Mapping, Assessment & Management of Transboundary Water Resources in the IGAD Sub-Region Project

Volume II

SOCIOECONOMIC COMPONENT

INTERGOVERNMENTAL AUTHORITY ON DEVELOPMENT

AFRICAN WATER FACILITY

SAHARA AND SAHEL OBSERVATORY

Mapping, Assessment & Management of Transboundary Water Resources in the IGAD Sub-Region Project

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Socioeconomic assessment and analysis of transboundary water resources in IGAD Sub-region

December 2011

Study conducted with the support of:

SEREFACO CONSULTANTS LIMITED
6 Katonga Road, Nakasero, P. O. Box 6916, KAMPALA
Tel. 256 41 4342397 or 4255577, Fax. 256 41 4230691
E-mail:serefaco@serefacoconsultants.com

ISBN: 978-9973-856-59-3

PREFACE

The IGAD sub-region represents one of the marginal regions of the world in terms of rainfall available for natural vegetation growth and crop production. About 80% of the IGAD sub-region is arid and semi arid with low level of water use. It has a population estimated at **206 million in 2010** and projected to reach **462 million in 2050** in an area of **5.2 million km^2**.

The most obvious manifestation has been periodic droughts and desertification that have consigned millions to perpetual poverty and deaths. The populations derive their livelihoods from water and land based primary production activities such as nomadic pastoralism and subsistence agriculture in a region where rainfall variability is high. The sub-region is the home of the greatest numbers of pastoral communities estimated to be about **17 million**. Dependable water availability is therefore vital to the development of the region.

The mounting concerns over water scarcity in the IGAD sub-region have focused attention to several socioeconomic challenges of water resource management.

Firstly, as the sub-region expects to advance economically and socially, the demand for water will increase as a result of population growth, rising incomes, changing dietary patterns, urbanization and industrial development. While demand will increase in all sectors, agriculture will account for the bulk of the water and will therefore be the focal point for adjustment of demand pressure.

Secondly, there are concerns as to whether the IGAD sub-region will have enough water to meet the food security needs of a rapidly growing population. Along with food security, water security has also become a fundamental issue for human development in the sub-region

While it is a fact that water occupies pivotal position in development in the IGAD sub-region, none of the **member countries has adequate information** to manage their water resources for the attainment of economic efficiency and equity in water allocation for different uses. Yet, four IGAD countries namely **Eritrea, Kenya, Djibouti and Somalia** are in the category of those experiencing water scarcity i.e. with **less than 1000 m^3 per person per year** or less.

Indeed by the year 2025 even Ethiopia and Uganda which are presently with adequate water will be water stressed (1000-2000 m^3/person/year) while Djibouti, Eritrea, Kenya, Somalia and Sudan will be in water barrier situation «500 m3/person/year » and therefore water will be limiting any sustainable development.

None of the IGAD Member States has at the present time water per capita necessary for industrial development (2400 m^3/day). This lack of water will severely constrain food production, ecosystem maintenance and economic development among other needs and uses.

Water resources link the IGAD Member states internally and externally with adjacent regions. Six transboundary river basins and six transboundary aquifer systems have been identified in this stage of the IGAD sub-region study. **The ratio of water demands to available supply averages which is 9% in 2011 will increase to 15% in 2031** as projected by this study which is known as "*Mapping, Assessment and Management of Transboundary Water Resources in the IGAD Sub-region Project*". However, there are specific problems that call the need for adequate knowledge of surface and ground water resources.

This Study (the first sub-regional study) has provided a platform for refocusing efforts within the sub-region towards better quantification and understanding of the extent of water scarcity and other water related factors that impact socioeconomic development in the sub-region. The most significant of the drivers of water demand in all sectors is population, which in the sub-region is projected to increase by 165% between 2010 and 2030, and by 136% between 2030 and 2050. This study demonstrates that these increases will create significant increases in water withdrawals for domestic supply and for industry.

The other significant sector is agriculture, which combines irrigation and livestock. Again here population is the most important parameter of change, driving the demand for food and hence the need to raise agricultural productivity through irrigation development.

The regional process has highlighted the **low level of water use** and hence of water security currently estimated as about 3% of the annually renewable water resources as a basic indicator of the overall lack of water infrastructure development to ensure water security for the social and economy and environmental use. The IGAD sub-region is one of the most vulnerable areas to climate variability and recurrent droughts.

Hence, there is need to further understand in depth the environmental situation and consolidate IGAD capacities to monitor the linkages between climate and the water system along with identification and mapping of the water resources and the major risks associated with degradation, pollution and water quality deterioration. Policies, strategies, and objectives of cooperation and how to achieve them should be set out in a second stage of the IGAD project study.

It is important to note that the IGAD project was implemented at national and sub-regional levels with active participation of the focal national institutions by employing national and regional consultants. The project coordination is done by OSS with the establishment of national coordination units in the focal national water institutions of the IGAD Member States. Steering Committee of the project was in place and the regional coordination and facilitation was done by IGAD.

We would like to thank everyone who contributed to the success of this project: the Ministries in charge of Water and national institutions, the IGAD and OSS cooperation partners (particularly the African Water Facility), the national teams, national and

international consultants, the project team within the Executive Secretariat of OSS and The IGAD Secretariat.

Our satisfaction was to pass the ownership of all project results by national teams and the establishment within the Executive Secretary of IGAD powerful tools to ensure the continuity of the project.

This final project report is made up of 7 individual documents namely

- Introduction, Overview and General Recommendations
- Volume 1: Institutional Framework Component Report
- Volume 2: Socioeconomic Component Report
- Volume 3: Environment Component Report
- Volume 4: GIS/Database Component Report
- Volume 5: Water Resources Modelling/Hydrology Component Report
- Volume 6: IWRM Component Report

We also thank SEREFACO Consultants Limited and its team for the excellent work carried out despite all the difficulties encountered particularly the lack of reliable data.

The Executive Secretary of OSS
Dr. Ing. Chedli FEZZANI

The Executive Secretary of IGAD
Eng. Mahboub Mohamed MAALIM

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LIST OF ACRONYMS

AEZ	Agro-ecological Zone
AfDB	African Development Bank
ASAL	Arid and Semi-Arid Land
CIA	Central Intelligence Agency (USA)
DPW	Dubai World Port
EAC	East African Community
ERWR	External Renewable Water Resources
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross Domestic Product
GIA	Gross irrigated area
Ha	Hectares (1 ha = 2.4712 acres)
IAS	Iullemeden Aquifer System
IFPRI	International Food Policy Research Institute
IGAD	Inter-governmental Authority on Development
IHO	International Hydrography Organisation
IMF	International Monetary Fund
IMO	International Maritime Organisation
IRWR	Internal Renewable Water Resources
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
JMP	Joint Monitoring Programme (of WHO/UNICEF)
MAM-TWR	Mapping, Assessment and Management of Transboundary Water Resources
MDG	Millenium Development Goal
NET	Net evapotranspiration rate
NIA	Net irrigated area
NWSAS	North Western Sahara Aquifer System
OSS	Sahara and Sahel Observatory
PPP valuation	Purchasing Power Parity (valuation of the dollar)
TLU	Tropical Livestock Unit (equivalent to 250 kg liveweight)

TOR	Terms of Reference (of MAM-TWR Project)
TRWR	Total Renewable Water Resources
UN	United Nations
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFPA	United Nations Fund for Population Activities
UNICEF	United Nations Children's Fund
WB	World Bank
WDI/ADI	World Development Report/Africa Development Report (by World Bank)
WHO	World Health Organisation
WR	Water Resources (eg report)
WWR	World Water Report (by UNESCO)

EXECUTIVE SUMMARY

OBJECTIVE AND SCOPE

The overall goal of the socioeconomic component was to establish a better understanding of: (i) the socioeconomic condition of the sub-region with specific regard to factors that drive the pressures on water resources; and (ii) the demand and uses of water for various socioeconomic purposes, including a preliminary quantified assessment of water use for domestic supply, industry, and agriculture. The component provided the necessary pathway for an in-depth investigation of the factors that impact on water resources and their uses. This included a review of the existing information on water resources of the sub-region vis-à-vis uses and demands in current and future scenarios.

Several socioeconomic challenges have underscored the analysis of the water resources of the IGAD Sub-region and their uses. The sub-region's march on the path of economic, political and social progress is constrained by many pit-falls, in particular: poverty and food insecurity; accelerated degradation of natural resources; environmental hazards that manifest themselves in frequent and severe droughts; and conflicts of various kinds - political, social, economic and religious. The countries of the sub-region are in an era of serious water shortages, which raises the spectre of looming water insecurity and the prospect of intensified competition for water in the future. The main challenge for the sub-region is, among others, how the water resources will be managed to meet rising food demand while at the same time protecting access of the poor and vulnerable people to the water that sustains their well-being.

In addressing these underlying constraints, the socioeconomic component envisaged a two-way causal relationship between water resources (supply and demand) on the one hand, and the processes of socioeconomic development on the other. Thus, depending on the situation of abundance or scarcity, the current supply and access to water resources may positively or negatively impact on the socioeconomic processes in the sub-region. On the other hand, uncontrollable trends in the key socioeconomic parameters (e.g. population and economic growth) can place unsustainable demands on water resources through over-exploitation. The implied competition for a finite supply requires that a balance be struck between supply and the rate of exploitation (demand) to avoid undue constraint on human and socioeconomic progress of the sub-region. An evaluation of demand management strategies was therefore an important aspect of the component, and this has been achieved by way of a concept note (in Chapter 5) which may form the basis of a more detailed proposal in future projects.

COMPONENT CONCEPT AND STRATEGY

The component used national reports as the building blocks for the core tasks of sub-regional assessments, analyses and synthesis of data and information (Chapter 2). These were significantly complemented and where necessary upgraded with complementary data and information from regional and international sources. To achieve the desired results more effectively, the study focused the assessment and analysis of water use in the most important water-using sectors (this was largely dictated by lack or inadequacy of data for the other sectors), namely water uses in the domestic, agriculture and industrial sectors.

Two models (Water Use Model and PODIUMSIM Model) were examined for potential application in the quantification, assessment and projection of water use. Both models provide tools for simulation of alternative scenarios of future water demand with respect to the variations of the key demand drivers. While the full application of the models was proscribed by insufficient data, they nonetheless provided the conceptual framework used in this study to work projections and scenarios of future water demand.

KEY FINDINGS

Key results of the socioeconomic component included, firstly the detailed assessment of the key drivers of water demand in the sub-region (Chapter 3), and secondly the projections of future water needs in various scenarios (Chapter 4). The Table below summarises the results of the preliminary quantification of total current and future water withdrawals in various scenarios. Though based on a limited set of scenarios (principally irrigation water use scenarios), the Table offers "a vision" of an emerging future competition for water and how this might be managed through adjustment in agriculture water use.

Summary of current and future water withdrawals by sector – 2010, 2030 and 2050

Sector	2010 Withdrawals		2030 Withdrawals				2050 Withdrawals			
	Qty	%	SC 1		SC 2		SC 1		SC 2	
			Qty	%	Qty	%	Qty	%	Qty	%
Domestic	**2.29**	**4.50**	**5.25**	**6.93**	**5.25**	**9.71**	**10.32**	**11.22**	**10.32**	**18.42**
Industry	**0.63**	**1.30**	**2.01**	**2.65**	**2.01**	**3.72**	**3.84**	**4.18**	**3.84**	**6.86**
Agriculture	**47.90**	**94.20**	**68.45**	**90.42**	**46.79**	**86.57**	**77.80**	**84.60**	**41.85**	**74.72**
- Irrigation	**46.13**	**90.70**	**65.57**	**86.61**	**43.91**	**81.24**	**73.94**	**80.40**	**37.99**	**67.83**
- Livestock	**1.77**	**3.50**	**2.88**	**3.81**	**2.88**	5.33	3.86	4.20	3.86	6.89
Total	**50.82**	**100.00**	**75.71**	**100.00**	**54.05**	**100.00**	**91.96**	**100.00**	**56.01**	**100.00**
% total AWR	**16.7%**		**24.9%**		**17.8%**		**30.2%**		**18.4%**	

The findings of the component reveal that:

- Overall water withdrawals are expected to increase substantially in the medium term (2030) and long-term (2050). The share of domestic supply will increase from 4.5% in 2010 to 9.7% in 2030 and to 18.4% in 2050. This is expected to reflect: (i) deliberate efforts by governments to accelerate access to potable water, and (ii) efforts to raise the level of household water security.

- The share of industry and livestock will also increase, reflecting efforts of governments to accelerate industrialisation and better targeting of improved water supply for livestock as a strategy for livestock development in the sub-region.
- The overall share of agriculture will decline, principally due to the declining share of irrigation withdrawals. This is predicated upon raising efficiency in irrigation water use (to 50% in 2030 and 60% in 2050) through improvements in irrigation technology and management.
- Water scarcity is looming over the sub-region and is a serious threat to any future plans for economic and social development. Countries of the sub-region will be critically water stressed by 2030, and the situation will reach life-threatening levels by 2050.

MAIN CONCLUSIONS

While several factors will drive the pressures on water resources, population and its dynamics will be the primary driver of all demands, including water demand (Chapter 6). High population growth is outstripping the pace at which water resources are being developed to meet the various socioeconomic needs of the sub-region. Associated with this is the low and unbalanced funding of the water and sanitation sector, with the tendency to concentrate water infrastructure in the urban centres and giving lower priority to rural areas.

The water issues of the sub-region are exacerbated by the fact that over 75% of the sub-region is classified as ASAL – these areas which are mostly water stressed and have low agricultural potential.

The impact of population on water resources will be at two levels:

- At the level of domestic water supply where pressure will be exerted to provide more water from both existing and new water sources as governments accelerate the achievement of the MDG goals for access to clean drinking-water in quantities that meet domestic water security needs; and
- At the level of agricultural water withdrawals, primarily for irrigation but also for livestock – the increased demand for food will put pressure on agricultural resources including land and water. The imperative to raise agricultural productivity to meet increased food demand will call for expansion of irrigated agriculture areas.

But as rain-fed agriculture continues to occupy a commanding place in the overall production system of the sub-region and cannot be wholly replaced with irrigation, it will be equally imperative to continue to accord it the priority it deserves as it will continue to account for over 50% of cereal production. However, the focus should change from area expansion to improved management of “green water” in rain-fed agriculture.

