178.446	127.966	306.178	111.559	458.739	32.522
2008	1034.281	822.574	459.468	178.184	105.229	311.454	92.577	465.389	54.198
2008	1034.281	822.72	461.858	177.909	123.604	316.043	107.665	461.428	29.464
2008	1019.766	810.499	454.321	174.36	142.032	328.197	116.674	458.095	4.592

2008	1014.49	806.911	454.887	178.252	131.679	313.161	114.249	458.065	21.919
2008	1034.281	821.887	465.837	184.225	152.627	316.587	126.09	453.637	1.788
2008	1011.485	803.851	452.502	180.506	147.313	320.429	121.132	454.575	4.061
2008	1034.281	822	465.66	184.82	162.916	304.365	134.715	452.62	3.733
2008	1003.283	797.252	450.03	183.627	140.992	329.493	115.693	454.865	1.081
2008	1025.583	815.332	458.532	175.04	142.47	318.487	118.647	457.651	11.731
2009	996.401	793.078	476.376	155.18	125.845	569.513	130.089	710.613	2.816
2009	996.401	793.08	476.344	156.605	125.557	568.015	130.109	709.735	3.374
2009	996.401	793.081	477.115	161.032	132.829	541.711	137.776	703.215	15.01
2009	996.401	858.123	522.28	151.442	154.154	534.533	158.211	708.157	5.015
2009	996.401	793.081	475.246	173.296	122.34	551.732	130.301	699.247	8.502
2009	996.401	793.078	472.286	154.354	140.117	550.687	144.993	706.847	1.778
2009	996.401	793.08	474.533	182.919	123.461	545.982	133.591	693.504	4.754
2009	996.401	793.079	477.027	161.738	132.167	537.261	137.283	702.303	19.088
2009	996.401	793.079	474.968	177.834	125.864	548.979	134.818	696.597	3.684
2009	996.401	793.078	474.565	189.652	126.362	535.733	137.408	688.751	5.998
2009	995.797	795.318	480.745	167.424	140.837	539.85	146.96	699.729	3.29
2009	996.401	793.081	474.365	184.267	120.748	542.793	131.106	692.655	9.693
2009	996.402	793.078	476.06	157.837	127.072	562.981	131.721	708.21	5.102
2009	996.401	793.079	475.677	169.649	126.077	557.214	133.474	701.401	1.899
2009	996.401	793.072	478.725	168.156	133.221	522.005	139.498	695.493	25.041
2009	996.401	793.081	474.421	154.681	127.382	565.387	133.147	709.878	2.698
2009	996.401	793.079	476.919	171.796	134.523	528.316	141.701	694.596	15.253
2009	996.401	793.077	474.186	149.584	126.832	558.979	131.963	711.155	11.676
2009	996.056	792.777	482.828	163.141	146.908	504.501	151.923	693.284	27.364
2009	996.401	793.06	482.933	163.067	147.986	506.557	152.998	693.387	24.275
2009	996.401	793.08	473.073	160.957	128.656	558.572	135.903	704.549	1.033
2009	996.401	793.081	473.13	151.117	127.501	565.238	133.466	711.139	3.721
2009	996.401	793.056	480.635	159.572	138.685	511.715	142.985	697.614	34.047
2009	996.401	793.053	476.617	153.806	138.936	534.099	142.845	706.199	20.565
2009	996.401	793.078	475.378	157.46	133.599	540.404	139.096	704.254	15.865
2009	996.401	793.079	475.151	174.198	127.068	552.588	135.603	698.228	0.927
2009	996.401	793.079	472.605	160.346	128.898	558.343	136.186	704.659	1.045
2009	996.401	793.078	472.532	171.397	128.001	550.309	136.917	697.636	1.077
2009	996.401	793.066	483.52	164.206	149.224	503.676	154.394	691.993	24.245
2009	996.401	793.08	476.901	166.427	129.515	554.459	135.822	702.571	3.416
2009	996.401	793.08	476.942	168.744	131.124	552.499	138.034	701.043	1.443
2009	996.401	793.057	477.639	155.44	140.314	529.971	144.418	703.99	20.769
2009	996.401	793.078	473.766	185.903	124.46	545.348	135.224	692.12	2.186
2009	996.401	793.078	475.097	184.9	128.75	540.723	139	691.654	2.354
2009	996.401	793.078	475.735	173.621	128.116	550.355	135.967	698.645	3.247
2009	996.401	793.069	477.296	164.509	136.406	516.219	141.704	696.994	30.185
2009	996.401	793.073	472.17	159.113	119.76	522.943	123.79	704.741	50.331

2009	996.401	793.065	476.421	158.945	138.035	522.893	142.364	701.874	27.803
2009	982.418	781.95	466.686	143.025	127.781	572.37	132.191	717.234	4.221
2009	977.336	777.894	469.707	161.748	143.843	519.288	148.811	698.058	20.704
2009	996.401	793.078	476.047	167.092	126.345	559.31	133.183	702.816	1.598
2009	974.44	775.599	465.692	154.495	131.24	561.211	136.076	709.743	3.727
2009	996.401	793.079	477.957	169.108	134.212	546.502	140.902	699.952	3.284
2009	966.539	769.309	462.828	157.507	129.505	564.705	134.143	708.41	1.048
2009	988.023	786.412	470.254	150.282	129.734	556.606	134.854	710.565	10.462
2010	1342.579	705.895	439.441	180.978	194.092	575.183	146.397	730.868	3.452
2010	1342.579	705.901	439.719	181.172	196.67	572.74	148.725	731.643	4.267
2010	1342.579	705.91	442.64	178.34	206.261	551.666	158.26	736.457	20.235
2010	1342.579	770.153	488.336	162.112	274.186	510.156	220.464	746.279	6.935
2010	1342.579	705.906	447.033	182.825	223.81	545.733	172.909	737.236	11.914
2010	1342.579	705.891	440.531	170.804	238.137	540.821	186.574	736.883	2.105
2010	1342.579	705.9	450.277	183.59	244.3	536.239	190.802	740.848	6.514
2010	1342.579	705.913	443.605	178.41	204.244	548.266	156.561	736.397	25.345
2010	1342.579	705.897	448.644	183.111	238.449	540.712	185.586	738.348	4.9
2010	1342.579	705.896	454.691	184.289	262.233	517.922	206.61	740.851	8.45
2010	1341.765	708.154	453.101	181.571	246.865	521.398	193.077	726.406	4.332
2010	1342.579	705.91	451.349	183.822	242.302	531.056	189.161	741.161	13.746
2010	1342.579	705.894	440.934	180.445	203.691	564.053	155.233	732.222	6.784
2010	1342.579	705.9	445.039	182.167	223.42	554.728	172.252	735.971	2.287
2010	1342.579	705.92	448.822	178.799	215.531	528.663	166.274	735.998	34.494
2010	1342.579	705.904	440.277	176.003	209.797	563.29	160.316	733.081	3.193
2010	1342.579	705.912	450.315	178.852	234.615	525.151	183.108	736.319	20.898
2010	1342.579	705.915	440.389	172.537	206.155	552.88	157.868	732.364	15.431
2010	1342.114	705.693	449.948	175.904	220.821	516.907	170.592	732.007	37.631
2010	1342.579	705.928	449.662	175.628	222.174	520.129	171.618	732.373	33.697
2010	1342.579	705.902	442.933	174.069	227.596	553.313	176.153	737.423	1.1
2010	1342.579	705.907	439.587	172.221	211.264	561.342	161.804	734.103	4.633
2010	1342.579	705.933	445.569	174.968	201.408	529.445	154.458	736.532	46.399
2010	1342.579	705.936	435.764	172.482	189.509	566.885	144.569	744.695	27.367
2010	1342.579	705.914	442.211	173.723	210.263	548.066	161.888	737.552	21.199
2010	1342.579	705.898	447.493	181.81	235.47	546.487	182.88	737.488	1.051
2010	1342.579	705.899	442.719	173.018	228.931	552.672	177.38	737.979	1.024
2010	1342.579	705.894	446.84	175.275	243.984	542.119	190.772	741.491	1.227
2010	1342.579	705.925	451.021	175.922	226.465	515.383	175.196	731.285	33.642
2010	1342.579	705.902	445.909	182.237	222.886	548.849	171.836	731.99	4.566
2010	1342.579	705.901	447.256	182.425	229.884	545.537	177.884	732.149	1.77
2010	1342.579	705.932	438.017	172.955	195.069	559.877	149.168	742.822	27.728
2010	1342.579	705.895	450.593	183.746	251.472	535.361	197.103	742.755	2.774
2010	1342.579	705.895	452.536	183.822	257.191	526.215	202.115	739.259	3.184
2010	1342.579	705.895	447.941	182.782	234.083	542.406	181.729	735.623	4.435

2010	1342.579	705.923	444.654	175.322	204.097	537.782	157.468	742.401	40.87
2010	1342.579	705.919	438.049	174.585	168.722	550.75	128.448	749.488	65.213
2010	1342.579	705.925	440.354	174.191	198.218	548.422	152.726	743.253	35.968
2010	1323.738	695.995	430.318	172.053	197.033	570.167	149.13	730.409	5.243
2010	1316.89	692.415	435.329	174.508	211.461	542.012	163.225	739.967	28.159
2010	1342.579	705.894	444.527	182.068	218.292	558.33	167.707	734.592	2.004
2010	1312.989	690.34	432.626	178.182	211.228	555.889	161.578	728.635	4.784
2010	1342.579	705.9	449.379	182.628	236.504	534.243	183.802	729.658	4.413
2010	1302.342	684.738	428.757	181.258	204.716	566.421	155.63	729.413	1.176
2010	1331.29	699.973	436.022	172.819	203.2	558.686	155.14	733.818	13.888
2011	1124.275	808.18	480.11	178.797	120.739	565.124	132.18	710.131	3.004
2011	1124.275	808.272	478.287	179.698	122.918	563.421	134.254	711.266	3.65
2011	1124.275	808.458	476.146	174.811	125.048	553.376	136.113	715.185	15.632
2011	1124.275	873.471	526.663	167.728	176.364	510.598	181.226	710.423	5.678
2011	1124.275	808.362	471.16	188.075	138.431	542.441	149.706	712.605	9.547
2011	1124.275	808.137	474.624	173.024	150.589	537.372	159.224	710.137	1.994
2011	1124.275	808.256	466.572	192.364	150.756	535.412	162.382	714.894	5.389
2011	1124.275	808.542	475.708	175.074	122.758	551.794	134.43	715.929	19.74
2011	1124.275	808.205	469.542	190.096	147.29	538.924	158.813	713.387	4.149
2011	1124.275	808.192	465.539	196.156	161.261	521.429	172.71	713.41	6.89
2011	1123.593	810.411	484.458	185.956	153.011	523.339	163.221	702.101	3.676
2011	1124.275	808.445	466.505	193.41	148.694	531.097	160.093	713.772	11.006
2011	1124.275	808.162	478.012	179.88	127.511	556.31	138.363	710.371	5.496
2011	1124.275	808.244	472.979	185.816	138.579	549.506	150.201	712.786	2.128
2011	1124.275	808.693	475.879	177.331	127.902	537.989	140.076	714.747	26.347
2011	1124.275	808.321	473.837	177.814	133.652	554.607	144.889	713.05	2.987
2011	1124.275	808.522	473.111	182.469	141.83	531.979	153.923	713.378	16.251
2011	1124.275	808.586	474.633	173.691	132.081	546.449	142.471	711.93	12.617
2011	1123.885	808.656	482.696	168.797	128.772	533.595	140.932	713.347	28.402
2011	1124.275	808.855	482.635	168.801	129.276	536.368	141.538	713.452	25.076
2011	1124.275	808.277	469.298	179.216	144.792	546.414	156.043	714.867	1.155
2011	1124.275	808.375	471.934	174.963	136.074	552.025	147.109	713.901	4.092
2011	1124.275	808.894	479.626	165.192	118.569	543.087	129.623	717.355	35.02
2011	1124.275	808.927	473.872	160.109	111.48	572.823	121.787	724.459	20.727
2011	1124.275	808.57	473.023	172.26	128.623	550.143	140.159	717.048	16.446
2011	1124.275	808.228	470.481	187.89	146.128	543.056	157.82	713.352	1.047
2011	1124.275	808.242	468.219	178.521	146.268	545.683	157.459	715.651	1.178
2011	1124.275	808.173	464.607	183.596	154.449	538.233	165.719	717.038	1.229
2011	1124.275	808.785	483.385	169.722	131.637	532.677	144.125	712.48	25.032
2011	1124.275	808.286	476.923	184.965	138.391	544.968	149.554	709.238	3.781
2011	1124.275	808.26	477.109	186.032	142.111	542.32	153.469	708.59	1.603
2011	1124.275	808.885	475.15	161.454	114.704	567.39	125.302	722.839	20.789
2011	1124.275	808.18	464.409	193.74	155.06	534.945	166.906	716.339	2.489

2011	1124.275	808.178	467.837	193.758	158.56	527.829	170.106	712.859	2.699
2011	1124.275	808.185	472.774	188.207	144.829	540.124	156.217	711.359	3.671
2011	1124.275	808.746	472.47	169.372	118.564	550.654	130.711	721.933	30.839
2011	1124.275	808.68	465.733	163.864	100.442	560.074	110.728	730.163	51.065
2011	1124.275	808.792	472.771	164.562	116.313	558.948	127.58	724.177	28.159
2011	1108.497	796.929	469.068	172.087	127.723	558.773	138.699	712.222	4.596
2011	1102.763	793.265	466.85	167.093	123.082	553.929	134.972	719.933	21.002
2011	1124.275	808.165	474.811	184.663	135.283	552.302	146.928	711.743	1.761
2011	1099.496	790.41	469.224	178.794	132.998	549.328	143.942	707.896	4.061
2011	1124.275	808.247	479.217	186.754	146.216	533.559	157.139	705.805	3.658
2011	1090.58	783.942	466.819	180.188	127.061	558.342	138.523	708.253	1.145
2011	1114.821	801.631	469.845	173.008	128.065	553.608	139.568	714.536	11.126
2012	1031.644	799.368	458.464	182.145	116.372	446.526	84.422	538.092	2.509
2012	1031.644	799.423	458.334	182.226	118.944	444.244	86.437	538.573	3.153
2012	1031.644	799.533	459.557	178.067	121.378	428.384	87.809	535.669	14.692
2012	1031.644	863.981	509.879	162.017	176.293	400.69	138.453	551.828	5.095
2012	1031.644	799.478	462.735	182.93	143.637	416.711	105.661	537.217	9.172
2012	1031.644	799.343	457.102	171.291	148.567	421.684	112.848	542.321	1.613
2012	1031.644	799.413	464.824	183.258	161.514	404.772	119.533	535.694	5.045
2012	1031.644	799.582	460.217	177.451	120.57	424.976	86.838	535.684	19.158
2012	1031.644	799.383	463.788	183.059	154.965	411.59	114.8	536.292	3.777
2012	1031.644	799.375	467.359	183.57	174.689	391.122	130.337	534.745	6.375
2012	1031.018	801.58	467.777	181.775	151.364	411.212	115.244	535.898	3.181
2012	1031.644	799.525	465.274	183.353	160.465	400.617	118.674	536.305	10.719
2012	1031.644	799.358	458.807	181.354	124.068	437.941	91.106	538.947	4.91
2012	1031.644	799.405	461.923	182.522	142.191	424.56	104.546	536.526	1.798
2012	1031.644	799.675	463.394	176.682	130.423	408.606	94.392	533.588	25.521
2012	1031.644	799.453	458.625	176.58	134.681	432.63	98.878	539.344	2.47
2012	1031.644	799.571	464.254	177.001	148.631	404.137	109.487	535.095	15.63
2012	1031.644	799.609	458.142	172.712	131.781	426.548	97.183	540.598	11.569
2012	1031.286	799.542	464.192	173.069	126.313	405.595	91.609	529.063	26.901
2012	1031.644	799.772	464.198	173.025	126.865	408.294	91.849	528.962	23.85
2012	1031.644	799.426	460.265	174.203	150.637	420.403	111.388	538.687	0.915
2012	1031.644	799.485	458.042	172.64	138.637	429.187	102.017	540.348	3.619
2012	1031.644	799.794	461.017	172.906	111.389	414.4	79.535	531.195	32.905
2012	1031.644	799.813	454.935	172.471	99.549	441.397	68.646	533.005	19.155
2012	1031.644	799.598	459.035	172.777	129.278	422.736	93.589	537.015	15.635
2012	1031.644	799.396	463.344	181.871	153.08	415.944	113.216	536.057	0.848
2012	1031.644	799.404	459.809	173.112	152.656	419.239	112.975	539.164	0.891
2012	1031.644	799.364	462.341	175.007	164.212	408.159	121.996	537.681	1.031
2012	1031.644	799.73	465.023	173.09	130.322	404.841	94.792	528.625	23.876
2012	1031.644	799.432	462.366	182.692	138.614	425.169	102.636	536.707	3.337
2012	1031.645	799.415	463.478	182.773	143.838	421.851	106.909	535.872	1.342

2012	1031.644	799.789	456.704	172.558	103.862	436.412	72.334	532.064	19.32
2012	1031.644	799.368	464.955	183.318	168.064	402.229	124.606	535.681	2.261
2012	1031.644	799.367	466.323	183.369	169.584	399.203	126.69	535.022	2.406
2012	1031.644	799.371	463.352	182.926	149.685	416.108	110.979	536.355	3.312
2012	1031.644	799.707	460.291	172.963	117.174	416.498	82.534	533.283	29.807
2012	1031.644	799.666	455.177	172.594	91.65	422.485	62.814	538.033	49.282
2012	1031.644	799.734	457.52	172.137	110.309	425.054	77.919	534.108	26.909
2012	1017.166	788.204	449.585	172.897	126.634	439.766	92.774	541.582	3.965
2012	1011.904	784.401	451.449	172.828	119.178	422.155	84.517	531.315	20.062
2012	1031.644	799.359	461.58	182.61	137.469	428.701	100.945	536.624	1.533
2012	1008.907	781.774	449.89	178.934	130.472	433.043	96.622	538.484	3.536
2012	1031.644	799.407	464.788	182.875	146.648	416.41	110.003	535.636	3.269
2012	1000.726	775.401	446.456	182.273	123.302	440.771	90.349	536.959	0.89
2012	1022.969	792.793	453.957	172.599	129.34	429.882	94.138	539.664	10.54
2013	0	0	0	182.145	0	0	0.396	0.419	0.006
2013	0	0	0	182.226	0	0.001	0.411	0.436	0.007
2013	0	0	0	178.067	0	0.001	0.465	0.49	0.006
2013	0	0.089	0.063	162.017	0	0	0.567	0.601	0.007
2013	0	0	0	182.93	0	0	0.581	0.614	0.01
2013	0	0	0	171.291	0	0.011	0.502	0.539	0.004
2013	0	0	0	183.258	0	0.001	0.701	0.737	0.008
2013	0	0	0	177.451	0	0.002	0.469	0.493	0.003
2013	0	0	0	183.059	0	0	0.643	0.677	0.008
2013	0	0	0	183.57	0	0	0.761	0.802	0.012
2013	0	0.004	0.003	181.775	0	0.006	0.511	0.545	0.006
2013	0	0	0	183.353	0	0.001	0.697	0.737	0.012
2013	0	0	0	181.354	0	0.008	0.428	0.462	0.007
2013	0	0	0	182.522	0	0.001	0.565	0.594	0.005
2013	0	0	0	176.682	0	0	0.525	0.55	0.004
2013	0	0	0	176.58	0	0.001	0.505	0.533	0.006
2013	0	0	0	177.001	0	0	0.604	0.635	0.007
2013	0	0	0	172.712	0	0	0.482	0.517	0.014
2013	0	0	0	173.069	0	0	0.477	0.497	0.001
2013	0	0	0	173.025	0	0	0.48	0.5	0.001
2013	0	0	0	174.203	0	0.005	0.61	0.643	0.003
2013	0	0	0	172.64	0	0.004	0.531	0.563	0.007
2013	0	0	0	172.906	0	0	0.436	0.453	0.001
2013	0	0	0	172.471	0	0.001	0.428	0.445	0.001
2013	0	0	0	172.777	0	0	0.517	0.545	0.007
2013	0	0	0	181.871	0	0.006	0.632	0.666	0.003
2013	0	0	0	173.112	0	0.007	0.623	0.658	0.003
2013	0	0	0	175.007	0	0.001	0.705	0.736	0.003
2013	0	0	0	173.09	0	0	0.488	0.508	0.001

2013	0	0	0	182.692	0	0.003	0.51	0.54	0.006
2013	0	0	0	182.773	0	0.009	0.54	0.574	0.003
2013	0	0	0	172.558	0	0	0.436	0.453	0.001
2013	0	0	0	183.318	0	0.004	0.745	0.782	0.005
2013	0	0	0	183.369	0	0.001	0.723	0.757	0.004
2013	0	0	0	182.926	0	0	0.595	0.624	0.005
2013	0	0	0	172.963	0	0	0.514	0.533	0.001
2013	0	0	0	172.594	0	0	0.433	0.449	0
2013	0	0	0	172.137	0	0	0.472	0.491	0.001
2013	0	0	0	172.897	0	0.006	0.445	0.478	0.008
2013	0	0	0	172.828	0	0	0.495	0.515	0.001
2013	0	0	0	182.61	0	0.007	0.532	0.564	0.003
2013	0	0	0	178.934	0	0.001	0.445	0.472	0.007
2013	0	0	0	182.875	0	0.005	0.529	0.562	0.005
2013	0	0	0	182.273	0	0.003	0.42	0.444	0.003
2013	0	0	0	172.599	0	0.009	0.489	0.528	0.009
27	1019.724	774.237	456.741	182.145	111.91	446.564	96.995	551.728	2.632
27	1019.724	774.341	456.605	182.226	113.357	444.646	98.349	551.84	3.238
27	1019.724	774.547	457.343	178.067	122.54	422.814	107.072	550.981	15.038
27	1019.724	841.225	505.541	162.017	162.352	403.987	143.452	560.536	5.05
27	1019.724	774.443	458.35	182.93	127.674	422.955	111.884	549.994	8.852
27	1019.724	774.189	453.298	171.291	138.875	424.015	121.851	554.407	1.665
27	1019.724	774.323	459.266	183.258	139.082	414.568	122.623	548.967	4.917
27	1019.724	774.637	457.697	177.451	121.747	418.905	106.416	550.676	19.337
27	1019.724	774.265	458.755	183.059	136.192	419.171	119.806	549.434	3.735
27	1019.724	774.25	460.296	183.57	149.139	402.182	131.894	547.676	6.246
27	1019.105	776.559	462.713	181.775	142.148	411.923	124.762	546.942	3.226
27	1019.724	774.532	459.356	183.353	137.479	410.753	121.12	548.904	10.252
27	1019.724	774.217	456.581	181.354	117.511	438.77	102.197	551.768	4.989
27	1019.724	774.309	458.235	182.522	128.023	429.752	112.153	550.057	1.829
27	1019.724	774.803	460.218	176.682	129.079	402.67	113.263	548.022	25.713
27	1019.724	774.396	455.709	176.58	123.406	436.178	107.724	552.549	2.546
27	1019.724	774.616	459.673	177.001	138.754	403.705	122.133	548.347	15.658
27	1019.724	774.686	455.176	172.712	122.499	428.446	106.88	553.049	11.666
27	1019.37	774.801	462.362	173.069	136.365	390.955	119.908	545.389	27.782
27	1019.724	774.981	462.293	173.025	137.216	393.474	120.633	545.567	24.674
27	1019.724	774.347	455.775	174.203	133.705	427.421	117.424	552.394	0.944
27	1019.724	774.456	454.758	172.64	125.593	433.859	109.786	553.479	3.627
27	1019.724	775.023	459.651	172.906	124.291	399.278	108.903	548.627	34.297
27	1019.724	775.059	454.726	172.471	117.144	425.322	102.306	553.758	20.334
27	1019.724	774.668	456.171	172.777	127.229	418.38	111.445	552.065	15.953
27	1019.724	774.292	458.442	181.871	135.227	423.311	118.905	549.765	0.872
27	1019.724	774.307	455.378	173.112	134.887	426.651	118.534	552.775	0.927

27	1019.724	774.23	456.46	175.007	142.164	418.188	125.442	551.68	1.033
27	1019.724	774.905	462.932	173.09	139.878	390.203	123.068	544.851	24.661
27	1019.724	774.357	458.655	182.692	127.975	427.859	111.914	549.472	3.374
27	1019.724	774.327	459.228	182.773	131.805	425.457	115.485	548.833	1.378
27	1019.724	775.013	455.889	172.558	120.56	420.568	105.425	552.492	20.535
27	1019.724	774.237	458.923	183.318	143.385	413.33	126.686	549.295	2.208
27	1019.724	774.234	459.962	183.369	146.796	408.716	129.693	548.038	2.387
27	1019.724	774.243	458.832	182.926	134.009	421.73	117.664	549.297	3.285
27	1019.724	774.861	457.69	172.963	125.486	403.819	110.102	550.69	30.569
27	1019.724	774.788	452.595	172.594	103.517	410.792	90.354	556.652	50.392
27	1019.724	774.912	455.892	172.137	122.497	411.442	107.462	552.66	27.699
27	1005.413	763.474	447.507	172.897	118.264	441.649	102.83	554.383	4.053
27	1000.212	760.028	449.548	172.828	130.533	407.951	114.583	549.819	20.832
27	1019.724	774.22	457.889	182.61	125.376	433.035	109.644	550.425	1.551
27	997.249	757.22	447.036	178.934	123.413	433.728	107.537	550.979	3.609
27	1019.724	774.312	460.127	182.875	135.68	418.797	118.959	547.736	3.273
27	989.163	751.013	444.005	182.273	117.902	441.283	102.475	550.539	0.948
27	1011.149	768.002	451.35	172.599	122.585	429.507	106.999	553.104	10.539