MAIN RECOMMENDATIONS

(1) *On population and its impacts on water demand*: Institute the collection and sharing of data and information on the impacts of population growth on water resources of the transboundary basins in the sub-region; and advise member states and share data and information on population movements in transboundary basins including cross-border ASAL zones. Other measures are: (i) accelerate the MDG targets and quantitative access targets to realise household water security; (ii) invest in new water resources development, focusing in rural areas and the ASAL zones; including new technologies for securing water supply and sanitation such as water harvesting, storage and purification suited to poor households.

(2) *On adjustment of water demand and food security*: (i) Specific surveys should be undertaken to update information on irrigation schemes in transboundary basins; (ii) Improved water use and management technologies be prioritised in existing and planned irrigation programmes; (iii) Emphasis should be given to promoting technologies to improve water management in rain-fed agriculture; and (iii) Irrigation policies and programmes must be underpinned by effective and active research and extension support.

(3) *On data and data sharing*: (i) The conceptual framework and findings of the socioeconomic component could form the basis of comprehensive baseline surveys of transboundary basins and sub-basins; (ii) the surveys should focus on an exhaustive collection of data on water users and their appropriate characterisation including domestic, agriculture, livestock, industry, environment, infrastructure, tourism & wildlife, etc; and (iii) the benefits of data and information sharing should be actively promoted: such benefits include empowerment and improved negotiation capacity; enhanced inter-state relationships; and improved administrative routines – for instance planning and decision making, improved communications among linked groups, etc.

1

INTRODUCTION

1. STUDY BACKGROUND

The MAM-TWR Project is being implemented as a part of the broader IGAD regional strategy that responds to the growing concerns over water scarcity in the sub-region. IGAD envisages, through this and other projects, to initiate a regional strategy to develop and manage the sub-region's water resources through cooperative arrangements by the member states. The strategy envisages:

- The elaboration and implementation of integrated water resources management plans with regard to transboundary water resources management; and
- The enhancement of sub-regional economic, social and environmental integration, thus contributing to a more effective use and better management of transboundary water resources for the benefit of each country.

Both IGAD and the governments of the member states are optimistic that the sub-region is endowed with potential water resources (found in transboundary river basins and aquifers) which can be developed and exploited for socioeconomic development and environment management purposes. The development of these resources is presently constrained by, amongst others, lack of adequate data, information and knowledge of the sub-region's water resources and the uses to which they are put.

2. UNDERLYING SOCIOECONOMIC CONTEXT OF THE STUDY

The IGAD Sub-region is a vast area, and is characterised by a great diversity of conditions and situations including physical, climatic, social and political features which combine to create opportunities as well as challenges in regional cooperation. The sub-region's march along the path of economic, political and social progress is constrained by many pit falls, in particular poverty and food insecurity, degradation of natural resources, political and civil instability, and looming water scarcity among others.

(i) Poverty and food insecurity: The sub-region is among the poorest in the world. The long term trend of economic growth has been slow and protracted, and poverty rates have remained high and pervasive. With very low per capita incomes, households have not the capacity to create effective demand for goods and services which in turn slows down the rate of economic expansion. The vast majority of the population is thus trapped in a vicious circle of poverty.

Food production is highly variable in the sub-region and follows closely on the patterns of rains. Also, both production and markets are not reliable. Long term analysis of emergency food situation shows that IGAD sub-region is chronically food insecure, and the situation is expected to become worse with the current onset of climate change.

(ii) Accelerated degradation of natural resources: Rapid population growth will increase pressure on the already fragile land and water resources in many parts of sub-region. There is already massive encroachment of environmentally sensitive areas for crop and livestock production, which has set in motion a cycle of:

- Progressive land degradation leading to decline of soil fertility and consequent low crop yields and low agricultural and food production;
- Reduction of areas of fallow land and greater exploitation of marginal lands;
- Worsening animal feed balance;
- Declining fuel-wood supplies, increasing use of crop residues for fuel, and consequent increased encroachment on forests to access fuel-wood and other energy needs; and
- More frequent droughts and disastrous floods leading to frequent crop failures.

(iii) Looming water scarcity and the prospect of intensified competition for water: The countries of the sub-region have entered, or are entering, an era of serious water shortages. Along with food security, water security has become a fundamental human development issue. In August 2010 the UN General Assembly declared access to safe drinking water as a human right. The parameters that constitute the foundation of access to water as a human right are defined by the UN as including the following:

- Physical accessibility – availability of water supply must be predictable, and clean drinking water must be within easy reach of the poor and disadvantaged segments of the population;
- Sufficiency – the quantity available must satisfy not only the basic processes of life, as water is a major constituent of living matter, but also other basic socioeconomic needs;
- Safety and acceptability – the beneficial use of water requires that its characteristics (chemical and biological) must match the requirements of the use for which it is demanded; and
- Affordability – water, when priced, must be affordable to all, irrespective of status and location.

As the sub-region expects to advance economically and socially, the demand for water will increase in all sectors as a result of population growth, rising incomes, changing dietary patterns, urbanization and industrial development. A 2006 UN report warns[1] that over the next few decades many developing countries, including those in the IGAD sub-region, will face the prospect of intensified competition for water. While population growth will be the principal driver of demand for water, agriculture will account for the bulk of the water

[1.] UNDP Human Development Report 2006

and will therefore be the focal point for adjustment of demand pressure. The prospects of achieving a wide range of MDGs that the UN set in 1990, as well as the well-being of future generations in the sub-region, hinge on the achievement of water security both in agriculture and in households.

(iv) Political and social instability: The IGAD sub-region is not only one of the most vulnerable areas to climate variability and recurrent droughts, but is also prone to conflicts of various kinds. The sub-region encompasses the Horn of Africa, which has been described in some quarters as the "Zone of Intensive Conflict" – which means that the conflicts often go beyond the political and embrace social (including ethnic), economic and even religious (spiritual) conflicts (BBC World Report, September 29 2009). A combination of conflict, climate change and rapid population growth has had an adverse impact on the sub-region including worsening the effects of drought. Recent famines have been on a large scale, building on the endemic high levels of poverty and food insecurity, as well as on social, economic and political inequalities among the people as well as among regions to create a generally unstable environment.

3. OBJECTIVE, SCOPE AND OUTPUTS OF THE SOCIOECONOMIC COMPONENT

The detailed tasks/activities of the socioeconomic component are given in Box 1. The overall goal was to establish a better understanding of: (i) the socioeconomic condition of the sub-region with specific regard to factors that drive the pressures on water resources; and (ii) water demand for various socioeconomic needs, including a preliminary quantified assessment of water use for domestic supply, agriculture, livestock, industry, transport, recreation, tourism and wildlife, and ecology.

Box 1: Terms of Reference for the Socio-economic Component

- Assessment and analysis of the situation and the trends of domestic water supply and use in order to provide basic inputs for future planning of domestic water supply and sanitation.
- Analysis of rain-fed and irrigated agriculture potential and water requirements, which is clearly stated as a key priority in national Poverty Reduction Strategy Papers (PRSPs) and in the sub-regional strategy for food security.
- Analysis of livestock water needs in view of the importance of livestock for the livelihood of millions of nomadic and semi nomadic people in the arid and semiarid zones.
- Assessment of public and industrial water use and other recreational and ecological use and needs.
- Assessment of gender issues in relation to the role of women and the youth in water resources management and identification of specific actions to enhance gender equity.
- Scenario analysis of future water demand and use and development of demand management strategies.

The socioeconomic component provided the necessary path-way for an in-depth investigation of the factors that impact on water resources and their uses. This included a review of the existing data and information on water using sectors and their demands in current and future scenarios. The specific objectives were:

- Acquisition, assessment, analysis and conceptualization of data and information needed to understand the situation and trend of water demand and supply for various socioeconomic purposes;
- Analysis of future water demand scenarios based on the trends in economic, social and demographic patterns of the sub-region;
- Development of water resources demand management strategies; and
- Assessment of gender issues in relation to the roles of women and the youth in water resources management and identifying specific actions to enhance gender equity.

The outputs related to these specific objectives are: (i) an updated knowledge of the socioeconomic condition of the sub-region based on a synthesis of the national and sub-regional assessments of factors that create the pressures on water resources; (ii) an understanding of the water demand for various socioeconomic purposes, including a preliminary quantified assessment of water use for domestic supply, agriculture, livestock, industries, recreation, ecology, etc in current and future scenarios; and (iii) a concept note on water demand management strategies, with special note on the role of women and the youth in water resources management.

4. REPORT PRESENTATION

This report consolidates the assessments and analyses of Phases I and II into a synthesis document that presents key findings, conclusions and recommendations which respond to and meet the needs of the study Terms of Reference. The report is presented in six chapters including this introductory chapter (*Chapter 1*) which discusses the study background, objectives, scope and outputs.

Chapter 2 discusses the study approach and methodology, emphasising its data requirements and the conceptual basis for analysis and projections of water futures.

Chapter 3 presents the socioeconomic issues that are relevant to the understanding of what drives the pressures on water resources in the sub-region. These challenges relate to human resources (population); natural resources (land, agriculture and water); economic, social and technological progress, amongst others.

Chapter 4 discusses current and future water use in three key sectors: domestic, agriculture and industry. The chapter focuses on the current situation and trend of domestic water supply, and analyses emerging trends and scenarios of water demand in the domestic, agriculture and industrial sectors, highlighting the impact of population growth on water resources.

Chapter 5 presents a Concept Note on water demand management, emphasizing the IWRM principles as the appropriate framework for effective and efficient management of demand. Finally, *Chapter 6* summarises the main conclusions and recommendations of the socioeconomic component.

2

APPROACH AND METHODOLOY

1. DATA REQUIREMENTS, SOURCES AND ACQUISITION PROCESS

National Reports: Throughout the phases of this project, the consultant has used national study reports as the building blocks for the core tasks of the sub-regional assessment, analysis and synthesis of data and information. The national reports were produced by national consultants of the five countries that are participating in the MAM-TWR project, namely Djibouti, Ethiopia, Kenya, Sudan and Uganda. The OSS Project Office also provided several documents to support the study, including those related to experiences with on-going projects in North Western Sahara Aquifer System (NWSAS) and Iullemeden Aquifer System (IAS)

Documents Review: While water data for the countries were mainly from national reports, these were significantly complemented with international data sources and through further literature research. Most of the key sources of data and information are given in the selected bibliographical references (see Annex 1), but important updates were obtained from the most recent *FAO AQUASTAT Survey, the World Bank's World Development Reports* (2008, 2009 and 2010), UNDP's *Human Development Reports* (2006, 2007/8) and World Bank's *Africa Development Indicators* (2007, 2009 and 2010). Complementary data acquisition, from the internet domains but also from available national, regional and international literature, formed a very significant part of the process of enhancing the national data, information and knowledge.

The following web-based sources have also been very useful in the sourcing and updating of data and information:

FAO: http://www.fao.org/docrep/w4347e00.htm

http://www.fao.org/nr/aquastat

United Nations: http://www.un.org/esa/population/

University of Kassel: http://www.usf.uni-kassel.de

Oregon State University: http://www.transboundarywaters.orst.edu/publications/register

Michigan State University: http://www.globalchange.umich.edu/globalchange2/current/lectures/freshwater_supply/freshwater.html

Pacific Institute: http://www.worldwater.org/data.html

IWMI: http://www.cgiar.org/iimi

Through this process, data was obtained that enabled the inclusion of Eritrea and Somalia in the overall assessment of the sub-region. The two countries have a total area of about 740,000 km2 and share important river basins with neighbouring countries.

At this juncture, it is necessary to point out that, whereas extensive use was made of both national and international sources of data, such sources had limitations which must be noted. Most of the socioeconomic data tended to be global and applicable only at national or regional level. Very little data was found which could be consistently applicable at the basin level, with the exception of some of the data for Ethiopia which were reported on a limited scale at basin level where master plans had been prepared. Countries are constantly updating their databases and it was not possible to access the most recent data which had not been officially released.

Stake-holders knowledge and views: Regional validation workshops brought together National Coordinators and Steering Committee members from the five participating states as well as experts from IGAD and OSS, and were the main forums for exchange and sharing of data and information to improve and strengthen the study. The first validation workshop was held in Entebbe, Uganda, during 30-31st August 2010; the second was held in Nairobi, Kenya, during 17-19th January 2011; and the third was held in Addis Ababa, Ethiopia, during 20-24th June 2011.

2. METHODOLOGY

2.1. Overview of water-using sectors

Each water-using sector was divided into components and/or sub-components and assessed and analysed separately (Box 2). Unfortunately, insufficient data prevented quantification of

Box 2: Decomposition of Water-using Sectors

Water-using Sector	Components/Sub-Components	Relevant TOR
1. Domestic	Households, municipalities, public services, commercial establishments/facilities	Situation and trends of domestic water supply and sanitation
2. Agriculture	Irrigation	
	Rain-fed and irrigated agriculture potential and water requirements	
	Livestock	Livestock water requirements
3. Industry	Manufacturing and mineral extraction; energy production	Industrial water needs and use
4. Infrastructure	Transport – navigation, road, rail; energy – hydropower	Water needs and use
5. Environment	Tourism, wildlife, recreation, ecology	Water requirements

water use in some important sectors such as transport, energy, tourism, wildlife, recreation and environment. This limitation has dictated the focus of the study to three water-using sectors, namely domestic, agriculture and industry.

Water use in the domestic sector includes drinking-water plus water withdrawn for maintenance of homes (cooking food, home hygiene, amenities, and household production). It also includes water used by municipalities, commercial establishments, and public services (e.g. hospitals, schools, government facilities).

Water use in agriculture comprises primarily two sub-components: irrigation water use and livestock sub-sector requirements.

Industrial uses of water include water for cooling plants, producing energy, cleaning and washing goods produced, and as ingredients in manufactured items and as solvent. The energy sector (hydropower and thermal energy) is included as a major component of the industrial sector as it is a major driver of industrialisation.

Although environment is a significant user of water, it is not included in this study due to lack of comprehensive data. Likewise, other sectors that are important users of water are not addressed, for instance recreation, transportation, tourism, wildlife and infrastructural facilities. These are very important sectors and should be areas for detailed research and data collection in future studies.

2.2. Conceptual framework, key parameters and assumptions

The MAM-TWR Project seeks to provide a quantified assessment of the future water demand, and to determine the extent of water scarcity, in the IGAD sub-region. Because of the dearth of data and information, this task faces formidable conceptual and empirical problems. The socioeconomic component does not attempt to overcome these problems, but it initiates actions and lays the foundation for the necessary database to improve the empirical basis for analysis of future water demand and supply scenarios. The detailed data requirements and the conceptual framework for its assessment, analysis and monitoring were prepared during Phase I and sharpened during Phase II (see Annex 2).