APPENDIX IV: DETAILED LANDUSE/SOIL/SLOPE DISTRIBUTION

	Area [ha]	Area [acres]
Watershed	334234.9694	825911.3210
Number of Sub basins: 45		

	Area [ha]	Area [acres]	%Wat.Area
LANDUSE:			
Water --> WATR	1213.0666	2997.5482	0.36
Residential-Med/Low Density --> URML	342.6742	846.7650	0.10
Forest-Deciduous --> FRSD	59686.9883	147489.5324	17.86
Forest-Mixed --> FRST	85.6685	211.6913	0.03
Range-Brush --> RNGB	1727.9345	4269.8126	0.52
Range-Grasses --> RNGE	41.9776	103.7287	0.01
Agricultural Land-Close-grown --> AGRC	76732.4585	189609.7417	22.96
Agricultural Land-Generic --> AGRL	194404.2011	480382.5011	58.16
SOILS:			
Fo48-2ab-42	78885.3091	194929.5430	23.60
Fr10-2-3a-566	139827.3415	345520.3522	41.84
Nh2-2c-848	105721.8373	261243.9460	31.63
Vp45-2-3a-960	9800.4815	24217.4798	2.93
SLOPE:			
0-10	241493.6299	596742.8342	72.25
10-20	74428.8314	183917.3638	22.27
20-30	14645.0377	36188.6203	4.38
30-50	3503.8435	8658.1724	1.05
50-9999	163.6269	404.3303	0.05

		Area [ha]	Area [acres]	%Wat.Area	%Sub.Area
SUBBASIN #	2	1579.5935	3903.2545	0.47	
LANDUSE:					
Forest-Deciduous --> FRSD		7.7102	19.0522	0.00	0.49
Agricultural Land-Close-grown --> AGRC		62.5380	154.5346	0.02	3.96
Agricultural Land-Generic --> AGRL		1512.0498	3736.3507	0.45	95.72
SOILS:					
Fr10-2-3a-566		1582.2980	3909.9375	0.47	100.17
SLOPE:					
0-10		1453.7952	3592.4006	0.43	92.04
10-20		126.7894	313.3031	0.04	8.03
20-30		1.7134	4.2338	0.00	0.11

		Area [ha]	Area [acres]	%Wat.Area	%Sub.Area
SUBBASIN #	3	16856.4092	41653.0298	5.04	
LANDUSE:					

Residential-Med/Low Density --> URML 28.2706 69.8581 0.01 0.17
Forest-Deciduous --> FRSD 2463.8273 6088.2405 0.74 14.62
Range-Brush --> RNGB 190.1842 469.9546 0.06 1.13
Agricultural Land-Close-grown --> AGRC 2178.5511 5383.3087 0.65 12.92
Agricultural Land-Generic --> AGRL 12024.4369 29712.9848 3.60 71.33

SOILS:
Fr10-2-3a-566 9214.5086 22769.5116 2.76 54.66
Nh2-2c-848 7670.7615 18954.8351 2.30 45.51

SLOPE:
0-10 10890.1854 26910.1925 3.26 64.61
10-20 4670.6490 11541.4073 1.40 27.71
20-30 1028.0225 2540.2951 0.31 6.10
30-50 283.5629 700.6981 0.08 1.68
50-9999 12.8503 31.7537 0.00 0.08
Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 4 9069.6204 22411.4856 2.71

LANDUSE:
Water --> WATR 1153.0986 2849.3643 0.34 12.71
Forest-Deciduous --> FRSD 2557.2061 6318.9840 0.77 28.20
Forest-Mixed --> FRST 85.6685 211.6913 0.03 0.94
Range-Brush --> RNGB 922.6502 2279.9148 0.28 10.17
Range-Grasses --> RNGE 41.9776 103.7287 0.01 0.46
Agricultural Land-Close-grown --> AGRC 53.1145 131.2486 0.02 0.59
Agricultural Land-Generic --> AGRL 4271.4336 10554.9261 1.28 47.10

SOILS:
Fr10-2-3a-566 3146.6056 7775.4199 0.94 34.69
Vp45-2-3a-960 5938.5435 14674.4379 1.78 65.48

SLOPE:
0-10 7729.0161 19098.7852 2.31 85.22
10-20 1096.5574 2709.6481 0.33 12.09
20-30 187.6141 463.6039 0.06 2.07
30-50 57.3979 141.8331 0.02 0.63
50-9999 14.5637 35.9875 0.00 0.16
Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 5 9253.4930 22865.8439 2.77

LANDUSE:
Residential-Med/Low Density --> URML 11.9936 29.6368 0.00 0.13
Forest-Deciduous --> FRSD 596.2531 1473.3711 0.18 6.44
Agricultural Land-Close-grown --> AGRC 4353.6754 10758.1497 1.30
47.05
Agricultural Land-Generic --> AGRL 4307.4144 10643.8364 1.29 46.55

SOILS:

Fr10-2-3a-566 9269.3365 22904.9940 2.77 100.17

SLOPE:

0-10	7012.8270	17329.0463	2.10	75.79
10-20	1637.9826	4047.5368	0.49	17.70
20-30	457.4700	1130.4313	0.14	4.94
30-50	154.2034	381.0443	0.05	1.67
50-9999	6.8535	16.9353	0.00	0.07

Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 6 14512.2479 35860.4903 4.34

LANDUSE:

Forest-Deciduous --> FRSD	3229.7041	7980.7604	0.97	22.26
Range-Brush --> RNGB	418.0625	1033.0533	0.13	2.88
Agricultural Land-Close-grown --> AGRC	786.4372	1943.3257	0.24	5.42
Agricultural Land-Generic --> AGRL	10102.8914	24964.7499	3.02	69.62

SOILS:

Fr10-2-3a-566	11218.2959	27720.9701	3.36	77.30
Vp45-2-3a-960	3318.7994	8200.9193	0.99	22.87

SLOPE:

0-10	14006.8070	34611.5205	4.19	96.52
10-20	488.3107	1206.6402	0.15	3.36
20-30	35.1241	86.7934	0.01	0.24
30-50	6.8535	16.9353	0.00	0.05

Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 7 3875.0071 9575.3363 1.16

LANDUSE:

Residential-Med/Low Density --> URML	31.6974	78.3258	0.01	0.82
Forest-Deciduous --> FRSD	116.5092	287.9001	0.03	3.01
Agricultural Land-Close-grown --> AGRC	2909.3038	7189.0351	0.87	75.08
Agricultural Land-Generic --> AGRL	824.1314	2036.4699	0.25	21.27

SOILS:

Fr10-2-3a-566 3881.6417 9591.7308 1.16 100.17

SLOPE:

0-10	3466.1493	8565.0282	1.04	89.45
10-20	357.2378	882.7525	0.11	9.22
20-30	50.5444	124.8978	0.02	1.30
30-50	7.7102	19.0522	0.00	0.20

Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 8 20146.4449 49782.8728 6.03

LANDUSE:

Forest-Deciduous --> FRSD 3293.9555 8139.5288 0.99 16.35

Agricultural Land-Close-grown --> AGRC	3695.7410	9132.3608	1.11	18.34
Agricultural Land-Generic --> AGRL	13191.2425	32596.2197	3.95	65.48

SOILS:

Fr10-2-3a-566	9619.7209	23770.8112	2.88	47.75
Nh2-2c-848	10561.2182	26097.2981	3.16	52.42

SLOPE:

	Area [ha]	Area [acres]	%Wat.Area	%Sub.Area
0-10	14328.9207	35407.4796	4.29	71.12
10-20	3873.0749	9570.5617	1.16	19.22
20-30	1532.6103	3787.1566	0.46	7.61
30-50	430.9128	1064.8070	0.13	2.14
50-9999	15.4203	38.1044	0.00	0.08

SUBBASIN # 11 11274.3806 27859.5582 3.37

LANDUSE:

Water --> WATR	59.9680	148.1839	0.02	0.53
Forest-Deciduous --> FRSD	5422.8189	13400.0565	1.62	48.10
Range-Brush --> RNGB	82.2418	203.2236	0.02	0.73
Agricultural Land-Close-grown --> AGRC	15.4203	38.1044	0.00	0.14
Agricultural Land-Generic --> AGRL	5706.3817	14100.7546	1.71	50.61

SOILS:

Fr10-2-3a-566	10889.3287	26908.0756	3.26	96.58
Vp45-2-3a-960	397.5020	982.2474	0.12	3.53

SLOPE:

	Area [ha]	Area [acres]	%Wat.Area	%Sub.Area
0-10	10152.5792	25087.5308	3.04	90.05
10-20	1048.5830	2591.1010	0.31	9.30
20-30	56.5412	139.7162	0.02	0.50
30-50	29.1273	71.9750	0.01	0.26

SUBBASIN # 12 6706.6444 16572.4535 2.01

LANDUSE:

Forest-Deciduous --> FRSD	505.4444	1248.9784	0.15	7.54
Agricultural Land-Close-grown --> AGRC	5098.1351	12597.7467	1.53	76.02
Agricultural Land-Generic --> AGRL	1114.5478	2754.1032	0.33	16.62

SOILS:

Fr10-2-3a-566	6718.1273	16600.8283	2.01	100.17

SLOPE:

0-10	4327.9749	10694.6423	1.29	64.53
10-20	1990.9370	4919.7048	0.60	29.69
20-30	316.1169	781.1407	0.09	4.71
30-50	83.0985	205.3405	0.02	1.24

Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 13 7311.2857 18066.5526 2.19

LANDUSE:

Forest-Deciduous --> FRSD 405.2122 1001.2996 0.12 5.54
Range-Brush --> RNGB 114.7958 283.6663 0.03 1.57
Agricultural Land-Close-grown --> AGRC 364.0913 899.6878 0.11 4.98
Agricultural Land-Generic --> AGRL 6439.7045 15912.8318 1.93 88.08

SOILS:

Fr10-2-3a-566 7178.1673 17737.6104 2.15 98.18
Vp45-2-3a-960 145.6365 359.8751 0.04 1.99

SLOPE:

0-10 6040.4891 14926.3505 1.81 82.62
10-20 1135.1082 2804.9092 0.34 15.53
20-30 137.0697 338.7060 0.04 1.87
30-50 11.1369 27.5199 0.00 0.15

Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 14 3734.7508 9228.7560 1.12

LANDUSE:

Residential-Med/Low Density --> URML 23.1305 57.1566 0.01 0.62
Forest-Deciduous --> FRSD 51.4011 127.0148 0.02 1.38
Agricultural Land-Close-grown --> AGRC 1493.2027 3689.7786 0.45 39.98
Agricultural Land-Generic --> AGRL 2173.4110 5370.6072 0.65 58.19

SOILS:

Fo48-2ab-42 83.0985 205.3405 0.02 2.23
Fr10-2-3a-566 3658.0468 9039.2167 1.09 97.95

SLOPE:

0-10 3560.3847 8797.8886 1.07 95.33
10-20 179.0473 442.4347 0.05 4.79
20-30 1.7134 4.2338 0.00 0.05

Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 15 16246.6364 40146.2509 4.86

LANDUSE:

Forest-Deciduous --> FRSD 4561.8500 11272.5594 1.36 28.08
Agricultural Land-Close-grown --> AGRC 4916.5178 12148.9612 1.47 30.26
Agricultural Land-Generic --> AGRL 6796.0856 16793.4674 2.03 41.83

SOILS:

Fr10-2-3a-566 5919.6964 14627.8658 1.77 36.44
Nh2-2c-848 10354.7570 25587.1222 3.10 63.73

SLOPE:

0-10 8057.1266 19909.5627 2.41 49.59
10-20 6343.7557 15675.7376 1.90 39.05
20-30 1517.1899 3749.0522 0.45 9.34
30-50 349.5277 863.7003 0.10 2.15
50-9999 6.8535 16.9353 0.00 0.04
Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 16 6686.9743 16523.8478 2.00

LANDUSE:

Residential-Med/Low Density --> URML 20.5605 50.8059 0.01 0.31
Forest-Deciduous --> FRSD 78.8151 194.7560 0.02 1.18
Agricultural Land-Close-grown --> AGRC 1602.8585 3960.7434 0.48 23.97
Agricultural Land-Generic --> AGRL 4996.1895 12345.8341 1.49 74.72

SOILS:

Fo48-2ab-42 3994.7242 9871.1633 1.20 59.74
Fr10-2-3a-566 2703.6993 6680.9761 0.81 40.43

SLOPE:

0-10 5628.4234 13908.1156 1.68 84.17
10-20 1044.2996 2580.5164 0.31 15.62
20-30 17.9904 44.4552 0.01 0.27
30-50 7.7102 19.0522 0.00 0.12
Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 17 19691.4673 48658.6002 5.89

LANDUSE:

Forest-Deciduous --> FRSD 5243.7716 12957.6218 1.57 26.63
Agricultural Land-Close-grown --> AGRC 8399.8008 20756.3277 2.51
42.66
Agricultural Land-Generic --> AGRL 6081.6100 15027.9623 1.82 30.88

SOILS:

Fo48-2ab-42 4308.2711 10645.9533 1.29 21.88
Fr10-2-3a-566 7628.7839 18851.1064 2.28 38.74
Nh2-2c-848 7788.1274 19244.8521 2.33 39.55

SLOPE:

0-10 12676.3745 31323.9553 3.79 64.37
10-20 6003.6516 14835.3233 1.80 30.49
20-30 759.0233 1875.5845 0.23 3.85
30-50 250.1521 618.1385 0.07 1.27
50-9999 35.9808 88.9103 0.01 0.18
Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 18 8995.2162 22227.6290 2.69

LANDUSE:

Residential-Med/Low Density --> URML 141.3531 349.2906 0.04 1.57

Forest-Deciduous --> FRSD 1121.4012 2771.0385 0.34 12.47

Agricultural Land-Close-grown --> AGRC 1540.3204 3806.2088 0.46 17.12

Agricultural Land-Generic --> AGRL 6207.5427 15339.1485 1.86 69.01

SOILS:

Fo48-2ab-42 8391.2339 20735.1586 2.51 93.29

Nh2-2c-848 619.3836 1530.5278 0.19 6.89

SLOPE:

0-10 4128.3672 10201.4017 1.24 45.90

10-20 4132.6506 10211.9862 1.24 45.94

20-30 619.3836 1530.5278 0.19 6.89

30-50 130.2162 321.7707 0.04 1.45

Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 21 11162.3466 27582.7166 3.34

LANDUSE:

Forest-Deciduous --> FRSD 65.9648 163.0023 0.02 0.59

Agricultural Land-Close-grown --> AGRC 5332.0102 13175.6638 1.60 47.77

Agricultural Land-Generic --> AGRL 5783.4834 14291.2767 1.73 51.81

SOILS:

Fo48-2ab-42 9682.2589 23925.3458 2.90 86.74

Fr10-2-3a-566 1499.1995 3704.5970 0.45 13.43

SLOPE:

0-10 10960.4336 27083.7794 3.28 98.19

10-20 211.6013 522.8774 0.06 1.90

20-30 9.4235 23.2860 0.00 0.08

SWAT OUTPUT STD
1

General Input/output section (file.cio):
ARCGIS-SWAT interface AV
MULTIPLE HRUs Land Use/Soil/Slope OPTION
Number of HRUs: 629
Number of Sub basins: 45

	Area [ha]	Area [acres]
Watershed	334234.9694	825911.3210

	Area [ha]	Area [acres]	%Wat.Area
LANDUSE:			
Agricultural Land-Generic --> AGRL	194404.2011	480382.5011	58.16
Forest-Deciduous --> FRSD	59686.9883	147489.5324	17.86
Agricultural Land-Close-grown --> AGRC	76732.4585	189609.7417	22.96
Residential-Med/Low Density --> URML	342.6742	846.7650	0.10
Range-Brush --> RNGB	1727.9345	4269.8126	0.52
Water --> WATR	1213.0666	2997.5482	0.36
Forest-Mixed --> FRST	85.6685	211.6913	0.03
Range-Grasses --> RNGE	41.9776	103.7287	0.01
SOILS:			
Fr10-2-3a-566	139827.3415	345520.3522	41.84
Nh2-2c-848	105721.8373	261243.9460	31.63
Vp45-2-3a-960	9800.4815	24217.4798	2.93
Fo48-2ab-42	78885.3091	194929.5430	23.60
SLOPE:			
0-10	241493.6299	596742.8342	72.25
10-20	74428.8314	183917.3638	22.27
20-30	14645.0377	36188.6203	4.38
50-9999	163.6269	404.3303	0.05
30-50	3503.8435	8658.1724	1.05

		Area [ha]	Area [acres]	%Wat.Area	%Sub.Area
SUBBASIN #	2	1579.5935	3903.2545	0.47	
LANDUSE:					
Forest-Deciduous --> FRSD		7.7102	19.0522	0.00	0.49
Agricultural Land-Close-grown --> AGRC		62.5380	154.5346	0.02	3.96
Agricultural Land-Generic --> AGRL		1512.0498	3736.3507	0.45	95.72
SOILS:					
Fr10-2-3a-566		1582.2980	3909.9375	0.47	100.17
SLOPE:					
10-20		126.7894	313.3031	0.04	8.03

0-10 1453.7952 3592.4006 0.43 92.04
20-30 1.7134 4.2338 0.00 0.11

HRUs
3 Forest-Deciduous --> FRSD/Fr10-2-3a-566/10-20 3.4267 8.4677 0.00 0.22 1
4 Forest-Deciduous --> FRSD/Fr10-2-3a-566/0-10 4.2834 10.5846 0.00 0.27 2
5 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/10-20 43.6910 107.9625 0.01 2.77 3
6 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/0-10 17.1337 42.3383 0.01 1.08 4
7 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/20-30 1.7134 4.2338 0.00 0.11 5
8 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/0-10 1432.3781 3539.4778 0.43 90.68 6
9 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/10-20 79.6717 196.8729 0.02 5.04 7

Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 3 16856.4092 41653.0298 5.04

LANDUSE:
Residential-Med/Low Density --> URML 28.2706 69.8581 0.01 0.17
Forest-Deciduous --> FRSD 2463.8273 6088.2405 0.74 14.62
Range-Brush --> RNGB 190.1842 469.9546 0.06 1.13
Agricultural Land-Close-grown --> AGRC 2178.5511 5383.3087 0.65 12.92
Agricultural Land-Generic --> AGRL 12024.4369 29712.9848 3.60 71.33

SOILS:
Nh2-2c-848 7670.7615 18954.8351 2.30 45.51
Fr10-2-3a-566 9214.5086 22769.5116 2.76 54.66

SLOPE:
0-10 10890.1854 26910.1925 3.26 64.61
10-20 4670.6490 11541.4073 1.40 27.71
20-30 1028.0225 2540.2951 0.31 6.10
50-9999 12.8503 31.7537 0.00 0.08
30-50 283.5629 700.6981 0.08 1.68

HRUs
10 Residential-Med/Low Density --> URML/Nh2-2c-848/0-10 7.7102 19.0522 0.00 0.05 1
11 Residential-Med/Low Density --> URML/Nh2-2c-848/10-20 17.1337 42.3383 0.01 0.10 2
12 Residential-Med/Low Density --> URML/Nh2-2c-848/20-30 3.4267 8.4677 0.00 0.02 3
13 Forest-Deciduous --> FRSD/Fr10-2-3a-566/10-20 146.4932 361.9920 0.04 0.87 4
14 Forest-Deciduous --> FRSD/Fr10-2-3a-566/0-10 615.9568 1522.0601 0.18 3.65 5
15 Forest-Deciduous --> FRSD/Fr10-2-3a-566/50-9999 6.8535 16.9353 0.00 0.04 6

16	Forest-Deciduous --> FRSD/Fr10-2-3a-566/30-50	35.1241	86.7934	0.01	0.21	7
17	Forest-Deciduous --> FRSD/Fr10-2-3a-566/20-30	84.8119	209.5743	0.03	0.50	8
18	Forest-Deciduous --> FRSD/Nh2-2c-848/30-50	44.5476	110.0795	0.01	0.26	9
19	Forest-Deciduous --> FRSD/Nh2-2c-848/50-9999	0.8567	2.1169	0.00	0.01	10
20	Forest-Deciduous --> FRSD/Nh2-2c-848/20-30	104.5156	258.2633	0.03	0.62	11
21	Forest-Deciduous --> FRSD/Nh2-2c-848/0-10	1111.9777	2747.7525	0.33	6.60	12
22	Forest-Deciduous --> FRSD/Nh2-2c-848/10-20	312.6902	772.6731	0.09	1.86	13
23	Range-Brush --> RNGB/Fr10-2-3a-566/10-20	7.7102	19.0522	0.00	0.05	14
24	Range-Brush --> RNGB/Fr10-2-3a-566/0-10	164.4836	406.4472	0.05	0.98	15
25	Range-Brush --> RNGB/Nh2-2c-848/0-10	12.8503	31.7537	0.00	0.08	16
26	Range-Brush --> RNGB/Nh2-2c-848/10-20	5.1401	12.7015	0.00	0.03	17
27	Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/0-10	629.6638	1555.9307	0.19	3.74	18
28	Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/10-20	404.3555	999.1827	0.12	2.40	19
29	Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/20-30	88.2386	218.0420	0.03	0.52	20
30	Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/30-50	17.9904	44.4552	0.01	0.11	21
31	Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/0-10	549.9921	1359.0579	0.16	3.26	22
32	Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/10-20	317.8303	785.3746	0.10	1.89	23
33	Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/30-50	35.9808	88.9103	0.01	0.21	24
34	Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/20-30	134.4996	332.3553	0.04	0.80	25
35	Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/0-10	4507.8788	11139.1939	1.35	26.74	26
36	Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/10-20	2107.4462	5207.6049	0.63	12.50	27
37	Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/20-30	325.5405	804.4268	0.10	1.93	28
38	Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/50-9999	4.2834	10.5846	0.00	0.03	29
39	Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/30-50	67.6782	167.2361	0.02	0.40	30
40	Agricultural Land-Generic --> AGRL/Nh2-2c-848/20-30	286.9896	709.1657	0.09	1.70	31

41 Agricultural Land-Generic --> AGRL/Nh2-2c-848/30-50 82.2418 203.2236 0.02
0.49 32
42 Agricultural Land-Generic --> AGRL/Nh2-2c-848/50-9999 0.8567 2.1169 0.00
0.01 33
43 Agricultural Land-Generic --> AGRL/Nh2-2c-848/10-20 1351.8496 3340.4880 0.40
8.02 34
44Agricultural Land-Generic --> AGRL/Nh2-2c-848/0-10 3289.6721 8128.9443 0.98
19.52 35

		Area [ha]	Area [acres]	%Wat.Area	%Sub.Area
SUBBASIN #	4	9069.6204	22411.4856	2.71	
LANDUSE:					
Water --> WATR		1153.0986	2849.3643	0.34	12.71
Forest-Deciduous --> FRSD		2557.2061	6318.9840	0.77	28.20
Forest-Mixed --> FRST		85.6685	211.6913	0.03	0.94
Range-Brush --> RNGB		922.6502	2279.9148	0.28	10.17
Range-Grasses --> RNGE		41.9776	103.7287	0.01	0.46
Agricultural Land-Close-grown --> AGRC		53.1145	131.2486	0.02	0.59
Agricultural Land-Generic --> AGRL		4271.4336	10554.9261	1.28	47.10
SOILS:					
Vp45-2-3a-960		5938.5435	14674.4379	1.78	65.48
Fr10-2-3a-566		3146.6056	7775.4199	0.94	34.69
SLOPE:					
0-10		7729.0161	19098.7852	2.31	85.22
10-20		1096.5574	2709.6481	0.33	12.09
20-30		187.6141	463.6039	0.06	2.07
30-50		57.3979	141.8331	0.02	0.63
50-9999		14.5637	35.9875	0.00	0.16

HRUs
45 Water --> WATR/Vp45-2-3a-960/0-10 1140.2483 2817.6106 0.34
12.57 1
46 Water --> WATR/Vp45-2-3a-960/10-20 12.8503 31.7537 0.00 0.14
2
47 Forest-Deciduous --> FRSD/Fr10-2-3a-566/20-30 31.6974 78.3258 0.01
0.35 3
48 Forest-Deciduous --> FRSD/Fr10-2-3a-566/30-50 3.4267 8.4677 0.00 0.04
4
49 Forest-Deciduous --> FRSD/Fr10-2-3a-566/10-20 47.9744 118.5471 0.01
0.53 5
50 Forest-Deciduous --> FRSD/Fr10-2-3a-566/0-10 123.3627 304.8354 0.04
1.36 6
51 Forest-Deciduous --> FRSD/Vp45-2-3a-960/10-20 146.4932 361.9920 0.04
1.62 7
52 Forest-Deciduous --> FRSD/Vp45-2-3a-960/0-10 2105.7328 5203.3711 0.63
23.22 8