Two models which provide tools for simulation of alternative scenarios of future water demand with respect to the variations of the key demand drivers were examined, namely the WaterGAP and the PODIUMSIM models[2]. Both models are outlined below.

2.2.1. The WaterGAP 2.0 Model

The WaterGAP model (Water – Global Assessment and Prognosis) was developed at the Centre for Environmental Systems Research of the University of Kassel, Germany, with assistance from the National Institute of Public Health and the Environment of the Netherlands[3]. The goal of the model is to provide a scientific-based overview of global water

2. These models are broadly similar in concept and applications. Note also the similarity with the WEAP (Water Evaluation and Planning) model used in the IWRM component.

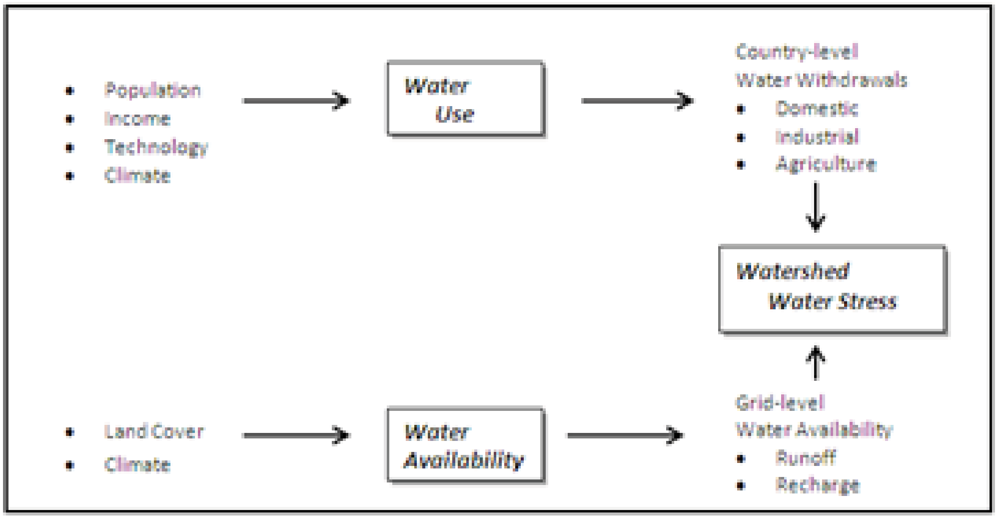
3. The description of the model is found in "World Water in 2025" by Alcamo, Henrichs and Rösch (see Http://www.usf.uni-kassel.de).

resources from a long-term perspective. WaterGAP is based on a class of environmental models called “integrated” models which were first developed during the 1980s to study large-scale environmental problems. These models aim to couple different disciplines in a single integrated framework, and to link science with policy.

The WaterGAP model consists of two main components – a Water Use model and a Water Availability (or Hydrology) model (Figure 1). The Water Use model incorporates the basic socioeconomic factors that lead to domestic, industrial and agricultural water use (*water use here is equivalent to water withdrawal*), while the Water Availability model incorporates physical and climatic factors that lead to river run-off and groundwater recharge.

The WaterGAP 2.0 model divides water use on a country level into domestic, agriculture, and industrial sector uses. Each of these sectors can further be sub-divided into their different components or sub-components where data is available. The model first computes, for each country, water use in the various sectors and then allocates these to grid cells and river basins within a country based on the population density and the ratio of the rural to urban population of each grid cell. The water use of all grid cells within a particular river basin is then summed up to obtain the total domestic water use in the river basin. Water use of the industrial sector is computed in a similar manner.

Two main concepts are used for modelling water use – “structural change” and “technological change”. These concepts are relevant in analysing trends in domestic and industrial water use where data and information is available. Structural changes (changes in incomes, lifestyles, consumption patterns, etc.) can either increase or decrease per capita water use. On the other hand, “technological changes” usually lead to improvements in the efficiency of water use and a decline in per capita water use over time.



Adapted from “World Water in 2025”, by Alcano. J, Henriichs. T, Rosch. T

FIGURE 1: Block Diagram of the WaterGAP Model.

Structural changes can also have a decisive influence on the amount of water needed for agriculture. For example, a substantial shift to greater consumption of meat can increase the demand for irrigated land to grow feed for livestock; or a possible shift from more intensive irrigated agriculture to more intensive rain-fed agriculture, or vice versa. In general, structural changes proceed hand in hand with technological changes, and they combine to provide changes in the resulting trends of per capita water use overtime.

Due to lack of adequate data, the impacts of structural change (changes in incomes, rate of urbanisation, lifestyles, technological change, etc.) on water demand have not been assessed in this study. It should be noted, however, that the IGAD sub-region, being largely marginalised in terms of economic, technological and social development, exhibits high poverty levels and low human development. Although the countries of the sub-region have designed and are implementing development plans aimed at economic and social transformation, with special emphasis on poverty eradication, most of these plans are short or medium term (5-10 years), and the likely impacts they would have on the trends of water demand and use in the medium to long-term term cannot be predicted with any degree of certainty.

2.2.2. The PODIUMSIM Model

The PODIUMSIM or Policy Dialogue Model is a tool that simulates alternative scenarios of future water demands with respect to the variations of the key demand drivers. This model has been widely used by IWMI, IFPRI, etc. and also applied to assess India's water scenarios in 2025 to 2050 (see http://www.cgiar.org/iimi). This model is similar to the WEAP and the WaterGAP, and has four broad components: crop demand, crop production, water demand and water accounting. These components are assessed at various temporal and spatial scales as indicated in Table 1.

The crop demand component assesses the future demand of grain and non-grain crops. These are the requirements of national food consumption by the population of a country. The major drivers of this component are the rural and urban population and the daily per capita calorie supply and per capita food consumption.

Component	Spatial Scale	Temporal Scale
Crop demand	National/sub-regional	Annually
Crop production	River basin	Seasonally
Water demand:		
- Domestic	River basin	Annually
- Irrigation	River basin	Monthly
- Livestock	River basin	Annually
- Industrial	River basin	Annually
- Environmental	River basin	Annually/monthly
Water accounting	River basin	Annually

Adapted from Joseph Alcamo, Thomas Henrichs and Thomas Rosch in World Water in 2025 – Global modelling and scenario analysis for the World Commission on Water for the 21st century.

TABLE 1. Spatial and Temporal Scales of Different Components

The crop production component assesses the national food production under both rain-fed and irrigated conditions by the country's population. The main driving forces behind food production include developments in the total harvested area, expansion of the irrigated area, and yields under rain-fed and irrigated conditions. The production surplus or deficit shows the quantities available for export or the quantities that need to be imported, respectively.

The water demand component assesses the requirement for the domestic, irrigation, livestock, industrial and environmental (and other) sectors. The domestic and industrial water requirements are driven by factors like population size, rate of urbanisation and industrial development. The livestock water requirements are driven by the livestock population and systems of production and management. The major parameters for the irrigation crop requirements are crop irrigated area, crop calendar, crop coefficients and potential evapotranspiration, and are strongly dependant on climatic factors and the types of crops grown. The requirements for the environment are assessed in relation to the total water diversions for domestic, irrigation, livestock, industrial and other uses.

The water accounting component presents an account of the potentially available water resources of different river basins with respect to consumptive use, return flows of different sectors, the non-beneficial use and the outflows. At any given time, only a part of the potentially utilisable water resources is developed and is used by the different sectors.

2.2.3. Key Parameters and Assumptions

Effective and full application of the Water Use and PODIUMSIM models in the current project was not possible due to the inadequacy of data. Nevertheless, they provided the necessary conceptual basis for the projections and scenario analysis of current and future water demand. The approaches and methodologies for the estimation and projections and the associated scenarios are based on certain key assumptions that are discussed in the relevant sections or sub-sections of Chapter 4. The key parameters are summarised below:

- **Population growth:** Population growth is taken as the primary driver of all demands in the sub-region - water, food, economic services, etc. – and is projected for the medium term (2030) and the long-term (2050), the year 2010 being taken as the base year. The year 2050 is chosen because most of the current U.N. projections are available for that year. It is also considered appropriate for assessing or analysing long–term impacts of population changes on water resources in the sub-region.
- **Domestic water demand:** The criteria for projecting water demand for the domestic sector are based on the key consideration that water is both a basic life need and an economic need, and is subject to scarcity and therefore economic demand (willingness to pay). The study has set 20 m3 as the target of annual per capita withdrawal for domestic supply (about 55 litres/capita/day) which assures households of effective household water security.
- **Urban and rural demands:** Separate projections for the urban and rural demands have not been made due to absence of a consistent set of data for the growth of urban sectors in the countries of the sub-region. There are also very wide variations in per capita water use in all the urban areas owing to concentrations of the very rich households along with large communities of very poor slum dwellers. Setting a sub-region wise and population wise target of 20 m3 is considered appropriate for this study in these circumstances.
- **Industrial water demand:** The target annual per capita withdrawal is set at 10m3 to

meet the growing water demand as a result of rapid industrialization planned by countries of the sub-region.

- **Irrigation water requirements:** Two irrigation scenarios (both analysed for the medium and long term) have been assumed: (i) **Scenario 1** assumes no change in irrigation efficiency, and that current per capita gross irrigated areas remain the same in the medium and long term; and (ii) **Scenario 2** assumes that countries will implement measures to raise irrigation efficiencies to 50% in 2030 and 60% in 2050. Thus, under scenario 1 population growth will drive irrigation water demand, while under scenario 2 the increased demand can be adjusted through efficient management of irrigation water. Data on current irrigation efficiency levels in the irrigation schemes have not been readily available, but it has been gauged from national reports and other sources that current efficiencies are very low.

- **Livestock water requirements:** The number of livestock will increase proportionately to the human population; the per head water requirements applicable to different species were obtained from country technical reports as well as from international sources (eg. FAO).

3

KEY SOCIOECONOMIC CHALLENGES OF THE SUB-REGION

1. AN OVERVIEW OF THE SUB-REGION

1.1. Land resources

The IGAD sub-region is a vast area comprising seven countries – Djibouti, Eritrea, Ethiopia, Kenya, Somalia, Sudan and Uganda - and stretches over an area of 5.21 million km^2 of which 4.89 million km^2 comprises the land area and 0.32 million km^2 comprises inland waters. The sub-region encompasses the Horn of Africa which is located in the east and north-east of the African continent. Table 2 shows the distribution of the land and surface inland water areas of sub-region.

Area in Km^2						
Country	Land Area	% share	Inland Water Area	% share	Total Area	% share
Djibouti	**23,180**	**0.48**	**20**	**0.02**	**23,200**	**0.43**
Eritrea	**101,000**	**2.06**	**16,600**	**5.25**	**117,600**	**2.26**
Ethiopia	**1,000,000**	**20.43**	**104,300**	**32.98**	**1,104,300**	**21.20**
Kenya	**569,140**	**11.63**	**11,227**	**3.55**	**580,367**	**11.14**
Somalia	**627,337**	**12.82**	**10,320**	**3.26**	**637,657**	**12.24**
Sudan	**2,376,000**	**48.55**	**129,813**	**41.05**	**2,505,813**	**48.10**
Uganda	**197,100**	**4.03**	**43,938**	**13.89**	**241,038**	**4.63**
Total	**4,893,757**	**100.00**	**316,218**	**100.00**	**5,209,975**	**100.00**

TABLE 2. Distribution of Land and Water Area in IGAD Sub-region

World Bank: Africa Development Indicators 2010; CIA Fact Book 2009

The sub-region embraces a great diversity of physical and climatic features and conditions. These may broadly be divided into six ecological zones: desert zone (mainly found in the northern part of North Sudan), arid, semi-arid, sub-humid, humid and highland zones. This variety of ecological conditions gives rise to a wide range of production possibilities as well as human activities and processes. However, the potentials of the different ecological zones are not the same: some zones support different combinations of crops and livestock and the associated livelihoods.

Table 3 shows the distribution of the land resources of the sub-region by agro-ecological zone (AEZ). Over 75% of the sub-region's land area is classified as arid and semi-arid land

(ASAL). Both Djibouti and Somalia are 100% arid, while more than 80% of Kenya and Sudan are classified as ASAL. Nearly 80% of Eritrea land falls within the ASAL zone, while 51% of Ethiopia is classified as ASAL. Uganda, on the other hand, has less than 20% of the land classified as ASAL.

% Distribution of Land by Agro-Ecological Zone						
Country	Arid	Semi-arid	Sub-humid	Humid	Highlands	Total Land Area (km²)
Djibouti	**100.0**	**0**	**0**	**0**	**0**	**23,180**
Eritrea	**67.3**	**12.5**	**0**	**0**	**20.3**	**101,000**
Ethiopia	**41.0**	**10.4**	**8**	**0**	**40.7**	**1,000,000**
Kenya	**72.7**	**9.5**	**2**	**0**	**15.7**	**569,140**
Somalia	**99.9**	**0.1**	**0**	**0**	**0**	**627,337**
Sudan	**60.2**	**25.4**	**13.6**	**0.8**	**0**	**2,376,000**
Uganda	**0.9**	**16.4**	**49.5**	**27.3**	**5.9**	**197,100**
Total	**60.2**	**16.5**	**10.5**	**1.5**	**11.3**	**4,893,757**

TABLE 3. Distribution of Land Area (in %) by Agro-Ecological Zone

Vivien Knips – Review of the Livestock Sector in the Horn of Africa, FAO, September 2004.

Figure 2 shows how, on average, the total land area of the sub-region is distributed among major uses during the period 2005-2007. The data is from the most recent FAO Statistical Year Book, 2009. The major land use types that are directly associated with man's intervention for livelihood and socioeconomic development are crop production and livestock rearing. Only about 10% of the total land area is cultivated (about 9% under arable land and 1% under permanent crops). About 60% of this is estimated to be cropped annually and about 40% left to fallow. Rangelands occupy about 44% of the land area and support over 400 million herds of various species of livestock, which is among the largest and most diversified in Sub-Saharan Africa.

The extensive geophysical and border linkages among the member states, combined

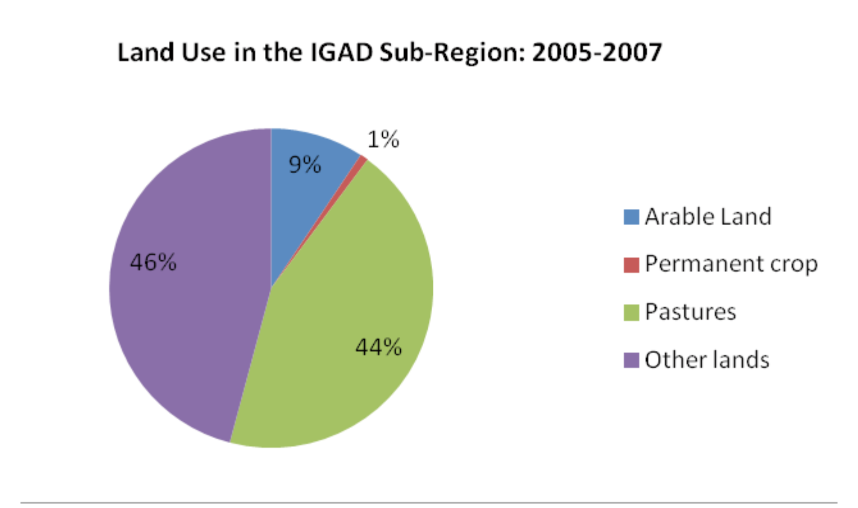


FIGURE 2: Major Land Use Distribution in the IGAD Sub-Region: 2005-2007 average

with the geo-social and geo-political diversity, presents several challenges in planning and promoting cooperation. Poverty, food insecurity and environmental hazards are the common denominators in this highly contrasting region. The sub-region is prone to conflicts of various kinds (political, social and even religious) which, combined with climate change and rapidly rising population, have worsened the impacts of drought and other adverse environmental conditions on the livelihood of the people. Levels of human development are low and social, economic and political inequalities among the people as well as among regions within the individual countries are pervasive.

1.2. Transboundary basins

The geophysical linkages provide opportunities for regional cooperation in several fields, including cooperation in water resources management through the six transboundary water basins identified in this study. These basins occupy 1.35 million Km2 or about 26% of the total area of the IGAD sub-region. The distribution of the basins and their areas by country is given in Table 4. About 94% of the total area of the basins lies in three countries: 45% in Ethiopia, 25% in Somalia and 24% in Kenya.

Country and Basin Area in Km^2								
Country	Djibouti	Eritrea	Ethiopia	Kenya	Somalia	Sudan	Uganda	Total
Ayesha	-	-	2,200	-	2,763	-	-	4,963
Gash-Baraka	-	41,640	-	-	-	24,909	-	66,549
Danakil	-	8,605	53,182	-	-	-	-	61,787
Juba-Shebelle	-	-	344,364	201,783	207,055	-	-	753,202
Ogaden	-	-	77,000	-	130,363	-	-	207,363
Turkana-Omo	-	-	125,287	126,910	-	1,530	2,540	256,267
Total	-	50,245	602,033	328,693	340,181	26,439	2,540	1,350,131
% Distribution	-	3.72	44.59	24.34	25.20	1.96	0.19	100.00

Table 4. Area of Transboundary Basins by Country

Table of the Water Resources Modelling Component; Also see: http://www.fao.org/docrep/w4347e00.htm, and http://www.transboundarywaters.orst.edu/publications/register

The basins may be grouped into the following categories:

1) The dry basins (Ayesha, Danakil and Ogaden), with negligible surface water resources and low population due mainly to the prevalence of the harsh environment, remoteness from the main centres of economic activities, and poor economic and social infrastructure. The populations of these basins are mainly nomadic and the dominant form of agriculture is pastoralism.

2) The semi-arid to arid basins (Gash-Baraka and the Juba-Shebelle) having some notable irrigation developments. The population of the Gash practices agro-pastoralist, tenant and horticultural farming systems, while the flood plains of the Juba and Shebelle rivers in Somalia provide the highest agricultural potential. The Juba-Shebelle basin has the highest population of all the six basins, about 44%, and is thus one of the most important transboundary basins in the sub-region along with the Turkana-Omo basin.

3) Turkana-Omo basin forms a part of the Great Rift Valley, which is the centre of considerable economic activities among the riparian states (except Uganda and Sudan which have only very small portions of the basin), and is the next largest basin with a population that is 36% of the total six basins.

2. DEMOGRAPHIC TRENDS

2.1. Population growth

One of the demographic processes that create the greatest pressures on water resources is population growth. The others are age and sex distribution, urbanisation and migration. Population growth directly affects water availability and quality through increased water demands and through pollution resulting from intensive water use. It also affects water resources indirectly through changes in land use and water use patterns.

The population of the IGAD sub-region is growing rapidly at about 2.7% per year, and is projected to increase from about 206.4 million in 2010 to 339.6 million in 2030 and to 462.4 million[4] in 2050 (Table 5). Thus, between 2010 and 2050, 256 million people will have been added to the sub-region's current population (133.2 million between 2010 and 2030, and 122.8 million between 2030 and 2050), or roughly 6.4 million people added per year – implying an annual long-term growth rate of about 2.3% per year. High fertility rates against

	Population (000)							% Change		
Country	1950	1980	1990	2000	2010	2030	2050	1990-2010	2010-2030	2030-2050
Djibouti	62	300	520	670	830	1,180	1,580	160%	142%	134%
Eritrea	1,140	2,380	3,160	4,100	5,240	7,380	10,800	166%	141%	146%
Ethiopia	18,434	37,720	48,290	64,300	79,800	133,330	173,800	165%	167%	130%
Kenya	6,265	16,630	22,110	30,090	38,610	61,500	85,400	175%	159%	139%
Somalia	2,264	6,490	7,410	8,720	9,340	15,010	23,650	126%	161%	158%
Sudan	9,190	19,370	25,020	31,440	40,900	61,980	75,900	163%	152%	122%
Uganda	5,210	12,810	16,180	23,250	31,680	59,190	91,300	196%	187%	154%
Total IGAD	**42,565**	**95,700**	**122,690**	**162,570**	**206,400**	**339,570**	**462,430**	**168%**	**165%**	**136%**

TABLE 5. Population Trends in IGAD Sub-region

National reports (census and projections); UN – Population Division; UNFPA; 2050 projections are from UNFPA State of World Population 2010; 2030 projections are by consultant.

declining mortality rates are the main driving forces behind the high population growth.

The rapidly rising population poses one of the greatest challenges to the socioeconomic progress of the sub-region. The direct impact of population growth will be at two levels: (i) at the level of domestic water supply – where pressure will be exerted to provide more water from existing and new water sources; and (ii) at the level of agricultural withdrawals,

4. The individual country's projections to 2050 are taken from UNFPA State of World Population 2010.

primarily for irrigation but also for livestock – the increased demand for food (crop and meat products) will exert pressure on agricultural resources including land and water resources.

The indirect impacts will include increased pressures on the already fragile environments, thus setting in motion a cycle of: progressive land degradation, reduced fallow land, greater exploitation of marginal lands, declining soil fertility and reduced crop yields; over-exploitation of tree cover/forests leading to declining fuel-wood supplies, increasing use of crop residues for fuel – hence competition with livestock; and more frequent droughts floods leading to more frequent famines. Rapid population growth will also drive urbanisation, leading to concentration of population in cities without adequate supporting infrastructure and creating informal settlements associated with poverty & increased problems of accessing social services.

2.2. Age and sex composition of the population

The age composition of the population (see Table 6) shows a relatively large young population (43%) in the age group 0 – 14 years, while the population in the old age bracket 65+ years is very small (2.8%). The overall population dependency ratio is therefore high at 87% (2010), being highest in Uganda (106) and lowest in Djibouti (66). According to the UN long-range population projections (UN World Population to 2300), countries in Sub-Saharan Africa are not expected to enter the beginning of the "demographic window"[5] until about the year 2045 or later. In the IGAD sub-region the demographic window begins in about 2047 and

Indicators	Countries							Total IGAD
	Djibouti	Eritrea	Ethiopia	Kenya	Somalia	Sudan	Uganda	
Population (million): 2010	0.83	5.24	79.80	38.61	9.34	40.90	31.68	206.40
Age Structure: 0-14 years	35.7%	42.5%	46.2%	42.3%	45.0%	40.2%	50.0%	43.1%
15-64 years	61.1%	53.9%	51.1%	55.1%	52.5%	57.2%	47.9%	54.1%
65+ years	3.3%	3.6%	2.7%	2.7%	2.5%	2.5%	2.1%	2.8%
Total Dependency Ratio	66	78	89	83	91	75	106	87
Sex ratio: males/100 females	86	98	97	101	100	103	101	98
Population growth rate %	2.18%	2.52%	3.20%	2.59%	2.81%	2.15%	3.56%	2.7%
Urban population %	87.0%	21.0%	17.0%	22.0%	37.0%	43.0%	13.0%	34.3%
Rate of urbanization %	2.2%	5.4%	4.3%	4.0%	4.2%	4.3%	4.4%	4.1%
Infant mortality rate*	56.65	42.33	78.99	53.49	107.42	78.1	63.7	68.67
Life expectancy at birth	60.73	62.15	55.80	58.82	50.00	52.52	52.98	56.14
Total fertility rate	2.79	4.6	6.07	4.38	6.44	4.37	6.73	5.05
HIV/AIDS-adult prevalence %	3.1%	1.3%	2.1%	6.7%	0.5%	1.4%	5.4%	2.9%
Literacy - total population %	67.9%	58.6%	42.7%	85.1%	37.8%	61.1%	66.8%	60.0%

Table 6. Some Key Recent Demographic Indicators of the IGAD Member States (2009/2010).

CIA World Fact Book; and World Bank: Africa and World Development Indicators 2010.

** (deaths/1000 live births)*

5. The demographic window is the period when the proportion of children and youth under 15 years falls below 30% and the proportion of people 65 years and older is still below 15% of the total population.

ends about 2081, the average length being 34 years, with the timing varying from country to country.

Life expectancy at birth is closely linked to age composition. The most recent UN statistics (UNFPA State of the World Population 2010) shows that life expectancy has been rising slowly in the sub-region, and this trend is expected to continue and reach an average of 66.9 years in 2050. Rising life expectancy is expected to produce lesser but continuing population growth by 2050, averaging about 2.3% to 3.1% annually over a forty year period. The actual population situation may, however, be influenced by several factors, principally the disease challenge which remains huge due to the high prevalence of many of the dangerous diseases in the sub-region, such as HIV/AIDS and malaria.

The water resources needs (as well as other services such as healthcare and education) associated with the current age and sex structure are not accurately known, but are assumed to be high and not adequately met by the governments of the sub-region. While it is expected that these needs will continue to be targeted through planned investments, no special needs arising from any increased longevity of life are expected in decades to come.

2.3. Spatial distribution of the population

Rural-Urban Distribution: Past trends show that the share of the rural population in the total population has been declining slowly but steadily over the past two decades. Conversely, the size of the urban population has been increasing but also slowly. This pattern is likely to continue for another decade or so, except in Sudan where urbanisation is expected to increase rapidly, and Djibouti where it could approach nearly 100% by 2050. Across the sub-region the rural population is expected to drop to 66%, and the urban population to increase to 34% in 2030. By 2050 the rural population is expected to drop further to 54%

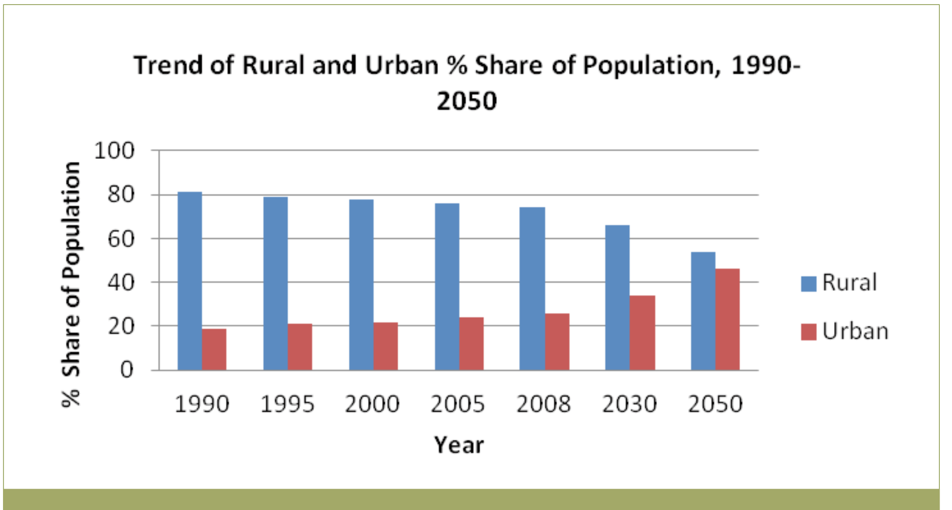


Figure 3: Rural- Urban Population Percentage Distribution: 2010, 2030 and 2050.

and the urban population to increase to 46%. While existing cities will grow very large, urbanization is likely to spread to other areas including existing small rural towns.

The drivers of urbanization will be the pace of industrialization, infrastructure development, growth of the services sector, and rising levels of education, amongst others. Other drivers include poverty prevalence in rural areas (people fleeing to the cities as rural areas fail to transform economically and socially), water scarcity and personal security. The growth of urbanization will have significant impact on water resources including, amongst others:

- In terms of numbers, about 162 million people will be added to the current urban population or about 4 million new additions annually (by 65 million between 2010 and 2030 and by 97 million between 2030 and 2050).
- Concentration of populations in cities without adequate supporting infrastructure will lead to growth of informal settlements associated with poverty, and increased problems of accessing services including water and sanitation;
- Increased danger of water and sanitation related diseases arising from urban water pollution; and
- Unplanned transformation of landscapes, and creation of structures that increase and/

Country	Year 2010			Year 2030			Year 2050		
	Total Popn	Urban Popn	% of Total Popn	Total Popn	Urban Popn	% of Total Popn	Total Popn	Urban Popn	% of Total Popn
Djiouti	0.83	0.72	87	1.18	1.04	88	1.58	1.42	90
Eritrea	5.24	1.10	21	7.38	2.52	34	10.80	4.30	40
Ethiopia	79.80	13.57	17	133.33	32.56	24	173.80	77.04	44
Kenya	38.61	8.49	22	61.50	18.45	30	85.40	37.06	43
Somalia	9.34	3.46	37	15.01	6.03	40	23.65	13.49	57
Sudan	40.90	18.00	44	61.98	44.63	72	75.90	51.13	67
Uganda	31.68	4.12	13	59.19	9.33	16	91.30	27.39	30
Total	206.40	49.46	24	339.57	114.56	34	462.43	211.83	46
% Change	100%	100%	-	165%	232%	-	136%	185%	-

TABLE 7. Current and Projected Urban Populations of IGAD Member States

or deflect surface water flows resulting in drainage problems, degraded water quality and causing floods that damage the infrastructure and cause water pollution.