53 Forest-Deciduous --> FRSD/Vp45-2-3a-960/50-9999 14.5637 35.9875 0.00
0.16 9
54 Forest-Deciduous --> FRSD/Vp45-2-3a-960/20-30 37.6942 93.1442 0.01
0.42 10
55 Forest-Deciduous --> FRSD/Vp45-2-3a-960/30-50 46.2610 114.3133 0.01
0.51 11
56 Forest-Mixed --> FRST/Vp45-2-3a-960/10-20 4.2834 10.5846 0.00 0.05
12
57 Forest-Mixed --> FRST/Vp45-2-3a-960/0-10 81.3851 201.1067 0.02 0.90
13
58 Range-Brush --> RNGB/Fr10-2-3a-566/10-20 84.8119 209.5743 0.03
0.94 14
59 Range-Brush --> RNGB/Fr10-2-3a-566/30-50 2.5701 6.3507 0.00 0.03
15
60 Range-Brush --> RNGB/Fr10-2-3a-566/20-30 19.7038 48.6890 0.01 0.22
16
61 Range-Brush --> RNGB/Fr10-2-3a-566/0-10 293.8431 726.1010 0.09
3.24 17
62 Range-Brush --> RNGB/Vp45-2-3a-960/10-20 1.7134 4.2338 0.00 0.02
18
63 Range-Brush --> RNGB/Vp45-2-3a-960/0-10 520.0081 1284.9659 0.16
5.73 19
64 Range-Grasses --> RNGE/Vp45-2-3a-960/0-10 41.9776 103.7287 0.01
0.46 20
65 Agricultural Land-Close-grown --> AGRC/Vp45-2-3a-960/0-10 53.1145 131.2486
0.02 0.59 21
66 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/30-50 5.1401 12.7015 0.00
0.06 22
67 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/10-20 641.6574 1585.5675
0.19 7.07 23
68 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/20-30 88.2386 218.0420 0.03
0.97 24
69 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/0-10 1804.1795 4458.2179
0.54 19.89 25
70 Agricultural Land-Generic --> AGRL/Vp45-2-3a-960/10-20 156.7734 387.3950
0.05 1.73 26
71 Agricultural Land-Generic --> AGRL/Vp45-2-3a-960/20-30 10.2802 25.4030
0.00 0.11 27
72 Agricultural Land-Generic --> AGRL/Vp45-2-3a-960/0-10 1565.1643 3867.5993
0.47 17.26 28

Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 5 9253.4930 22865.8439 2.77

LANDUSE:
Residential-Med/Low Density --> URML 11.9936 29.6368 0.00 0.13
Forest-Deciduous --> FRSD 596.2531 1473.3711 0.18 6.44
Agricultural Land-Close-grown --> AGRC 4353.6754 10758.1497 1.30
47.05

Agricultural Land-Generic --> AGRL 4307.4144 10643.8364 1.29 46.55

SOILS:

Fr10-2-3a-566 9269.3365 22904.9940 2.77 100.17

SLOPE:

0-10 7012.8270 17329.0463 2.10 75.79
50-9999 6.8535 16.9353 0.00 0.07
30-50 154.2034 381.0443 0.05 1.67
20-30 457.4700 1130.4313 0.14 4.94
10-20 1637.9826 4047.5368 0.49 17.70

HRUs

73 Residential-Med/Low Density --> URML/Fr10-2-3a-566/0-10 11.9936 29.6368 0.00 0.13 1
74 Forest-Deciduous --> FRSD/Fr10-2-3a-566/50-9999 2.5701 6.3507 0.00 0.03 2
75 Forest-Deciduous --> FRSD/Fr10-2-3a-566/30-50 47.1177 116.4302 0.01 0.51 3
76 Forest-Deciduous --> FRSD/Fr10-2-3a-566/20-30 101.0889 249.7957 0.03 1.09 4
77 Forest-Deciduous --> FRSD/Fr10-2-3a-566/10-20 255.2923 630.8399 0.08 2.76 5
78 Forest-Deciduous --> FRSD/Fr10-2-3a-566/0-10 190.1842 469.9546 0.06 2.06 6
79 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/50-9999 4.2834 10.5846 0.00 0.05 7
80 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/30-50 83.0985 205.3405 0.02 0.90 8
81 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/20-30 256.1489 632.9569 0.08 2.77 9
82 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/0-10 3195.4367 7896.0839 0.96 34.53 10
83 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/10-20 814.7079 2013.1839 0.24 8.80 11
84 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/30-50 23.9872 59.2736 0.01 0.26 12
85 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/20-30 100.2322 247.6788 0.03 1.08 13
86 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/0-10 3615.2126 8933.3710 1.08 39.07 14
87 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/10-20 567.9824 1403.5130 0.17 6.14 15

	Area [ha]	Area [acres]	%Wat.Area	%Sub.Area
SUBBASIN # 6	14512.2479	35860.4903	4.34	

LANDUSE:

Forest-Deciduous --> FRSD 3229.7041 7980.7604 0.97 22.26
Range-Brush --> RNGB 418.0625 1033.0533 0.13 2.88

Agricultural Land-Close-grown --> AGRC 786.4372 1943.3257 0.24 5.42
Agricultural Land-Generic --> AGRL 10102.8914 24964.7499 3.02 69.62

SOILS:
Fr10-2-3a-566 11218.2959 27720.9701 3.36 77.30
Vp45-2-3a-960 3318.7994 8200.9193 0.99 22.87

SLOPE:
0-10 14006.8070 34611.5205 4.19 96.52
10-20 488.3107 1206.6402 0.15 3.36
30-50 6.8535 16.9353 0.00 0.05
20-30 35.1241 86.7934 0.01 0.24

HRUs
88 Forest-Deciduous --> FRSD/Fr10-2-3a-566/0-10 511.4412 1263.7968 0.15
3.52 1
89 Forest-Deciduous --> FRSD/Fr10-2-3a-566/10-20 34.2674 84.6765 0.01
0.24 2
90 Forest-Deciduous --> FRSD/Vp45-2-3a-960/30-50 6.8535 16.9353 0.00
0.05 3
91 Forest-Deciduous --> FRSD/Vp45-2-3a-960/10-20 95.0921 234.9773 0.03
0.66 4
92 Forest-Deciduous --> FRSD/Vp45-2-3a-960/20-30 23.9872 59.2736 0.01
0.17 5
93 Forest-Deciduous --> FRSD/Vp45-2-3a-960/0-10 2558.0627 6321.1009 0.77
17.63 6
94 Range-Brush --> RNGB/Fr10-2-3a-566/0-10 388.0785 958.9614 0.12 2.67 7
95 Range-Brush --> RNGB/Vp45-2-3a-960/0-10 29.9840 74.0919 0.01 0.21 8
96 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/0-10 604.8199 1494.5403
0.18 4.17 9
97 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/10-20 41.9776 103.7287
0.01 0.29 10
98 Agricultural Land-Close-grown --> AGRC/Vp45-2-3a-960/10-20 1.7134 4.2338
0.00 0.01 11
99 Agricultural Land-Close-grown --> AGRC/Vp45-2-3a-960/0-10 135.3563 334.4722
0.04 0.93 12
100 Agricultural Land-Close-grown --> AGRC/Vp45-2-3a-960/20-30 2.5701 6.3507
0.00 0.02 13
101 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/10-20 287.8463 711.2826
0.09 1.98 14
102 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/0-10 9349.0083 23101.8668
2.80 64.42 15
103 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/20-30 0.8567 2.1169 0.00
0.01 16
104 Agricultural Land-Generic --> AGRL/Vp45-2-3a-960/20-30 7.7102 19.0522
0.00 0.05 17
105 Agricultural Land-Generic --> AGRL/Vp45-2-3a-960/0-10 430.0561 1062.6901
0.13 2.96 18
106 Agricultural Land-Generic --> AGRL/Vp45-2-3a-960/10-20 27.4139 67.7412
0.01 0.19 19
Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 7 3875.0071 9575.3363 1.16

LANDUSE:

Residential-Med/Low Density --> URML 31.6974 78.3258 0.01 0.82
Forest-Deciduous --> FRSD 116.5092 287.9001 0.03 3.01
Agricultural Land-Close-grown --> AGRC 2909.3038 7189.0351 0.87 75.08
Agricultural Land-Generic --> AGRL 824.1314 2036.4699 0.25 21.27

SOILS:

Fr10-2-3a-566 3881.6417 9591.7308 1.16 100.17

SLOPE:

0-10 3466.1493 8565.0282 1.04 89.45
20-30 50.5444 124.8978 0.02 1.30
30-50 7.7102 19.0522 0.00 0.20
10-20 357.2378 882.7525 0.11 9.22

HRUs

107 Residential-Med/Low Density --> URML/Fr10-2-3a-566/0-10 31.6974 78.3258 0.01 0.82 1
108 Forest-Deciduous --> FRSD/Fr10-2-3a-566/0-10 56.5412 139.7162 0.02 1.46 2
109 Forest-Deciduous --> FRSD/Fr10-2-3a-566/20-30 23.1305 57.1566 0.01 0.60 3
110 Forest-Deciduous --> FRSD/Fr10-2-3a-566/30-50 5.9968 14.8184 0.00 0.15 4
111 Forest-Deciduous --> FRSD/Fr10-2-3a-566/10-20 30.8407 76.2089 0.01 0.80 5
112 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/20-30 23.9872 59.2736 0.01 0.62 6
113 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/10-20 234.7318 580.0340 0.07 6.06 7
114 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/0-10 2648.8714 6545.4937 0.79 68.36 8
115 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/30-50 1.7134 4.2338 0.00 0.04 9
116 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/0-10 729.0393 1801.4926 0.22 18.81 10
117 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/20-30 3.4267 8.4677 0.00 0.09 11
118 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/10-20 91.6653 226.5096 0.03 2.37 12

Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 8 20146.4449 49782.8728 6.03

LANDUSE:

Forest-Deciduous --> FRSD 3293.9555 8139.5288 0.99 16.35
Agricultural Land-Close-grown --> AGRC 3695.7410 9132.3608 1.11 18.34
Agricultural Land-Generic --> AGRL 13191.2425 32596.2197 3.95 65.48

SOILS:

Fr10-2-3a-566	9619.7209	23770.8112	2.88	47.75
Nh2-2c-848	10561.2182	26097.2981	3.16	52.42

SLOPE:

10-20	3873.0749	9570.5617	1.16	19.22
0-10	14328.9207	35407.4796	4.29	71.12
30-50	430.9128	1064.8070	0.13	2.14
20-30	1532.6103	3787.1566	0.46	7.61
50-9999	15.4203	38.1044	0.00	0.08

HRUs
119 Forest-Deciduous --> FRSD/Fr10-2-3a-566/10-20 13.7070 33.8706 0.00
0.07 1
120 Forest-Deciduous --> FRSD/Fr10-2-3a-566/0-10 769.3035 1900.9875 0.23
3.82 2
121 Forest-Deciduous --> FRSD/Nh2-2c-848/30-50 93.3787 230.7435 0.03
0.46 3
122 Forest-Deciduous --> FRSD/Nh2-2c-848/10-20 865.2523 2138.0817 0.26
4.29 4
123 Forest-Deciduous --> FRSD/Nh2-2c-848/20-30 285.2763 704.9319 0.09
1.42 5
124 Forest-Deciduous --> FRSD/Nh2-2c-848/0-10 1267.0378 3130.9137 0.38
6.29 6
125 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/10-20 74.5316 184.1714
0.02 0.37 7
126 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/30-50 5.1401 12.7015
0.00 0.03 8
127 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/0-10 420.6326 1039.4041
0.13 2.09 9
128 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/20-30 30.8407 76.2089
0.01 0.15 10
129 Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/30-50 280.1361 692.2304
0.08 1.39 11
130 Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/50-9999 13.7070 33.8706
0.00 0.07 12
131 Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/0-10 1036.5894 2561.4642
0.31 5.15 13
132 Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/20-30 745.3163 1841.7139
0.22 3.70 14
133 Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/10-20 1088.8472 2690.5959
0.33 5.40 15
134 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/0-10 7909.7767 19545.4537
2.37 39.26 16
135 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/20-30 7.7102 19.0522 0.00
0.04 17
136 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/10-20 388.0785 958.9614
0.12 1.93 18
137 Agricultural Land-Generic --> AGRL/Nh2-2c-848/10-20 1442.6583 3564.8808
0.43 7.16 19

138 Agricultural Land-Generic --> AGRL/Nh2-2c-848/20-30 463.4668 1145.2497 0.14
2.30 20
139 Agricultural Land-Generic --> AGRL/Nh2-2c-848/30-50 52.2578 129.1317 0.02
0.26 21
140 Agricultural Land-Generic --> AGRL/Nh2-2c-848/50-9999 1.7134 4.2338 0.00
0.01 22
141 Agricultural Land-Generic --> AGRL/Nh2-2c-848/0-10 2925.5808 7229.2564 0.88
14.52 23
Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 11 11274.3806 27859.5582 3.37

LANDUSE:
Water --> WATR 59.9680 148.1839 0.02 0.53
Forest-Deciduous --> FRSD 5422.8189 13400.0565 1.62 48.10
Range-Brush --> RNGB 82.2418 203.2236 0.02 0.73
Agricultural Land-Close-grown --> AGRC 15.4203 38.1044 0.00 0.14
Agricultural Land-Generic --> AGRL 5706.3817 14100.7546 1.71 50.61

SOILS:
Vp45-2-3a-960 397.5020 982.2474 0.12 3.53
Fr10-2-3a-566 10889.3287 26908.0756 3.26 96.58