Population distribution by agro-ecological zones: Availability of water is the key determinant

Country	% Distribution of Population by AEZ					
	Arid	Semi-Arid	Sub-Humid	Humid	Highlands	Total **Population (000)**
Djibouti	100%	0%	0%	0%	0%	830
Eritrea	31%	10%	0%	0%	59%	5,240
Ethiopia	10%	9%	4%	0%	77%	79,800
Kenya	14%	22%	13%	0%	51%	38,610
Somalia	100%	0%	0%	0%	0%	9,340
Sudan	60%	29%	10%	1%	0%	40,900
Uganda	0%	13%	60%	18%	9%	31,680
Total IGAD	**24%**	**16%**	**15%**	**3%**	**42%**	**206,400**

TABLE 8. Distribution of IGAD Population by AEZs (%)

Vivien Knips – Review of the Livestock Sector in the Horn of Africa, FAO 2004.

of human settlements and hence distribution over the sub-region. The distribution of population by agro-ecological zone is shown in Table 8.

The following features of population distribution in the AEZs may be noted:

1) About 42% of the sub-region's population is located in the highland zones. These are concentrated in Ethiopia (77%), Eritrea (59%) and Kenya (51%). These zones receive more than 1,000 mm of rainfall annually, rising to over 2,000 mm in certain parts. Across the sub-region, highland zones occupy only 11.3% of the total land area, but this rises to 40.7% in Ethiopia, 20.3% in Eritrea, and 15.7% in Kenya.

2) In Djibouti and Somalia, entire populations live in arid lands since all the areas of these countries are classified as arid (with some pockets of semi-arid in Somalia). Developed groundwater sources are major determinants of settlements in Djibouti where over 85% of the population live in urban areas (about 80% in Djibouti City). In Somalia the majority of the population is nomadic (pastoralist or agro-pastoralist). The agro-pastoralist and settled farmers live in villages or small settlements where water resources are reliable, while nomadic pastoralists move seasonally with their livestock depending on the availability of water and pasture. The most important agricultural areas are in south Somalia, in the Juba-Shebelle basin.

3) In Sudan, 89% of the population live in arid and semi-arid zones and 11% in the sub-humid and humid zones – these mainly in the south. The Nile River is the most important source of all economic livelihoods, and the population is therefore concentrated along the Nile and its tributaries, and in areas of developed irrigation schemes.

4) Uganda's population is spread across the agro-ecological zones, though with a high concentration (about 60%) found in sub-humid areas.

Distribution of population in the transboundary basins: An attempt was made to estimate the populations in transboundary basins. These estimates are given in Table 9. In the absence of actual population census statistics from the countries sharing the basins, the basin population estimates were derived from data of the different constituent regions of each country. It was assumed that the number of people to be considered in the sharing of

	Country and Basin - Population in 000							
Country	Djibouti	Eritrea	Ethiopia	Kenya	Somalia	Sudan	Uganda	Total
Ayesha	-	-	137	-	85	-	-	222
Gash-Baraka	-	1,274	-	-	-	137	-	1,411
Danakil	-	258	1,447	-	-	-	-	1,705
Juba-Shebelle	-	-	17,918	4,937	5,191	-	-	28,046
Ogaden	-	-	4,744	-	3,960	-	-	8,704
Turkana-Omo	-	-	15,960	6,831	-	11	69	22,871
Total	-	1,532	40,206	11,768	9,236	148	69	62,959
% Distribution	-	2.43	63.86	18.69	14.67	0.24	0.11	100.00

Table 9. Population of transboundary basins by country

the basin water resources would be proportional to the ratio of the regional area that falls within the basin.

Table 9 shows estimates of the basin populations based on these assumptions. The table reveals the following important information about the importance of the transboundary basins.

- The transboundary basins account for about 30% of the total population of the sub-region. The Juba-Shebelle and Turkana-Omo are the most important basins, accounting for 44.5% and 36.3% respectively of the total population of the basins.
- The transboundary basins are very significant for Ethiopia, Kenya and Somalia. Over 60% of the population of the basins is found in Ethiopia, about 17% in Kenya and 15% in Somalia. About 50% of the total population of Ethiopia are in the transboundary basins, while for Somalia nearly 99% of the total population are in the basins.

2.4. Migration

Population migration is an important factor in the assessment of both global and localised water resources. The population trends analysed above do not, however, specifically reflect the impact of migration on the growth of population. But it is expected that the prevalence of conflict in the sub-region has resulted in both internal and external migration. World Bank data for 2005 shows that the share of migrant stock in the local populations is low, averaging 13.7% in Djibouti and less than 1.25% in other countries. Total net out-migration in the sub-region was reported in 2005 as about 820,000 per year with Sudan leading with 530,000, followed by Ethiopia (340,000) and Somalia (200,000). Only Kenya and Eritrea had positive net migration. It is difficult to differentiate between security related migration (fleeing insecurity or political strife) and economic related migration (fleeing from poverty).

These statistics are, however, considered to be conservative and the sub-region as a whole is regarded as being awash with problems of population movements both internal and external. Somalia and Eritrea have, for instance experienced massive outflows of population in recent years largely as a result of intensified internal conflicts. In Somalia, a combination of drought and war has forced an unprecedented number of people to neighbouring Kenya and Ethiopia. Intensified conflict since 2006 has forced thousands out of the country to Yemen, Djibouti and other Middle East countries.

A considerable level of migration in the sub-region is triggered by water scarcity. The high prevalence of migratory pastoralists (and even agriculturalists) is only perhaps more than matched by refugee movements. The two may differ in their causes but the general impacts on water resources are the same: once people have moved, water must be provided for them in their places of destination. The arrival of additional people into an area often creates environmental stresses, besides worsening existing water crises and straining the capacity of the local delivery infrastructure, as well as resulting in water conflicts. Climate change is also predicted to lead to more frequency and intensity of extreme weather events, which are likely to result in an overall increase in the displacement of people in the future.

3. ECONOMIC GROWTH AND POVERTY

3.1. Key socioeconomic indicators of the sub-region

Growth in income per capita is highly correlated with many development indicators such as access to water and sanitation, education, technological advancement and increased consumption, amongst others. There is a strong link between economic growth and water resources development. Economic growth demands an increased harnessing of water resources because as households become richer they demand and use more water resources. This is shown by the current trend of concentration of industrial establishments in urban centres where developed water resources are found. The contrary situation is in rural areas where developed water sources are few. Economic expansion affects water use through growth in the number of consumers and through changes in their water use habits, in the way goods and services are produced and in the location of activities, all of which affect national, regional and even international trade.

Table 10 gives a summary of the key socioeconomic indicators of IGAD member states. The sub-region's total gross domestic product (GDP) was about US$ 288 billion (PPP valuation)

Indicators	Countries							Total IGAD
	Djibouti	Eritrea	Ethiopia	Kenya	Somalia	Sudan	Uganda	
GDP (US$ billion) PPP US$ 2009	2.011	4.198	76.74	63.73	5.731	92.81	43.22	288.44
GDP - real growth rate	6.4%	2.5%	8.0%	2.0%	2.6%	3.8%	6.6%	4.6%
GPD - per capita (PPP2009 US$)	2,800	700	900	1,600	600	2,300	1,300	1,457
GDP Structure								
Agriculture	3.2%	17.3%	43.8%	21.4%	65.0%	32.6%	22.2%	29.4%
Industry	14.9%	23.2%	13.2%	16.3%	10.0%	29.2%	25.1%	18.8%
Services	81.9%	59.5%	43.0%	62.3%	25.0%	38.2%	52.8%	51.8%
Exports (US$ Bn)	0.28	0.07	1.66	4.87	0.30	5.07	1.21	13.46
Imports (US$ Bn)	0.37	0.47	3.92	6.73	0.80	6.39	2.40	21.08
Labour force (million)	0.35	1.94	37.90	17.47	3.45	11.92	15.0	88.03
Labour force structure %								
Agriculture	NA	80%	85%	75%	71%	80%	82%	
Industry	NA	20%*	5%	25%*	29%*	7%	5%	
Services	NA		10%			13%	13%	
Unemployment rate	59.0%	NA	NA	40.0%	NA	18.7%	NA	39.2%
Population below poverty line	42.0%	50.0%	38.7%	50.0%	NA	40.0%	35.0%	42.6%
Human Development Index	0.516	0.483	0.406	0.521	NA	0.526	0.505	0.493
Human Poverty Index	28.5	36.0	54.9	30.8	NA	34.4	34.7	36.550

Table 10. Some Key Economic Indicators of IGAD Member States – (2009/2010) Estimates

CIA World Fact Book and World Bank Development Indicators 2010.

in 2009 with an annual growth of about 4.6%. The services sector contributed about 52% making it not only the largest but also the fastest growing sector in the sub-region.

Although the economies of the sub-region show some relatively impressive growth rates, the vast majority of the population remain poor because the benefits of this growth are not widely shared. Rather, there is unequal distribution of incomes, which are concentrated in few regions and urban centres and among a few people within countries. For instance, while the share of the agriculture sector in GDP has been declining over a period of time, the proportion of the active population engaged in agriculture remains high at more than 70%, and agriculture continues to be the main sector from which the majority of people derive their livelihoods. Because the agricultural sector has either stagnated or been declining over a long-term period, poverty is more rooted in the rural rather than in the urban areas.

Low incomes reflect the high prevalence of poverty in the sub-region and have the effect of reducing the capacity of households to create real demand for goods and services including better education and technological advancement, which in turn slows down the rate of economic expansion. The countries in the sub-region are trapped in a vicious circle of poverty, which is exacerbated by rapidly growing populations.

Poverty has many consequences that drive the pressure on water resources, including: engaging in low input and low output land use practices as a result of inability to access improved technologies; overexploitation of natural resources including water resources; and creating pressure on the inadequately provided water supply and sanitation services.

Better education would enable people to improve their economic situation, leading to empowerment, better health and longer life expectancy. An educated population has a better understanding of the need for sustainable use of water including aquatic ecosystems and the important environmental goods and services they provide. More importantly, education can lead to greater water use efficiency – for instance, acquiring knowledge of water systems, conservation practices, new materials and emerging technologies that can help to extend water services to existing and new areas including informal areas. Education not only fosters economic growth but also increases expectation of a better life for families and societies, and can help accelerate the demographic transitions through declines in fertility and infant mortality rates.

How to reverse the stagnation of the agricultural sector is one of the key challenges for governments in the sub-region. Massive injections of investments and modernisation of the agriculture and rural sector are needed to achieve high gains in agricultural productivity and accelerate the shift of labour from agriculture to the industrial and non-agricultural sectors. This would increase the rate of increase of non-agricultural labour and, indirectly, the rate of urbanisation[6].

The prospects for future growth of the economies of the sub-region are dependent on the successful implementation of the various poverty reduction strategy programmes (PRSPs), which must be underpinned by substantial investments in infrastructure development, including energy, transport and water infrastructure. Some of the economies (Sudan and Uganda) have added potentials in oil revenues that could turn around these economies if invested prudently. Medium-term forecasts by international financial institutions (IMF, WB, AfDB) indicate that some of these economies could grow by between 4% and 7%, which

6. This is contrary to the belief in some quarters that massive improvements in the agriculture and rural sector could reverse the rural-urban migration flow. Experience throughout the world and in history shows that as agriculture modernizes and productivity rises, the proportion of the labour force that remains declines substantially.

would maintain the rates achieved during 2000 – 2008.

3.2. Globalisation and trade

Globalisation is the term used to describe regional and international flows of goods and services, people, finance and investments. Patterns of international trade can be analysed to investigate the hidden flows of water through goods and services that are traded. This is important in relation to policies and strategies for managing national and international water resources, especially those in transboundary basins. Water-intensive products are heavily traded over large distances as countries import and export water in "virtual" form embedded in agricultural and industrial commodities[7]. UNESCO[8] estimates that the global volume of virtual water flows in commodities is US$ 1,625 billion m^3, accounting for 40% of total water consumption. About 80% virtual water flows relate to trade in agricultural products, and the remainder to industrial products.

The IGAD sub-region's external trade patterns can be analysed to show the levels of virtual water flows and how significant these are in terms of overall water resources of the sub-region. The external trade pattern of the sub-region shows that annual imports far exceed exports by more than one and a half times in value terms (Table 11). Agriculture is the major source of products exported. The export base is narrow and only a few products (comprising mainly a few primary agricultural products) account for over 75% of total exports.

The countries of the sub-region are net importers of food: US$ 3.4 billion in 2007 compared to exports of US$ 1.5 billion the same year. As a comparison, the food imports of Sub-Saharan African countries, excluding South Africa and Nigeria, was US$ 20.9 billion in 2007

	Exports (Annual average)			Imports (Annual average)		
Country	1980-89	1990-99	2000-08	1980-89	1990-99	2000-08
Djibouti	..	210	276	..	295	365
Eritrea	..	132	73	..	482	486
Ethiopia	608	715	1,679	1,093	1,330	3,915
Kenya	1,805	2,594	4,869	2,154	3,071	6,725
Somalia	119	90	..	403	346	..
Sudan	841	579	5,069	1,744	1,289	6,390
Uganda	371	500	1,209	619	1,039	2,401
Total*	3,744	4,820	13,175	6,013	7,852	20,282
SSA**	32,451	43,553	106,876	38,640	51,177	106,642

Table 11. Trend of Exports and Imports of Goods and Services – Nominal US$ Million.

World Bank – Africa Development Indicators 2010.

** Totals are for the countries with indicated figures; ** Sub-Saharan Africa excluding South Africa and Nigeria.*

[7] Virtual water is a tool that determines the movement of water through trade. Water footprints measure how much water is used in the production and consumption of goods and services. Both concepts are used to describe the relationships among water management and trade, and water use as it pertains to human consumption.

[8] UNESCO: World Water Development Report 3, 2009.

compared to US$ 12.1 billion of food exports the same year. They are also importers of large quantities of cereals: 4.4 million metric tons in 2007 compared to exports of 0.2 million metric tons the same year.

A study for the *UNDP Human Development Report 2006* (that covered ten riparian states of the Nile Basin) showed that among the five countries which are also members of the IGAD sub-region, all except Eritrea were significant exporters of virtual water – water embedded in the export of primary crop products (Table 12).

Country	Gross Virtual Water Flows (million m^3/yr)								Net Virtual Water Import (million m^3/yr)			
	Related to the trade of crop products		Related to the trade of livestock products		Related to the trade of industrial products		Total Trade		Related to the trade of crop products	Related to the trade of livestock products	Related to the trade of industrial products	Total Trade
	Exp	Imp	Exp	Imp	Exp	Imp	Exp	Imp				
Eritrea	14	238	18	7	ND	27	32	272	224	(11)	27	240
Ethiopia	2,143	346	90	2	5	89	2,238	437	(1,797)	(88)	84	(1,801)
Kenya	4,638	2,361	161	13	28	182	4,827	2,556	(2,277)	(148)	154	(2,271)
Sudan	7,251	520	273	10	56	89	7,580	619	(6,731)	(263)	33	(6,961)
Uganda	4,432	1,201	77	3	1	88	4,510	1,292	(3,231)	(74)	87	(3,218)
Total	**18,478**	**4,666**	**619**	**35**	**90**	**475**	**19,187**	**5,176**	**(13,812)**	**(584)**	**385**	**(14,011)**

TABLE 12. Virtual Water Flows of the Countries of the Nile Basin that are Members of IGAD.

UNDP Human Development Report 2006 – Managing Transboundary Water Resources for Human Development, by Anders Jagerskog and David Phillips

ND = No Data

Global virtual water trade can save water if products are traded from countries with high water productivity to countries with low productivity. Countries with water shortages can import water-intensive goods and services, while countries with abundant water supply can take advantage of this through exports. However, while the benefits of this trade are reaped broadly at regional or international level, many countries have trade patterns that do not promote or benefit from this advantage. Thus, trade distortions and failure to properly price water resources may worsen water-related problems of trading partners.

4. AGRICULTURE AND FOOD SECURITY

4.1. Food production

Agriculture is the most important sector and is the cornerstone of the economies of the sub-region. The main crops grown in the sub-region may be grouped into two categories, namely: (i) food crops which are further classified into cereals, pulses, oilseeds, roots and tubers, and horticulture/vegetables; and (ii) cash earning crops mainly cotton, coffee, tea, sisal, sugarcane, fruit trees, etc. Without underrating the importance of the export crops, the food crops sub-sector is given special significance because of its food security implications. Table 13 gives the trend of area and production of the main food crops in the sub-region

Crop	1994-1996		1999-2001		2005-2007	
	Ha	Qty	Ha	Qty	Ha	Qty
Cereals	**19,550**	**17,187**	**19,128**	**15,628**	**25,854**	**26,618**
Roots and Tubers	**1,683**	**10,610**	**1,977**	**15,273**	**2,000**	**16,745**
Pulses	**3,373**	**2,000**	**3,563**	**2,392**	**4,097**	**2,959**
Oil Crops	**4,308**	**688**	**5,328**	**760**	**4,717**	**857**
Vegetables	**620**	**4,408**	**689**	**4,149**	**854**	**5,648**
Total	**29,534**	**34,893**	**30,685**	**38,202**	**37,522**	**52,648**
% Change	**100%**	**100%**	**104%**	**109%**	**122%**	**138%**

FAO Statistical Year Book, 2009.

Table 13. Area and Production of Crops in IGAD Sub-region (000 Ha and 000 tonnes).

during the past decade and a half. While there has been a general upward trend in both area and production, the rate of change in output has only been slightly above that of area, as seen from Figure 4.

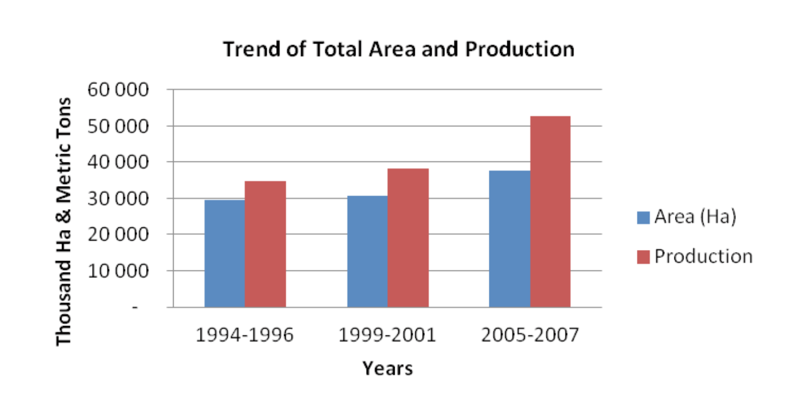


Figure 4: Trend of Total area and Production.

Cereals form a major component of the total food production and are an important diet of the population of the sub-region. Annual cereal production constituted about 50% of the production of the major food categories during the period 2005-2007 (Figure 5). Roots and tubers constituted about 31% and vegetables 11%. Oil crops and pulses constituted only about 7% of total output. The structure of food production and consumption in the sub-region shows an imbalance in the food components, with cereals and roots constituting over 80%, pulses and oilseeds 8% and vegetables 11%.

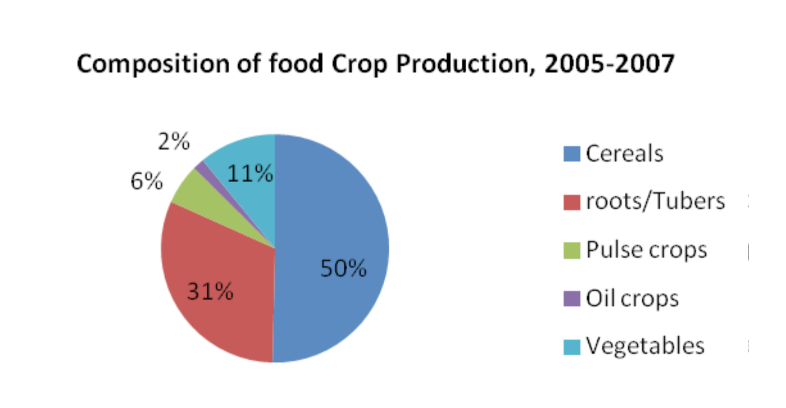


Figure 5: Share of major food crop categories in the IGAD sub-region.

Food production is, however, highly variable and follows closely on the patterns of rains.

Also, both production and markets are not reliable. Long term analysis of emergency food situation shows that IGAD sub-region is chronically food insecure, and the situation is expected to become worse with the current onset of climate change. These assessments are confirmed by recent reports of aid agencies (WFP and Oxfam) which show that, across the whole sub-region, food insecurity manifests itself through large shortfalls in aggregate food production and supplies, and widespread lack of access. Over the years the number of people affected has been increasing quite dramatically: in 2009 23 million people across the region which was twice the 2006 number; and in 2010 over 9 million people were in need of emergency assistance. Pastoralists, agro-pastoralists and other livestock herders are the most affected due to loss of livestock which is their main source of livelihood.

Several factors contribute significantly to causes of food insecurity in the sub-region including, amongst others, the following:

- A combination of conflict (wars), climate change (severe droughts and floods), and rapid population growth;
- The skewed distribution of land resources: 60% of the land is classified as arid, 17% as semi-arid, and 23% as humid, sub-humid and highland (areas of high potential); while 40% of the population reside in the ASAL (77% of land area), 60% reside in the more favourable land areas where they put great pressure through inappropriate land use.
- The distribution of land resources has impact on land use: only about 10% of the sub-region's land area is put to crops, while pastures take up about 44% of the land area.
- Technological improvements in agricultural production, market access and development, and crop loss management including effective reserve storage, are very low. This is also reflected in the current balance between rain-fed and irrigated agriculture.

4.2. Rain-fed and irrigated agricultural potential

The potential for agriculture in the sub-region is largely determined by rainfall levels, with isohyets roughly following latitudes and ranging from less than 100 mm in the desert/severe arid zones to 1500 – 2500 mm in the high potential zones. Where rainfall is insufficient and appropriate soil and water conditions permit, additional potential is created by the possibility of irrigation. Table 14 summarises the data on rain-fed and irrigated agriculture potential. Rain-fed agriculture areas currently constitute about 95% of cropland (Col 1 – Col 4)÷ 100), or potentially 88% if all the irrigation potential area were fully developed and utilised.

The irrigation potential of the sub-region is estimated at about 6.54 million ha or 12% of cropland. The irrigation potential is assessed on the basis of the prospects of water availability, climatic and soil resources, and technology and finances. Of the irrigation potential area, only 2.53 million ha (2.22 million ha full or partial control irrigation and 0.30 million ha spate/equipped lowlands) or 38.6% of irrigation potential is equipped for irrigation. The area actually irrigated is, however, much lower – averaging about 40% over the sub-region - ranging from 10% in Uganda to 80% in Kenya (Table 15).

Table 15 gives a summary of the irrigated area by type/method of irrigation. This Table

Country	Arable + permanent cropland 000 Ha	Potential irrigation area 000 Ha	% of arable+ permanent cropland	Equipped Irrigation Area 000 Ha	% of potential irrigation area	Undeveloped area 000 Ha	% share of rain-fed area a	b
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Djibouti	10.0	2.4	24	1.0	41.7	1.4	76.0	90.0
Eritrea	642.0	187.5	29.2	21.6	11.5	165.9	70.8	96.6
Ethiopia	15,077.0	2,700.0	17.9	289.5	10.7	2,410.5	82.1	98.1
Kenya	5,700.0	539.0	9.5	114.6	21.3	424.4	93.8	98.0
Somalia	1,027.0	240.0	23.4	200.0	83.3	40.0	76.6	80.5
Sudan	19,456.0	2,784.0	14.3	1,884.0	67.7	900.0	85.7	90.3
Uganda	12,170.0	90.0	0.7	14.4	16.0	75.6	99.3	99.9
Total	**54,082.0**	**6,542.9**	**12.1**	**2,525.1**	**38.6**	**3,117.8**	**88.2**	**95.3**

Data on cropland, potential and equipped irrigated area are from FAO AQUASTAT Survey 2005; the potential irrigation area for Kenya iss taken from the national report.

Note: Column (a), % of rain-fed land with potential irrigated area excluded; column (b), % of rain-fed land with only equipped areas excluded from total cropland.

** The total equipped and water managed area includes spate irrigation area (17,490 ha in Eritrea, 150,000 ha in Somalia, and 132,000 ha in Sudan), equipped lowlands or wetlands (3,570 ha in Uganda); non-equipped wetlands (6,415 ha in Kenya, and 49,780 ha in Uganda) are excluded.*

Table 14. Rain-fed and Potential Irrigated Lands, 2007 – 000 Ha.

provides data on the methods or types of irrigation systems in use in the various countries. With the exception of Djibouti and Eritrea which rely on groundwater sources for irrigation, all the countries depend on surface water sources – 94% in Kenya, 96% in Sudan, and almost 100% in Ethiopia and Uganda. Surface water irrigation in these countries is associated with very high wastage of water – in Kenya for instance, canal irrigation is only 30% efficient, compared to efficiencies of 60% in sprinkler systems and 80% in drip systems.

The current irrigation policies in these countries emphasise increasing the area under irrigation and reclamation of poorly drained or degraded land, and give less emphasis on

Irrigation and Drainage	Djibouti	Eritrea	Ethiopia	Kenya	Somalia	Sudan	Uganda	Total
Irrigation Potential	2,400	187,500		353,060	240,000	2,784,000	90,000	6,356,960
Area under full control irrigation	1,012	4,100	289,530	103,203	50,000	1,730,970	5,580	2,184,395
- surface irrigation	-	4,100	283,163	39,217	50,000		5,350	381,830
- sprinkler irrigation	-	-	6,355	61,986	-		230	68,571
- localised irrigation	-	-	12	2,000	-		-	2,012
Equipped lowland area	-	-	-	-	-		3,570	3,570
Spate irrigation area	-	17,490	-	-	150,000	132,000	-	299,490
Total area equipped for irrigation	1,012	21,590	289,530	103,206	200,000	1,862,970	9,150	2,487,458
Actually irrigated area	388	13,490		97,200	65,000	800,000	5,900	
Other agric. water managed area	-	-	-	6,415	-	-	49,780	56,195
Total water managed area	1,012	21,590	289,530	109,618	200,000	1,862,970	58,930	2,543,653

FAO AQUASTAT Survey 2005

Table 15. Summary of Existing Irrigation Area by Type/Method of Irrigation (in Hectares)

improving water use efficiency. As a result overall irrigation efficiencies in many of the schemes are very low. Though data is not readily available to assess efficiencies in the

Country	Total Irrigation Area	Irrigated Land by Basin							Irrigated Areas Outside the Basins A (Ha)
		Ayesha	Danakil	Gash-Barka	Juba-Shebelle	Ogaden	Turkana-Omo	TOTAL BASINS	
Djibouti	1,000	0	0	0	0	0	0	0	1,000
Eritrea	21,600	0	4,756	5,057	0	0	0	9,813	11,787
Ethiopia	289,500	0	4,756	0	48,783	1,721	46,953	102,213	187,287
Kenya	121,000	0	0	0	7,134	0	9,720	16,854	104,146
Somalia	200,000	0	0	0	142,814	23,429	0	166,243	33,757
Sudan	1,884,000	0	0	13,677	0	0	0	13,677	1,870,323
Uganda	58,900	0	0	0	0	0	0	0	58,900
Total	**2,576,000**	**0**	**9,512**	**18,734**	**198,731**	**25,150**	**56,673**	**308,800**	**2,267,200**

FAO Global Irrigation Map 2007

Table 16. Irrigated Lands by Transboundary Basin.

various schemes, most of the reports attest to this.

Data on the distribution of the irrigated areas within the six transboundary basins was obtained from the FAO Global Irrigation Map 2007. This data is given in Table 16.

As can be seen from the Table, both Djibouti and Uganda have no irrigation schemes in the transboundary basins. Ayesha basin has no irrigation indicated. Danakil and Ogaden show some irrigated areas though various reports show low irrigation potentials in these dry basins. The total irrigation within the basins was about 0.31 million ha; 64% of this is located within the Juba-Shebelle basin. Somalia's share of this basin's irrigation is 72%.