SLOPE:
0-10 10152.5792 25087.5308 3.04 90.05
10-20 1048.5830 2591.1010 0.31 9.30
30-50 29.1273 71.9750 0.01 0.26
20-30 56.5412 139.7162 0.02 0.50
HRUs
154 Water --> WATR/Vp45-2-3a-960/0-10 59.9680 148.1839 0.02 0.53
1
155 Forest-Deciduous --> FRSD/Fr10-2-3a-566/0-10 4949.0718 12229.4039 1.48
43.90 2
156 Forest-Deciduous --> FRSD/Fr10-2-3a-566/10-20 286.1329 707.0488 0.09
2.54 3
157 Forest-Deciduous --> FRSD/Fr10-2-3a-566/30-50 16.2770 40.2213 0.00
0.14 4
158 Forest-Deciduous --> FRSD/Fr10-2-3a-566/20-30 23.1305 57.1566 0.01
0.21 5
159 Forest-Deciduous --> FRSD/Vp45-2-3a-960/10-20 40.2642 99.4949 0.01
0.36 6
160 Forest-Deciduous --> FRSD/Vp45-2-3a-960/20-30 0.8567 2.1169 0.00
0.01 7
161 Forest-Deciduous --> FRSD/Vp45-2-3a-960/0-10 107.0857 264.6141 0.03
0.95 8
162 Range-Brush --> RNGB/Fr10-2-3a-566/0-10 57.3979 141.8331 0.02
0.51 9
163 Range-Brush --> RNGB/Fr10-2-3a-566/10-20 24.8439 61.3905 0.01
0.22 10
164 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/0-10 15.4203 38.1044
0.00 0.14 11

165 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/0-10 4823.9957 11920.3347
1.44 42.79 12
166 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/30-50 12.8503 31.7537
0.00 0.11 13
167 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/20-30 32.5540 80.4427
0.01 0.29 14
168 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/10-20 647.6542 1600.3859
0.19 5.74 15
169 Agricultural Land-Generic --> AGRL/Vp45-2-3a-960/10-20 49.6878 122.7809
0.01 0.44 16
170 Agricultural Land-Generic --> AGRL/Vp45-2-3a-960/0-10 139.6397 345.0567
0.04 1.24 17
Area [ha] Area[acres] %Wat.Area %Sub.Area

SUBBASIN # 12 6706.6444 16572.4535 2.01

LANDUSE:
Forest-Deciduous --> FRSD 505.4444 1248.9784 0.15 7.54
Agricultural Land-Close-grown --> AGRC 5098.1351 12597.7467 1.53
76.02
Agricultural Land-Generic --> AGRL 1114.5478 2754.1032 0.33 16.62

SOILS:
Fr10-2-3a-566 6718.1273 16600.8283 2.01 100.17

SLOPE:
0-10 4327.9749 10694.6423 1.29 64.53
10-20 1990.9370 4919.7048 0.60 29.69
30-50 83.0985 205.3405 0.02 1.24
20-30 316.1169 781.1407 0.09 4.71
HRUs
171 Forest-Deciduous --> FRSD/Fr10-2-3a-566/0-10 234.7318 580.0340 0.07
3.50 1
172 Forest-Deciduous --> FRSD/Fr10-2-3a-566/10-20 167.0537 412.7980 0.05
2.49 2
173 Forest-Deciduous --> FRSD/Fr10-2-3a-566/30-50 30.8407 76.2089 0.01
0.46 3
174 Forest-Deciduous --> FRSD/Fr10-2-3a-566/20-30 72.8183 179.9376 0.02
1.09 4
175 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/10-20 1482.9225
3664.3757 0.44 22.11 5
176 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/0-10 3376.1973 8342.7524
1.01 50.34 6
177 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/30-50 41.9776 103.7287
0.01 0.63 7
178 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/20-30 197.0377 486.8899
0.06 2.94 8
179 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/0-10 717.0457 1771.8558
0.21 10.69 9
180 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/10-20 340.9608 842.5312
0.10 5.08 10

181 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/20-30 46.2610 114.3133
0.01 0.69 11
182 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/30-50 10.2802 25.4030
0.00 0.15 12

Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 13 7311.2857 18066.5526 2.19

LANDUSE:

Forest-Deciduous --> FRSD 405.2122 1001.2996 0.12 5.54
Range-Brush --> RNGB 114.7958 283.6663 0.03 1.57
Agricultural Land-Close-grown --> AGRC 364.0913 899.6878 0.11 4.98
Agricultural Land-Generic --> AGRL 6439.7045 15912.8318 1.93 88.08

SOILS:

Fr10-2-3a-566 7178.1673 17737.6104 2.15 98.18
Vp45-2-3a-960 145.6365 359.8751 0.04 1.99

SLOPE:

30-50 11.1369 27.5199 0.00 0.15
0-10 6040.4891 14926.3505 1.81 82.62
10-20 1135.1082 2804.9092 0.34 15.53
20-30 137.0697 338.7060 0.04 1.87

HRUs

183 Forest-Deciduous --> FRSD/Fr10-2-3a-566/30-50 6.8535 16.9353 0.00
0.09 1
184 Forest-Deciduous --> FRSD/Fr10-2-3a-566/0-10 244.1554 603.3201 0.07
3.34 2
185 Forest-Deciduous --> FRSD/Fr10-2-3a-566/10-20 88.2386 218.0420 0.03
1.21 3
186 Forest-Deciduous --> FRSD/Fr10-2-3a-566/20-30 13.7070 33.8706 0.00
0.19 4
187 Forest-Deciduous --> FRSD/Vp45-2-3a-960/0-10 52.2578 129.1317 0.02
0.71 5
188 Range-Brush --> RNGB/Fr10-2-3a-566/0-10 102.8023 254.0295 0.03
1.41 6
189 Range-Brush --> RNGB/Fr10-2-3a-566/10-20 11.9936 29.6368 0.00
0.16 7
190 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/10-20 30.8407 76.2089
0.01 0.42 8
191 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/0-10 331.5373 819.2452
0.10 4.53 9
192 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/20-30 1.7134 4.2338
0.00 0.02 10
193 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/0-10 5225.7812 12913.1667
1.56 71.48 11
194 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/20-30 121.6493 300.6016
0.04 1.66 12
195 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/10-20 994.6118 2457.7355
0.30 13.60 13

196 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/30-50 4.2834 10.5846 0.00 0.06 14
197 Agricultural Land-Generic --> AGRL/Vp45-2-3a-960/0-10 83.9552 207.4574 0.03 1.15 15
198 Agricultural Land-Generic --> AGRL/Vp45-2-3a-960/10-20 9.4235 23.2860 0.00 0.13 16

Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 14 3734.7508 9228.7560 1.12

LANDUSE:

Residential-Med/Low Density --> URML 23.1305 57.1566 0.01 0.62
Forest-Deciduous --> FRSD 51.4011 127.0148 0.02 1.38
Agricultural Land-Close-grown --> AGRC 1493.2027 3689.7786 0.45 39.98
Agricultural Land-Generic --> AGRL 2173.4110 5370.6072 0.65 58.19

SOILS:

Fr10-2-3a-566 3658.0468 9039.2167 1.09 97.95
Fo48-2ab-42 83.0985 205.3405 0.02 2.23

SLOPE:

10-20 179.0473 442.4347 0.05 4.79
0-10 3560.3847 8797.8886 1.07 95.33
20-30 1.7134 4.2338 0.00 0.05

HRUs

199 Residential-Med/Low Density --> URML/Fr10-2-3a-566/10-20 4.2834 10.5846 0.00 0.11 1
200 Residential-Med/Low Density --> URML/Fr10-2-3a-566/0-10 18.8471 46.5721 0.01 0.50 2
201 Forest-Deciduous --> FRSD/Fr10-2-3a-566/0-10 51.4011 127.0148 0.02 1.38 3
202 Agricultural Land-Close-grown --> AGRC/Fo48-2ab-42/0-10 45.4043 112.1964 0.01 1.22 4
203 Agricultural Land-Close-grown --> AGRC/Fo48-2ab-42/10-20 5.9968 14.8184 0.00 0.16 5
204 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/10-20 81.3851 201.1067 0.02 2.18 6
205 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/0-10 1360.4165 3361.6572 0.41 36.43 7
206 Agricultural Land-Generic --> AGRL/Fo48-2ab-42/0-10 31.6974 78.3258 0.01 0.85 8
207 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/0-10 2052.6183 5072.1225 0.61 54.96 9
208 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/10-20 87.3819 215.9251 0.03 2.34 10
209 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/20-30 1.7134 4.2338 0.00 0.05 11

Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 15 16246.6364 40146.2509 4.86

LANDUSE:

Forest-Deciduous --> FRSD	4561.8500	11272.5594	1.36	28.08
Agricultural Land-Close-grown --> AGRC	4916.5178	12148.9612	1.47	30.26
Agricultural Land-Generic --> AGRL	6796.0856	16793.4674	2.03	41.83

SOILS:

Fr10-2-3a-566	5919.6964	14627.8658	1.77	36.44
Nh2-2c-848	10354.7570	25587.1222	3.10	63.73

SLOPE:

0-10	8057.1266	19909.5627	2.41	49.59
10-20	6343.7557	15675.7376	1.90	39.05
20-30	1517.1899	3749.0522	0.45	9.34
30-50	349.5277	863.7003	0.10	2.15
50-9999	6.8535	16.9353	0.00	0.04

HRUs

210	Forest-Deciduous --> FRSD/Fr10-2-3a-566/0-10	16.2770	40.2213	0.00	0.10	1
211	Forest-Deciduous --> FRSD/Fr10-2-3a-566/10-20	7.7102	19.0522	0.00	0.05	2
212	Forest-Deciduous --> FRSD/Fr10-2-3a-566/20-30	7.7102	19.0522	0.00	0.05	3
213	Forest-Deciduous --> FRSD/Fr10-2-3a-566/30-50	1.7134	4.2338	0.00	0.01	4
214	Forest-Deciduous --> FRSD/Nh2-2c-848/10-20	2095.4526	5177.9681	0.63	12.90	5
215	Forest-Deciduous --> FRSD/Nh2-2c-848/0-10	1621.7055	4007.3155	0.49	9.98	6
216	Forest-Deciduous --> FRSD/Nh2-2c-848/30-50	184.1874	455.1362	0.06	1.13	7
217	Forest-Deciduous --> FRSD/Nh2-2c-848/50-9999	2.5701	6.3507	0.00	0.02	8
218	Forest-Deciduous --> FRSD/Nh2-2c-848/20-30	624.5237	1543.2293	0.19	3.84	9
219	Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/10-20	976.6214	2413.2803	0.29	6.01	10
220	Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/0-10	1303.8752	3221.9409	0.39	8.03	11
221	Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/30-50	48.8311	120.6640	0.01	0.30	12
222	Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/20-30	258.7190	639.3076	0.08	1.59	13
223	Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/50-9999	1.7134	4.2338	0.00	0.01	14
224	Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/10-20	1159.0954	2864.1827	0.35	7.13	15
225	Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/0-10	796.7175	1968.7287	0.24	4.90	16
226	Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/20-30	316.1169	781.1407	0.09	1.95	17

227 Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/50-9999 2.5701 6.3507
0.00 0.02 18
228 Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/30-50 52.2578 129.1317
0.02 0.32 19
229 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/10-20 520.0081 1284.9659
0.16 3.20 20
230 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/0-10 2745.6768 6784.7048
0.82 16.90 21
231 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/20-30 30.8407 76.2089
0.01 0.19 22
232 Agricultural Land-Generic --> AGRL/Nh2-2c-848/20-30 279.2795 690.1135 0.08
1.72 23
233 Agricultural Land-Generic --> AGRL/Nh2-2c-848/30-50 62.5380 154.5346 0.02
0.38 24
234 Agricultural Land-Generic --> AGRL/Nh2-2c-848/10-20 1584.8681 3916.2882
0.47 9.76 25
235 Agricultural Land-Generic --> AGRL/Nh2-2c-848/0-10 1572.8745 3886.6515 0.47
9.68 26

Area [ha] Area[acres] %Wat.Area %Sub.Area

SUBBASIN # 16 6686.9743 16523.8478 2.00

LANDUSE:

Residential-Med/Low Density --> URML 20.5605 50.8059 0.01 0.31
Forest-Deciduous --> FRSD 78.8151 194.7560 0.02 1.18
Agricultural Land-Close-grown --> AGRC 1602.8585 3960.7434 0.48 23.97
Agricultural Land-Generic --> AGRL 4996.1895 12345.8341 1.49 74.72

SOILS:

Fo48-2ab-42 3994.7242 9871.1633 1.20 59.74
Fr10-2-3a-566 2703.6993 6680.9761 0.81 40.43

SLOPE:

0-10 5628.4234 13908.1156 1.68 84.17
20-30 17.9904 44.4552 0.01 0.27
30-50 7.7102 19.0522 0.00 0.12
10-20 1044.2996 2580.5164 0.31 15.62