The potentials for irrigation expansion as a strategy should be assessed in tandem with the potentials of rain-fed agriculture. Although the countries of the sub-region have plans to expand irrigation over the next decade or so, these will depend on the availability of resources, and in some countries on whether sufficient priority is accorded to irrigation relative to other development needs. Both expansion of irrigated area and rehabilitation of existing areas will probably be considered in the development plans but the point must be made and noted that existing schemes are highly underutilised due to disused infrastructures.

The imperative to raise agricultural productivity to meet the growing demand for food has thus important implications for water resources.

- Expansion of irrigation will increase the demand for water but this must be weighed against increased irrigated yields, which must rise substantially above current levels.
- Rain-fed agriculture will have to rise and still account for more than 50% of cereal production – this highlights the critical importance of boosting the productivity of "green water"[9] through enhanced moisture retention and improved cultivation practices.

9. Green water is water absorbed by the soil and transpirated by plants.

4.3. Livestock potential

The sub-region has a combined ruminant herd of over 350 million (Table 17): The livestock population is characterised by large herds of camels, sheep and goats, raised in arid and semi-arid zones, and cattle, bred in the medium rainfall savannah and in the high rainfall zones. The largest herds are found in Ethiopia and Sudan – both account for over 70% of the total cattle herd, 50% of the sheep and 60% of the goats. In Djibouti the local production of livestock is small. However, Djibouti is a major transit centre for regional trade in live animals, serving mainly Ethiopia and exporting to Egypt and the Arabian Peninsula. Over the whole sub-region the population of livestock oscillates depending on water availability, with major decreases during periods of severe drought.

Species	Djibouti	Eritrea	Ethiopia	Kenya	Somalia	Sudan	Uganda	Total
Cattle	42	1,960	49,300	12,780	5,350	41,400	11,400	122,232
Sheep	103	2,120	25,000	9,600	13,100	51,100	34,100	135,123
Goats	545	1,720	21,900	14,600	12,700	43,100	12,400	106,965
Camels	71	76	760	1,000	7,000	4,400		13,307
Donkeys	7		5,400	300				5,707
Horses			1,800	2	1	26		1,829
Mules			374		22	1		397
Asses					20	750	17	787
Pigs				300	4		3,200	3,504
Poultry	6		38,100				37,400	75,506

National Reports; FAO Statistical Year Book 2009. Note: The data in the Table are not exhaustive

TABLE 17. Estimates of Main Ruminant Livestock Population in 2009 ('000 Nos).

The main basis of the livestock potential in the sub-region is its rangelands potential, which is quite extensive. Estimates of grazing land vary between 180-220 million hectares (36-45% of the sub-region's land area). Rangelands are found in most ecological zones: desert in the north, semi-desert, low rainfall savannah and high rainfall woodlands in the south. Annual grasses with scattered trees and bush dominate rangelands in the arid and semi-arid zones. In the medium to high rainfall zones, perennial grasses increase with wood cover density. A large proportion (80%) of the range is in semi-arid and low rainfall savannah woodland zones characterized by erratic rainfall and recurrent droughts. Forage from rangelands is estimated to provide, depending upon the region, from 55-80% of the national herd feed requirements.

Livestock is owned by pastoral groups (strictly livestock dependent) and agro-pastoral ones (dependent on livestock and crops) and raised under semi-nomadic and nomadic systems with traditional movements occurring between wet and dry season grazing areas. Traditional communal systems and extensive (ranching) and intensive (dairying) occur in the higher rainfall areas. Free grazing and browsing of rangelands and woodlands is the most common livestock raising system. The body condition of the herds declines with the reduction of the quality and quantity of the dry season forage; pastures fail to meet the animals' maintenance requirements, particularly those of the sedentary livestock which does not have the mobility of the transhumant herds.

Several factors constrain livestock development, three of which represent a direct challenge for the MAM-TWR project. The first is to initiate recognition and to develop strategies for ensuring the development of water resources to meet the needs of livestock. Unlike the human MDG, the water requirements need to be considered in the context of the livestock commodity or production chain, from the farmers' level to the level of local slaughtering.

The second major challenge is the high population growth, poverty and underdevelopment. All the seven IGAD member states are classified among the least developed, low income, food deficient countries with widespread poverty and under-nutrition. The widespread poverty has secondary effects:

- The poor people in the sub-region depend heavily on the income from livestock, but can seldom afford to eat animal products – they must trade them for staples with lower costs per calories. Thus, though IGAD countries have large livestock herds, average animal per capita consumption of animal products is extremely low.
- As a corollary to the above, growth in livestock production has barely kept pace with the growth in demand for food of animal origin, and per capita production is either declining or only marginally increasing. Improvement in the supply of meat and milk depends critically on increases in livestock productivity, which is generally poor across the region's various production systems.

Closely linked to poverty and underdevelopment is the absence of technological and management advancement in the traditional livestock sector. This is the third major challenge. While significant advances in the livestock sector have occurred in other regions of the world, this has not occurred in the IGAD sub-region, along with the rest of Sub-Saharan Africa. The technologies and management of livestock are based on a complex variety of production systems which do not lend themselves easily to modernisation.

Range-based livestock production (extensive grazing system) is the dominant land use in the arid zones and in the lower rainfall areas of the semi-arid zones. These systems involve seasonal and annual mobility of livestock in search of pastures over large areas of rangeland.

The migratory nature of pastoralism is closely linked to nomadism which is a lifestyle in the major arid and semi-arid zones. Some of the disadvantages of the nomadic production system that translate into transboundary issues and call for sub-regional action for their resolution include amongst others; full dependence on the natural range, which has been subjected to decrease in area because of competitive horizontal expansion of crop production activities and continued degradation of the remaining pastures; and (ii) the shortage of water supply in nomads' areas and along stock routes, especially during the dry season. Both of issues often result in conflict with other users over access to grazing resources, intensifying on the stock routes especially during migration. Over the sub-region, these conflicts have expanded and intensified, with small arms crossing borders and resulting in insecurity over areas not even connected with grazing land.

5. INDUSTRY AND INFRASTRUCTURE

5.1. Manufacturing

With the exception of Kenya and Sudan, the industrial base of the countries in the sub-region is very low. Nevertheless, the countries have ambitions to accelerate the pace of industrialisation as one of the strategies for poverty reduction and employment creation. There has been substantial increase in industrial value-added in the recent years. For instance, between 1995 and 2005 industrial value added increased by 473% in Sudan, 427% in Kenya, 334% in Ethiopia and 278% in Uganda.

The structure of manufacturing indicates the dominance of food and related processing activities, which is a reflection of the agricultural sector as the base for industrialisation. In Djibouti where agricultural potential is very low, the food industry is little developed as a consequence. The only factories are a Coca-Cola bottling and a desalinating plant, an ice making plant, and a flavoured drink and Popsicle plant. The mineral potential is very low, the only known deposits of significance being salt located in Assal Lake. The current strategy for the industrial sector is to identify and develop a motor assembly, and to focus on known potential resources such as salt, seafood, meat, and construction materials.

In Ethiopia, industrialisation is being driven by a more conducive investment environment following a series of reforms that have opened up the economy to investment. The industries are classified into fifteen major groups, with the top four being: (i) the manufacture of food products and beverages constituting 26.4% of the total establishments (mainly flour, bread, edible oils, soft drinks, beer and other alcoholic beverages); (ii) the manufacture of other non-metallic mineral products, 19.7%; (iii) the manufacture of furniture and other products NEC, 15.9%; and (iv) the manufacture of paper, paper products and printing, 8.1%. Regional distribution shows a concentration of industries in Addis Ababa (51.21% of the establishments), Oromiya (15.38%), Tigray (10.81%), Amhara (9.42%) and SNNP (8.39%). The other regions have mostly less than 1% of the industries.

In Kenya, industrial activity is dominated by food processing such as grain milling, beer production, sugar cane crushing, and fabrication of consumer goods. Kenya also refines crude petroleum into petroleum products which are mainly consumed locally.

There are approximately 2,500 industries in Kenya – 48% of them are concentrated in Nairobi. The total value of the manufacturing sector is projected to be KShs 62 billion in 2010 at 1988 prices. Among the districts, Nairobi has the highest value added of KShs 29 billion. Others are Mombasa, Nakuru, Kiambu and Kisumu which account for KShs 44 billion in 2010 or 71% of the Nairobi total. Industries are located in both urban and rural areas:

- **Urban based industries**: These include tanneries, textile mills, breweries, creameries, paper recycling mills, chemical processing factories, slaughter houses, soft drink plants, and other types of small industries.
- **Rural based industries**: Major agricultural based rural factories include coffee pulping and fermenting which have increased from 500 in 1965 to over 2,000 to date. There are also major sugar milling factories, sisal fibre processing factories, pulp and paper mills, slaughter houses, and tanneries, textile mills and fruit canneries.

In Sudan the main components of industrial activity are manufacturing, which consists mainly of medium and small scale enterprises in food processing, including sugar refining and edible oils; there is also soap manufacture, cotton ginning and textiles, cement, shoes, petroleum refining, pharmaceuticals, armaments and automobile/light truck assembly.

The growth of manufacturing was until 1998 constrained by, among other things, heavy reliance on imports of fuel and restricted access to other imported inputs. After 1998, and following the start of petroleum production and exports, the supply of raw materials and imported machinery increased. There was also increased foreign direct investment which benefited the manufacturing sector. On the whole, economic growth was largely driven by direct foreign investment and oil production and exports.

Most of the current industrial and other associated developments are concentrated around Khartoum and Port Sudan. Rural areas have not benefited much, although the growing investment in food processing, especially sugar factories, is being located in rural areas which may thus provide increased employment opportunities.

The acceleration of industrialisation in the sub-region will create pressure on water resources. The challenge for the MAM-TWR project is to initiate a process of building the data and knowledge base on industrial water use. This is necessary to aid: (i) the monitoring of withdrawals of scarce water resources for the sector that is set to grow rapidly in future; (ii) provision of advice on efficiency measures for water saving in the various industries; and (iii) industrial and service location in the IGAD transboundary basins and sub-basins. In order to achieve these goals, the MAM-TWR project needs to proceed with a number of actions which include: the establishment of the industrial database of the countries, focusing on locations so as to identify industries that are located in the identified sub-basins; and the classification of industries so as to identify specific processes and their water use.

5.2. Energy demand

Water and energy share the same demand drivers – population and economic growth, and social and technological advancement. The demand for energy (heat, light, power, transportation, etc) is increasing rapidly, and water is needed for the production of energy of all types. Therefore, the expansion of energy supply will affect water resources needed for industrial and related environmental services[10].

In the IGAD sub-region, energy production is still low but increasing, though slowly. Energy use is closely related to growth in the modern sectors – industry, motorised transport and urban centres. Fossil fuel (almost entirely oil products) constitutes about 24% of total energy use in the sub-region, except in Ethiopia where it constitutes less than 10%. Oil is a major source of electricity generation in Eritrea and Djibouti (almost 100%), and has been increasing in Kenya and Sudan, but declining in Ethiopia. Hydropower is the most significant source of electricity generation in Ethiopia (over 95% of total electricity generation) and Uganda (Tables 18 and 19).

[10.] Industrial use consists primarily of two components: manufacturing and electricity generation. National electricity production is usually taken as the driving force of industrial water use because electricity generation dominates industrial water use in most countries, and because the amount of electricity produced in a country gives a rough indication of the level of its manufacturing activity.

	Energy Prodn		Energy Use									Alternative and nuclear		Net energy imports		GDP per unit of energy use	
	Total million metric tons of oil equiv.		Total million metric tons of oil equiv. Average annual growth			Per capita kilos of oil equiv.		% of total				% of total energy use		% of total energy use		2005 PPP $ per kilo of oil equiv.	
								Fossil fuel		combustible renewables and waste							
Country/ Year	'90	'07	'90	'07	1990-07	'90	'07	'90	'07	'90	'07	'90	'07	'90	'07	'90	'07
Djibouti	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Eritrea	0.7	0.5	0.9	0.7	-2.2	276	151	19.3	26.5	80.7	73.5	0	0	19	26	1.9	4
Ethiopia	14.1	20.9	14.9	22.8	2.6	308	290	5.5	8.5	93.9	90.2	0.6	1.3	5	9	1.8	2.6
Kenya	9	14.7	11.2	18.3	3	479	485	19.5	19.6	75.9	74	4.4	6.4	20	20	3	3
Somalia	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sudan	8.8	34.6	10.6	14.7	2.6	392	363	17.5	26.3	81.8	72.8	0.8	0.9	17	-136	2.5	5.2
Uganda	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

TABLE 18. Energy Production and Use in IGAD Member States. *World Bank – World Development Indicators, 2010.*

Country	Electricity production		Sources of electricity									
	billion KW hours		coal		gas		% of total oil		hydropower		nuclear power	
	1990	2007	1990	2007	1990	2007	1990	2007	1990	2007	1990	2007
Djibouti	..	..	..	..	..	..	..	..	..	..	..	..
Eritrea	0.1	0.3	0.0	0.0	0.0	0.0	100	99.3	0.0	0.0	0.0	0.0
Ethiopia	1.2	3.5	0.0	0.0	0.0	0.0	11.6	3.8	88.4	96.2	0.0	0.0
Kenya	3.2	6.8	0.0	0.0	0.0	0.0	7.1	28.8	76.6	51.4	0.0	0.0
Somalia	..	..	..	..	..	..	..	..	..	..	..	..
Sudan	1.5	4.5	0.0	0.0	0.0	0.0	36.8	68.0	63.2	32.0	0.0	0.0
Uganda	..	..	..	..	..	..	..	..	..	..	..	..

TABLE 19. Sources of Electricity.

Energy prices have been on a steady increase since the early 1970s, and are linked to increasing oil prices. High fuel prices are encouraging the development of alternative energy types such as wind and solar energy which require little water to produce. These developments can be quite attractive in some IGAD member states, particularly, hydropower development (note the huge potential in Ethiopia) which offers one energy strategy to reduce dependence on fossil fuels and limit greenhouse emissions. This strategy that can also provide the focal point for regional cooperation and is especially important for the long-term reduction in the consumption of combustible renewable sources, which currently constitute about 80% of total energy use across the sub-region.

5.3. Transport

Transport is a major sector in which water use must be huge and growing, but with hardly any data that may aid any meaningful assessments. Both the national and international reports provided little data on the sub-region's transportation networks. Like the manufacturing sector, all the countries in the sub-region are investing in transport infrastructure as one of the strategies to improve the competitiveness of their economies.