HRUs

236 Residential-Med/Low Density --> URML/Fo48-2ab-42/0-10 10.2802 25.4030
0.00 0.15 1
237 Residential-Med/Low Density --> URML/Fr10-2-3a-566/0-10 10.2802 25.4030
0.00 0.15 2
238 Forest-Deciduous --> FRSD/Fo48-2ab-42/0-10 49.6878 122.7809 0.01
0.74 3
239 Forest-Deciduous --> FRSD/Fr10-2-3a-566/20-30 12.8503 31.7537 0.00
0.19 4
240 Forest-Deciduous --> FRSD/Fr10-2-3a-566/30-50 5.1401 12.7015 0.00
0.08 5
241 Forest-Deciduous --> FRSD/Fr10-2-3a-566/10-20 11.1369 27.5199 0.00
0.17 6

242 Agricultural Land-Close-grown --> AGRC/Fo48-2ab-42/10-20 75.3883 186.2883
0.02 1.13 7
243 Agricultural Land-Close-grown --> AGRC/Fo48-2ab-42/0-10 696.4853 1721.0499
0.21 10.42 8
244 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/10-20 49.6878 122.7809
0.01 0.74 9
245 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/0-10 781.2971 1930.6243
0.23 11.68 10
246 Agricultural Land-Generic --> AGRL/Fo48-2ab-42/10-20 515.7246 1274.3814
0.15 7.71 11
247 Agricultural Land-Generic --> AGRL/Fo48-2ab-42/0-10 2647.1580 6541.2598
0.79 39.59 12
248 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/30-50 2.5701 6.3507 0.00
0.04 13
249 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/0-10 1433.2347 3541.5947
0.43 21.43 14
250 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/20-30 5.1401 12.7015 0.00
0.08 15
251 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/10-20 392.3619 969.5460
0.12 5.87 16

Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 17 19691.4673 48658.6002 5.89

LANDUSE:

Forest-Deciduous --> FRSD 5243.7716 12957.6218 1.57 26.63
Agricultural Land-Close-grown --> AGRC 8399.8008 20756.3277 2.51
42.66
Agricultural Land-Generic --> AGRL 6081.6100 15027.9623 1.82 30.88

SOILS:

Fo48-2ab-42 4308.2711 10645.9533 1.29 21.88
Fr10-2-3a-566 7628.7839 18851.1064 2.28 38.74
Nh2-2c-848 7788.1274 19244.8521 2.33 39.55

SLOPE:

30-50 250.1521 618.1385 0.07 1.27
20-30 759.0233 1875.5845 0.23 3.85
10-20 6003.6516 14835.3233 1.80 30.49
0-10 12676.3745 31323.9553 3.79 64.37
50-9999 35.9808 88.9103 0.01 0.18

HRUs

252 Forest-Deciduous --> FRSD/Fo48-2ab-42/30-50 2.5701 6.3507 0.00 0.01
1
253 Forest-Deciduous --> FRSD/Fo48-2ab-42/20-30 18.8471 46.5721 0.01
0.10 2
254 Forest-Deciduous --> FRSD/Fo48-2ab-42/10-20 122.5060 302.7185 0.04
0.62 3
255 Forest-Deciduous --> FRSD/Fo48-2ab-42/0-10 597.9664 1477.6050 0.18
3.04 4

256	Forest-Deciduous --> FRSD/Fr10-2-3a-566/30-50	3.4267	8.4677	0.00	0.02	5
257	Forest-Deciduous --> FRSD/Fr10-2-3a-566/10-20	326.3972	806.5437	0.10	1.66	6
258	Forest-Deciduous --> FRSD/Fr10-2-3a-566/0-10	899.5197	2222.7582	0.27	4.57	7
259	Forest-Deciduous --> FRSD/Fr10-2-3a-566/20-30	35.1241	86.7934	0.01	0.18	8
260	Forest-Deciduous --> FRSD/Nh2-2c-848/50-9999	19.7038	48.6890	0.01	0.10	9
261	Forest-Deciduous --> FRSD/Nh2-2c-848/30-50	117.3659	290.0170	0.04	0.60	10
262	Forest-Deciduous --> FRSD/Nh2-2c-848/0-10	1454.6519	3594.5175	0.44	7.39	11
263	Forest-Deciduous --> FRSD/Nh2-2c-848/10-20	1362.9865	3368.0079	0.41	6.92	12
264	Forest-Deciduous --> FRSD/Nh2-2c-848/20-30	282.7062	698.5811	0.08	1.44	13
265	Agricultural Land-Close-grown --> AGRC/Fo48-2ab-42/30-50	24.8439	61.3905	0.01	0.13	14
266	Agricultural Land-Close-grown --> AGRC/Fo48-2ab-42/20-30	97.6621	241.3280	0.03	0.50	15
267	Agricultural Land-Close-grown --> AGRC/Fo48-2ab-42/10-20	647.6542	1600.3859	0.19	3.29	16
268	Agricultural Land-Close-grown --> AGRC/Fo48-2ab-42/0-10	1461.5054	3611.4528	0.44	7.42	17
269	Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/30-50	0.8567	2.1169	0.00	0.00	18
270	Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/10-20	950.0642	2347.6560	0.28	4.82	19
271	Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/20-30	43.6910	107.9625	0.01	0.22	20
272	Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/0-10	2045.7648	5055.1872	0.61	10.39	21
273	Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/20-30	119.0793	294.2508	0.04	0.60	22
274	Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/0-10	1782.7624	4405.2951	0.53	9.05	23
275	Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/30-50	18.8471	46.5721	0.01	0.10	24
276	Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/50-9999	0.8567	2.1169	0.00	0.00	25
277	Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/10-20	1206.2131	2980.6129	0.36	6.13	26
278	Agricultural Land-Generic --> AGRL/Fo48-2ab-42/20-30	1.7134	4.2338	0.00	0.01	27
279	Agricultural Land-Generic --> AGRL/Fo48-2ab-42/10-20	271.5693	671.0613	0.08	1.38	28
280	Agricultural Land-Generic --> AGRL/Fo48-2ab-42/0-10	1061.4333	2622.8547	0.32	5.39	29

281 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/20-30 2.5701 6.3507 0.00 0.01 30
282 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/10-20 695.6286 1718.9330 0.21 3.53 31
283 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/0-10 2625.7409 6488.3370 0.79 13.33 32
284 Agricultural Land-Generic --> AGRL/Nh2-2c-848/0-10 747.0297 1845.9478 0.22 3.79 33
285 Agricultural Land-Generic --> AGRL/Nh2-2c-848/10-20 420.6326 1039.4041 0.13 2.14 34
286 Agricultural Land-Generic --> AGRL/Nh2-2c-848/20-30 157.6301 389.5119 0.05 0.80 35
287 Agricultural Land-Generic --> AGRL/Nh2-2c-848/30-50 82.2418 203.2236 0.02 0.42 36
288 Agricultural Land-Generic --> AGRL/Nh2-2c-848/50-9999 15.4203 38.1044 0.00 0.08 37

		Area [ha]	Area [acres]	%Wat.Area	%Sub.Area
SUBBASIN #	18	8995.2162	22227.6290	2.69	

LANDUSE:

	Area [ha]	Area [acres]	%Wat.Area	%Sub.Area
Residential-Med/Low Density --> URML	141.3531	349.2906	0.04	1.57
Forest-Deciduous --> FRSD	1121.4012	2771.0385	0.34	12.47
Agricultural Land-Close-grown --> AGRC	1540.3204	3806.2088	0.46	17.12
Agricultural Land-Generic --> AGRL	6207.5427	15339.1485	1.86	69.01

SOILS:

	Area [ha]	Area [acres]	%Wat.Area	%Sub.Area
Fo48-2ab-42	8391.2339	20735.1586	2.51	93.29
Nh2-2c-848	619.3836	1530.5278	0.19	6.89

SLOPE:

	Area [ha]	Area [acres]	%Wat.Area	%Sub.Area
10-20	4132.6506	10211.9862	1.24	45.94
0-10	4128.3672	10201.4017	1.24	45.90
20-30	619.3836	1530.5278	0.19	6.89
30-50	130.2162	321.7707	0.04	1.45

HRUs
289 Residential-Med/Low Density --> URML/Fo48-2ab-42/10-20 53.9712 133.3655 0.02 0.60 1
290 Residential-Med/Low Density --> URML/Fo48-2ab-42/0-10 87.3819 215.9251 0.03 0.97 2
291 Forest-Deciduous --> FRSD/Fo48-2ab-42/0-10 563.6990 1392.9285 0.17 6.27 3
292 Forest-Deciduous --> FRSD/Fo48-2ab-42/10-20 351.2410 867.9342 0.11 3.90 4
293 Forest-Deciduous --> FRSD/Fo48-2ab-42/20-30 26.5572 65.6243 0.01 0.30 5
294 Forest-Deciduous --> FRSD/Nh2-2c-848/20-30 67.6782 167.2361 0.02 0.75 6
295 Forest-Deciduous --> FRSD/Nh2-2c-848/30-50 38.5508 95.2611 0.01 0.43 7

296 Forest-Deciduous --> FRSD/Nh2-2c-848/0-10 21.4171 52.9228 0.01 0.24
8
297 Forest-Deciduous --> FRSD/Nh2-2c-848/10-20 52.2578 129.1317 0.02
0.58 9
298 Agricultural Land-Close-grown --> AGRC/Fo48-2ab-42/0-10 433.4828 1071.1578
0.13 4.82 10
299 Agricultural Land-Close-grown --> AGRC/Fo48-2ab-42/20-30 164.4836 406.4472
0.05 1.83 11
300 Agricultural Land-Close-grown --> AGRC/Fo48-2ab-42/10-20 759.8800 1877.7014
0.23 8.45 12
301 Agricultural Land-Close-grown --> AGRC/Fo48-2ab-42/30-50 35.9808 88.9103
0.01 0.40 13
302 Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/20-30 39.4075 97.3780
0.01 0.44 14
303 Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/10-20 62.5380 154.5346
0.02 0.70 15
304 Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/0-10 29.9840 74.0919
0.01 0.33 16
305 Agricultural Land-Close-grown --> AGRC/Nh2-2c-848/30-50 14.5637 35.9875
0.00 0.16 17
306 Agricultural Land-Generic --> AGRL/Fo48-2ab-42/30-50 41.1209 101.6118 0.01
0.46 18
307 Agricultural Land-Generic --> AGRL/Fo48-2ab-42/20-30 280.1361 692.2304
0.08 3.11 19
308 Agricultural Land-Generic --> AGRL/Fo48-2ab-42/0-10 2879.3198 7114.9431
0.86 32.01 20
309 Agricultural Land-Generic --> AGRL/Fo48-2ab-42/10-20 2713.9795 6706.3790
0.81 30.17 21
310 Agricultural Land-Generic --> AGRL/Nh2-2c-848/10-20 138.7830 342.9398 0.04
1.54 22
311 Agricultural Land-Generic --> AGRL/Nh2-2c-848/0-10 113.0825 279.4325 0.03
1.26 23
312 Agricultural Land-Generic --> AGRL/Nh2-2c-848/20-30 41.1209 101.6118 0.01
0.46 24

Area [ha] Area [acres] %Wat.Area %Sub.Area

SUBBASIN # 21 11162.3466 27582.7166 3.34

LANDUSE:

Forest-Deciduous --> FRSD 65.9648 163.0023 0.02 0.59
Agricultural Land-Close-grown --> AGRC 5332.0102 13175.6638 1.60
47.77
Agricultural Land-Generic --> AGRL 5783.4834 14291.2767 1.73 51.81

SOILS:

Fo48-2ab-42 9682.2589 23925.3458 2.90 86.74
Fr10-2-3a-566 1499.1995 3704.5970 0.45 13.43

SLOPE:

0-10 10960.4336 27083.7794 3.28 98.19
20-30 9.4235 23.2860 0.00 0.08
10-20 211.6013 522.8774 0.06 1.90

HRUs
341 Forest-Deciduous --> FRSD/Fo48-2ab-42/0-10 65.9648 163.0023 0.02
0.59 1
342 Agricultural Land-Close-grown --> AGRC/Fo48-2ab-42/20-30 6.8535 16.9353
0.00 0.06 2
343 Agricultural Land-Close-grown --> AGRC/Fo48-2ab-42/0-10 4751.1775 11740.3971
1.42 42.56 3
344 Agricultural Land-Close-grown --> AGRC/Fo48-2ab-42/10-20 58.2546 143.9501
0.02 0.52 4
345 Agricultural Land-Close-grown --> AGRC/Fr10-2-3a-566/0-10 515.7246 1274.3814
0.15 4.62 5
346 Agricultural Land-Generic --> AGRL/Fo48-2ab-42/10-20 153.3467 378.9273
0.05 1.37 6
347 Agricultural Land-Generic --> AGRL/Fo48-2ab-42/0-10 4644.0918 11475.7830
1.39 41.60 7
348 Agricultural Land-Generic --> AGRL/Fo48-2ab-42/20-30 2.5701 6.3507 0.00
0.02 8
349 Agricultural Land-Generic --> AGRL/Fr10-2-3a-566/0-10 983.4749 2430.2156
0.29 8.81 9

AVE MONTHLY BASIN VALUES

MON	RAIN (MM)	SNOW FALL (MM)	SURF Q (MM)	LAT Q (MM)	WATER YIELD (MM)	ET (MM)	SED YIELD (T/HA)	PET (MM)
1	63.33	60.36	30.92	0.07	39.59	2.69	1.34	4.84
2	52.24	51.68	34.18	0.03	37.47	4.40	1.38	8.47
3	61.00	57.20	92.46	0.38	95.53	17.57	3.84	28.55
4	71.46	38.71	50.00	1.35	61.11	37.45	2.38	68.19
5	89.79	7.45	17.54	1.53	36.72	57.96	1.31	119.79
6	98.37	0.00	24.38	1.37	43.29	75.12	2.55	142.34
7	90.63	0.00	14.59	1.24	29.17	81.88	1.68	134.80
8	107.54	0.00	28.26	1.30	37.00	68.80	2.44	107.48
9	75.07	0.07	15.14	1.05	20.97	59.67	1.12	91.25
10	110.52	28.43	29.33	1.86	38.01	35.05	1.78	48.41
11	103.70	66.67	42.57	1.41	57.08	13.88	1.88	16.61
12	93.89	87.87	37.39	0.39	52.46	3.80	1.62	4.39

AVE ANNUAL BASIN STRESS DAYS

WATER STRESS DAYS = 2.26
TEMPERATURE STRESS DAYS = 123.44
NITROGEN STRESS DAYS = 7.95
PHOSPHORUS STRESS DAYS = 0.14
AERATION STRESS DAYS = 0.00

1

General Input/Output section (file.cio):

AVE ANNUAL BASIN VALUES

PRECIP = 1018.0 MM
SNOW FALL = 398.95 MM
SNOW MELT = 394.05 MM
SUBLIMATION = 3.44 MM
SURFACE RUNOFF Q = 417.07 MM
LATERAL SOIL Q = 11.96 MM
TILE Q = 0.00 MM
GROUNDWATER (SHAL AQ) Q = 113.32 MM
GROUNDWATER (DEEP AQ) Q = 6.39 MM
REVAP (SHAL AQ => SOIL/PLANTS) = 8.91 MM
DEEP AQ RECHARGE = 6.45 MM
TOTAL AQ RECHARGE = 128.93 MM
TOTAL WATER YLD = 548.75 MM
PERCOLATION OUT OF SOIL = 129.31 MM
ET = 458.3 MM
PET = 775.1MM
TRANSMISSION LOSSES = 0.00 MM
SEPTIC INFLOW = 0.00 MM
TOTAL SEDIMENT LOADING = 23.32 T/HA
TILE FROM IMPOUNDED WATER = 0.000 (MM)
EVAPORATION FROM IMPOUNDED WATER = 0.000 (MM)
SEEPAGE INTO SOIL FROM IMPOUNDED WATER = 0.000 (MM)

APPENDIX V: INTRODUCTORY LETTER FROM THE UNIVERSITY OF NAIROBI

UNIVERSITY OF NAIROBI

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

Telephone: +254 2 318262
Extension: 28016
Fax: +254 2 245566
Email-geography@uonbi.ac.ke

P.O. BOX 30197-00100
NAIROBI
KENYA

July 24, 2018

The Secretary
Teachers Service Commission
Nairobi, Kenya.

Dear Sir/Madam,

RE: OKECH CLIFFORD OMONDI

This is to confirm that the above named is a Master of Arts student (Registration Number – C50/88424/2016) at the Department of Geography and Environmental Studies, **University of** Nairobi undertaking **a Masters course in Climatology**.

Mr. Omondi has successfully completed his coursework, gone to the field for data collection and is now doing data analysis.

Any assistance accorded to him will be highly appreciated.

CHAIRMAN
Department Of Geography
and Environmental Studies
UNIVERSITY OF NAIROBI

Dr. Boniface Wambua
Chairman, Department of Geography & Environmental Studies

APPENDIX VI: RESEARCH AUTHORIZATION LETTER FROM THE MINISTRY OF EDUCATION

MINISTRY OF EDUCATION

STATE DEPARTMENT OF BASIC EDUCATION

Telegrams: "SCHOOLING" Homa Bay
Telephone + 254722767574
When replying please quote
cdehomabay@gmail.com

COUNTY DIRECTOR OF EDUCATION
HOMA BAY COUNTY
P.O BOX 710
HOMA BAY
DATE: 13TH APRIL, 2018

REF: MOE/CDE/HBC/ADM/11/VOL.II/49

CLIFFORD OMONDI OKETCH
UNIVERSITY OF NAIROBI
P.O BOX 30197 -00100
NAIROBI

RE: RESEARCH AUTHORIZATION.

Following your application to carry out research on ***"Impact of Climate variability on water Resources in Homa Bay County"*** *You* are hereby authorized to undertake research in **Homa Bay County** for the period ending **5th April, 2019**.

Please note that as an applicant who has been licensed under the Science, Technology and Innovation Act 2013 to conduct research in Kenya, you shall deposit a copy of the final research report to the **County Director of Education Office Homa Bay** within **one year** of completion. The soft copy and the hard copy.

COUNTY DIRECTOR OF EDUCATION
HOMA BAY COUNTY
P. O. Box 710 - 40300, HOMA BAY
Email: cdehomabay@gmail.com

SHEM OMBONYO
FOR: COUNTY DIRECTOR OF EDUCATION
HOMA BAY
CC

1. **County Commissioner**
   Homa Bay County.

ISO 9001
BUREAU VERITAS
Certification

APPENDIX VII: RESEARCH AUTHORIZATION LETTER FROM THE OFFICE OF THE PRESIDENT

OFFICE OF THE PRESIDENT

MINISTRY OF INTERIOR AND COORDINATION OF NATIONAL GOVERNMENT

Telephone: Homa Bay 22104 or 22105/Fax: 22491
E-mail: cc_homabay@yahoo.com
When replying please quote

COUNTY COMMISSIONER
HOMA BAY COUNTY
P. O. BOX 1 – 40300
HOMA BAY

REF NO: EDUC 12/1 VOL.III/87

11TH APRIL, 2018

All Deputy County Commissioners
HOMA BAY COUNTY

RE: RESEARCH AUTHORIZATION-CLIFFORD OMONDI OKETCH

This is to confirm to you that the above named has been authorized to carry out a research on "**Impact of Climate Variability on Water Resources in Homa Bay County**," for the period ending **5th April, 2019.**

Please accord him the necessary assistance as you note that all ethical practices are observed.

ALFRED K.LANGAT
FOR: COUNTY COMMISSIONER
HOMA BAY COUNTY.

cc

The County Director of Education
HOMA BAY COUNTY.

Clifford Omondi Oketch

**Please note our e-mail address cc_homabay@yahoo.com*

APPENDIX VIII: PLAGIARISM REPORT

IMPACT OF CLIMATE VARIABILITY ON SURFACE WATER RESOURCES IN HOMA BAY COUNTY

by Clifford Omondi

Submission date: 30-Oct-2018 02:59PM (UTC+0300)

Submission ID: 1029595745

File name: cliff_latest1.doc (36.67M)

Word count: 20984

Character count: 126201

IMPACT OF CLIMATE VARIABILITY ON SURFACE WATER RESOURCES IN HOMA BAY COUNTY

ORIGINALITY REPORT

8%	6%	5%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Springer Geography, 2016. Publication	1%
2	195.202.82.11 Internet Source	<1%
3	Nile River Basin, 2011. Publication	<1%
4	d-scholarship.pitt.edu Internet Source	<1%
5	repository.out.ac.tz Internet Source	<1%
6	cog.go.ke Internet Source	<1%
7	www.kenya-information-guide.com Internet Source	<1%

APPENDIX IX: RESEARCH AUTHORIZATION LETTER FROM NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471, 2241349,3310571,2219420
Fax:+254-20-318245,318249
Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/18/19333/22093**

Date: **5th April, 2018**

Clifford Omondi Okech
University of Nairobi
P.O Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Impact of climate variability on water resources in Homa Bay County,"*** I am pleased to inform you that you have been authorized to undertake research in **Homabay County** for the period ending **5th April, 2019.**

You are advised to report to **the County Commissioner and the County Director of Education, Homabay County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Homabay County.

The County Director of Education
Homabay County.

National Commission for Science, Technology and Innovation is ISO9001:2008 Certified

APPENDIX X: RESEARCH PERMIT

CONDITIONS

1. The License is valid for the proposed research, research site specified period.
2. Both the Licence and any rights thereunder are non-transferable.
3. Upon request of the Commission, the Licensee shall submit a progress report.
4. The Licensee shall report to the County Director of Education and County Governor in the area of research before commencement of the research.
5. Excavation, filming and collection of specimens are subject to further permissions from relevant Government agencies.
6. This Licence does not give authority to transfer research materials.
7. The Licensee shall submit two (2) hard copies and upload a soft copy of their final report.
8. The Commission reserves the right to modify the conditions of this Licence including its cancellation without prior notice.

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No.A 18130

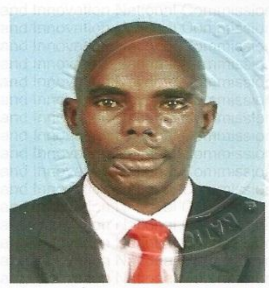
CONDITIONS: see back page

THIS IS TO CERTIFY THAT:
MR. CLIFFORD OMONDI OKECH
of UNIVERSITY OF NAIROBI, 39-40326 RODI-KOPANY,has been permitted to conduct research in *Homabay County*

on the topic: *IMPACT OF CLIMATE VARIABILITY ON WATER RESOURCES IN HOMA BAY COUNTY*

for the period ending:
5th April,2019

Permit No : NACOSTI/P/18/19333/22093
Date Of Issue : 5th April,2018
Fee Recieved :Ksh 1000



Applicant's Signature

Director General
National Commission for Science, Technology & Innovation

APPENDIX XI: DECLARATION OF ORIGINALITY

UNIVERSITY OF NAIROBI
COLLEGE OF HUMANITIES AND SOCIAL SCIENCES

STATEMENT OF FEES ACCOUNT **Date :** 05-Sep-2018

Name : CLIFFORD OMONDI OKECH (KENYAN) **Reg. Number :** C50/88424/2016

Overall Status : CURRENT **ACADEMIC YEAR STATUS:** CURRENT

Academic Year : 2015/2016 **Billing Currency :** KES

Transaction Id	Date	Description	Debits DR	Credits CR	Balance	Cur.Rate
2180099537	16-SEP-16	FEES PAYMENTS	0.00	25,000.00	-25,000.00	KES=1
		Academic Year Totals :	**0.00**	**25,000.00**	**-25,000.00**	
Closing Balance : -25,000.00						
Academic Year : 2016/2017	**ACADEMIC YEAR STATUS:**CURRENT					
Opening Balance			0.00	25,000.00		**-25,000.00**
C50/88424/2016-2016/2017-SEM1	25-OCT-16	FEES PAYABLE FOR SEM1	79,500.00	0.00	54,500.00	KES=1
2180116620	25-OCT-16	FEES PAYMENTS	0.00	23,500.00	31,000.00	KES=1
2180116642	25-OCT-16	FEES PAYMENTS	0.00	174,500.00	-143,500.00	KES=1
C50/88424/2016-2016/2017-SEM2	27-FEB-17	FEES PAYABLE FOR SEM2	76,500.00	0.00	-67,000.00	KES=1
C50/88424/2016-2016/2017-SEM3	23-AUG-17	FEES PAYABLE FOR SEM3	62,000.00	0.00	-5,000.00	KES=1
		Academic Year Totals :	**218,000.00**	**223,000.00**	**-5,000.00**	
Closing Balance : -5,000.00						
Academic Year : 2017/2018	**ACADEMIC YEAR STATUS:**CURRENT					
Opening Balance			0.00	5,000.00		**-5,000.00**
2180299444	04-SEP-18	FEES PAYMENTS	0.00	56,000.00	-61,000.00	KES=1
C50/88424/2016-2017/2018-SEM3	05-SEP-18	FEES PAYABLE FOR SEM4	74,500.00	0.00	13,500.00	KES=1
2180299574	05-SEP-18	FEES PAYMENTS	0.00	13,000.00	500.00	KES=1
2180299600	05-SEP-18	FEES PAYMENTS	0.00	500.00	0.00	KES=1
		Academic Year Totals :	**74,500.00**	**74,500.00**	**0.00**	
		GRAND TOTALS :	**292,500.00**	**292,500.00**	**0.00**	
Closing Balance : 0.00						

Checked By :..

Approved By :..
BURSAR

NB: Valid with an Official University of Nairobi Stamp
Any fee balance disqualify one for sitting for examination