In Djibouti, the transportation/navigational potential revolves around its strategic location as a regional and international transhipment and refuelling centre. The International Port of Djibouti (PAID), a port complex constructed with financial support from the Emirate investors through a franchise agreement with the Dubai Port World (DPW), handles between 4.5 and 5 million metric tons of goods per year, 85 % of which is from Ethiopia. Ethiopia became landlocked following the independence of Eritrea which retained the port of Hassawa. The new deep water port has an oil as well as container terminal which is complemented by a 700 ha commercial free zone.

Over 80% of the road traffic in the Djibouti territory is along the corridor between Djibouti city and Galafi which is exclusively for international trade traffic to and from Ethiopia. A survey by BCEOM in 2004 showed that overall traffic of heavy goods vehicles reached about 1,100 PL per day in both directions, with only about 800 PL 2way per day on the northern corridor. Average daily traffic of heavy commercial vehicles has increased more than 15% since 1999.

In Ethiopia, details of the national transport policy and strategy were not available for analysis. But the national Socioeconomic report identified four focal areas of water navigation potential: (i) navigation on Lake Tana, which is particularly important for the local people and their goods, as well as for tourists – about 100,000 passengers are recorded on average each year on the routes. The major concerns are the drop in the lake water levels as a result of the planned hydropower and other developments. Public transport already suffered in 2002 and 2003 when water levels dropped by about half a meter following construction of the Chara Chara weir, thus preventing the use of large boats; (ii) potential for river transport on the Omo and Gojeb Rivers is presently limited to commercial rafting for tourists. Potentials for other uses exist but are not yet studied; (iii) in the Awasa and Arba Minch Lakes, provision of boat services for tourists has become a means of self-employment for the communities around; and (iv) the Juba River has been identified in the Genale Dawa Master Plan Study as having potential for transport of goods and linking with the Somali port of Kismayu.

In Kenya, there is considerable water navigation potential - both inland and coastal water surfaces – which needs to be assessed in a systematic way. For instance, Kenya has nine lakes with a surface area of 10,747 km2 (WR report). The shared lakes include Lake Victoria, Turkana, Jipe, Chala, Logibi and Amboseli. Kenya has five major drainage basins with river flows and tributaries.

In addition to water transport, Kenya is intensifying investments in its transport infrastructure as a whole, which comprises road, railway, marine, pipeline and air transport. The road network accounts for over 80% of the country's total passenger and freight traffic. Kenya is also a major hub for the rest of the East African countries. With the coming into force on July 1, 2010 of the East African Customs Union, the real significance of the transport infrastructure will become very apparent and Kenya, as well as the other countries in the sub-region, will have to invest substantially in this sector. The implications for water use and demand for these developments now and in the future, should be of interest in the planning and management of water resources.

In Uganda, besides air, road and rail transport, inland waterways have become important as major transit transport links for Uganda in East Africa. Under the auspices of the EAC, Uganda, Kenya and Tanzania plan to invest in the improvement of the ports of Mwanza, Kisumu, Port Bell and Jinja on Lake Victoria (NBI 2008). The EAC also plans to implement a project to enhance safety on Lake Victoria in collaboration with the International Maritime Organisation (IMO) and the International Hydrography Organisation (IHO). Uganda currently has access to the sea through two main corridors (the 2,000 km long Northern Corridor and the 1,500 km long Central Corridor) and through the Lake Victoria Crossing.

Given the paucity of basic data, the immediate challenge for the MAM-TWR project is to initiate a process for developing a database on the sectors and for monitoring the use of water resources. A holistic strategy is proposed. Firstly, the strategy should embrace water use in all transport modes. It is important therefore, first to classify the different modes of transport (road, rail, air, water), and within each mode to further classify the means of transport by type of vehicles or craft and their capacities and their water utilisation.

Secondly, in water for navigation requirements, the “in-stream” use of water is not considered; however, stretches of water surfaces (lakes and rivers) that are navigable (km and sq km) are important for assessing the potential for river navigation. The focus of estimation is therefore on water use in the crafts that navigate water bodies: hence, the number and types of water crafts and their capacities (engines etc); and average annual or seasonal number of people using the various types of crafts.

5.4. Tourism, wildlife and ecology

Tourism is a major source of foreign exchange revenue for the countries in the IGAD sub-region. Almost every country has a tourism development master plan in place, with targeted investments in the essential infrastructure for the sector. The major attraction (and the key driver) in the tourism industry is undoubtedly wildlife but there is also ecological and archaeological tourism which attracts worldwide interests.

The water requirements for the tourism and wildlife sector comprises the diversions from surface water and groundwater resources for use by the population of tourists and other people using tourist facilities (hotels, lodges, water crafts, vehicles, etc), and the water needs of the wildlife itself. The former can be estimated directly from the numbers of people using the tourist facilities. For the wildlife, however, they depend on the water needed to maintain the environmental ecosystems. This is the water left after withdrawals for human, agriculture and industrial use and includes reflows from these industries. The crucial issue here is whether the water needed to effectively maintain the ecological integrity of the environment is enough, bearing in mind that both aquatic and terrestrial wildlife must depend on this water.

Mainstream tourism embraces major attractions which can be found in almost all the river basins of the sub-region: wildlife, historical and archaeological sites, scenic and special natural views and features. Others include sport fishing, gorilla tracking, chimpanzee habituation, water tourism and white water rafting. The link with the population and habitat of wildlife is obvious. In this regard, the real threat to the sub-region's tourism potential has been the massive decline in the major species of wildlife including fish; for example by as much as 80-96% in some species between 1960 and 2004. This threat is found throughout the IGAD sub-region, and should elicit efforts towards cooperation in protecting the environment for wildlife.

Global warming now appears to be a major threat to future growth of tourism in the sub-region. Warning signs of this phenomenon are evident from the rising sea levels, tsunamis, advancing desertification, flooding and receding snow and ice in mountains. Reduction in precipitation would devastate wildlife and reduce attractiveness of nature reserves thereby reducing income from the current vast investment in tourism.

Quite clearly, nature and climate are the resources for tourism in the IGAD sub-region as in the other countries. While the sector needs to strengthen existing conservation initiatives by diversifying products so as to reduce this impact on the environment, it is important to include in these initiatives special efforts to analyse the ecological needs for water resources. This has not been addressed in the national reports.

The richness of the sub-region's biodiversity is one of the main drivers for tourism. Many of the attractions are in the ASAL zones, which are home to most of the wildlife. The biological resources contribute to economic development of the sub-region through nature-based tourism and tourist-related activities. The rare and endemic wild fauna and flora of the varied ecosystems attract tourists and generate foreign revenue. The semi-desert and scrub ecosystem are also considered as the basis of an expanded eco-tourism. Big game and bird fauna are abundant in the rift valley and the lowlands.

Wildlife as a natural resource asset in the sub-region has certainly not been undervalued. However the challenge is how to maximize the growth of the tourism industry, while at the same time minimizing the impacts on the parks. The impact of tourism on environment is largest where visitation is concentrated. The potential for integrating wildlife conservation with resources development is good, and there is need to undertake more research into water needs of the tourism, wildlife and ecology sector. Both Uganda and Ethiopia reports provide data which can aid the initiation of the work.

4

ASSESSMENT OF WATER DEMAND AND USE

1. OVERVIEW OF WATER WITHDRAWALS

This chapter begins with an overview of the current estimates of annual water withdrawals for the key sectors: domestic, agriculture and industry. Table 20 presents these estimates by country, and is a convenient starting point for the discussions that follow in the rest of the chapter. Water withdrawal in this study is equivalent to water use. Some fraction of the water withdrawn is for consumptive use – it is evaporated or incorporated into a product – and the remainder is returned to the environment where it may be available for re-use.

The data and information used in this chapter are the latest available as reported from the source. However, it should be noted that countries are regularly updating their databases and such data may be available already but not officially released and accessible to the consultant. For instance, it has been learned that Uganda is currently updating its information on water resources and withdrawals which will be available only after this study.

Country	Popn	Total With-drawals (=DWR)	Annual Sectoral Withdrawals								
			Domestic		Industry		Agriculture				
	2010		Total P/C		Total P/C		Total	Irrigation Total	Irrigation P/C	Livestock Total P/C	
	Mill	2010 Km^3	mill m^3	m^3	mill m^3	m^3	mill m^3	mill m^3	m^3	mill m^3	m^3
	1	2	3	4	5	6	7	8	9	10	11
Djibouti	**0.83**	**0.03**	**17.5**	**21.1**	**0.0**	**0.0**	**12.5**		**12.3**	**2.3**	**2.8**
Eritrea	**5.24**	**0.63**	**33.4**	**6.4**	**1.3**	**0.2**	**595.4**	**574.7**	**109.7**	**20.7**	**3.9**
Ethiopia	**79.80**	**5.56**	**333.0**	**4.2**	**21.0**	**0.3**	**5,204.0**	**4,455.8**	**55.8**	**748.2**	**9.4**
Kenya	**38.61**	**2.74**	**410.0**	**10.6**	**180.0**	**4.7**	**2,136.0**	**1,987.2**	**51.5**	**148.8**	**3.9**
Somalia	**9.34**	**3.30**	**33.0**	**3.5**	**2.0**	**0.2**	**3,265.0**	**3,071.8**	**328.9**	**193.2**	**20.7**
Sudan	**40.90**	**37.94**	**1,139.0**	**27.8**	**379.0**	**9.3**	**36,424.0**	**35,917.2**	**878.2**	**506.8**	**12.4**
Uganda	**31.68**	**0.64**	**328.0**	**10.4**	**50.0**	**1.6**	**259.0**	**110.5**	**3.5**	**148.5**	4.7
Total	**206.40**	**50.84**	**2,293.9**	**11.1**	**633.3**	**3.1**	**47,895.9**	**46,127.4**	**223.5**	**1,768.5**	**8.6**
% Distrib.		**100.0**	**4.5**		**1.3**		**94.2**	**90.7**		**3.5**	

TABLE 20. Annual Water Withdrawals by Sector - Total and Per Capita (2010)

National reports; FAO AQUASTAT Survey 2005; World Bank: World Development Indicators 2010 & Africa Development Indicators 2010.

Figure 6 shows the distribution and relative significance of water withdrawals in different sectors. Total water withdrawals in the sub-region are estimated at about 50.84 km^3 and constitute about 17% of total annual renewable water resources (TAWR) estimated at about 304 km^3. Withdrawals for agriculture account for 94.2% of water withdrawals (90.7% for irrigation and 3.5% for livestock), while domestic water supply and industrial water use account respectively for 4.5% and 1.3%.

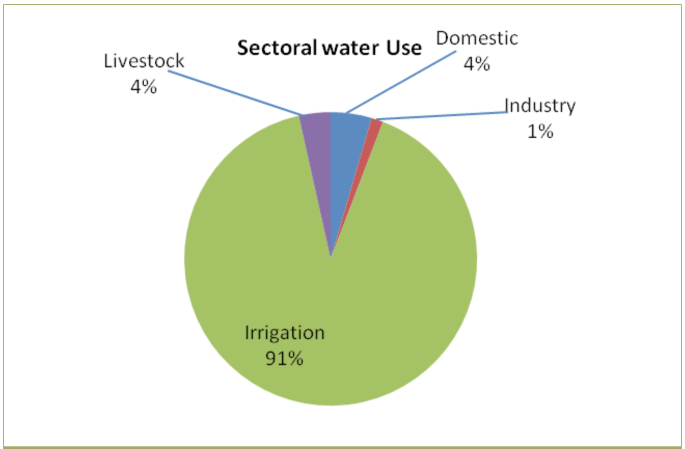


FIGURE 6: Sectoral Water Use (water sharing).

2. SITUATION AND TREND OF DOMESTIC WATER SUPPLY

2.1. Quantification of domestic water supply

Domestic water supply is a fundamental requirement for human life and well-being. The basic quantity for domestic household supply should be estimated based on the need to cover the following range of primary uses:

- Consumption – water for drinking and cooking, which is basic to support health;
- Hygiene – beyond physical health, additional water is required for maintaining personal and domestic cleanliness, e.g. hand and food washing, bathing and laundry;
- Productive use – at household level includes water for brewing, animal watering, small scale food production (home gardening), etc;
- Amenity uses of domestic water – includes, for example, vehicle washing, lawn watering (car washing may be a productive use if it is used to provide income).

Domestic water supply may therefore be divided into two elements: (i) the basic requirement to sustain life and health; and (ii) the additional requirement for sustaining livelihoods (including poverty reduction) and improving the quality of life. Thus, water is not only a source of life but it is also an economic resource that is subject to scarcity and therefore to demand management. Domestic demand for water is determined by several factors which include household size, family income, water-using technology (e.g. appliances), lifestyles, consumption patterns, and water prices, amongst others. These factors are important in assessing current and future water demands.

Water withdrawals for domestic supply are given a very high priority by all the countries in the IGAD sub-region. According to available evidence, the quantity of water used by a household is primarily dependent on access as determined by distance and/or time for collection. The WHO/UNICEF JMP considers reasonable access to domestic water supply as being the "availability of at least 20 litres per person per day (annual per capita of 7.3 m^3) from a source within one kilometre from the user's dwelling." Accessibility is, however, a function of service levels which are categorized below (Table 21). This categorization is useful for evaluation of current and future withdrawals.

Service level	Access measure	Needs met	Level of health concern
No access: (quantity collected often below (l/c/d)	More than 1000 m or 30 minutes total collection time	No water security Consumption – cannot be assured Hygiene – not possible (unless practiced at source)	Very high
Basic access: (average quantity unlikely to exceed 20 l/c/d - the minimum quantity required to sustain health)	Between 100 and 1000 m or 5 to 30 minutes total collection time	Basic household water security Consumption – should be assured Hygiene – hand washing and basic food hygiene possible; laundry/ bathing difficult to assure unless carried out at source	High
Intermediate access: (average quantity about 50 l/c/d – the basic requirement)	Water delivered through one tap on plot (or within 100m or 5 minutes total collection time	Effective water security Consumption – assured Hygiene – all basic personal and food hygiene assured; laundry and bathing should also be assured	Low
Optimal access: (average quantity 100 l/c/d and Above – optimal requirement)	Water supplied through multiple taps continuously	Optimal water security Consumption – all needs met Hygiene – all needs should be met	Very low

Table 21. Summary of requirement for water service level to promote health.

Guy Howard/Jamie Bartram: Domestic Water Quantity – Service Level and Health, WHO 2003.

The different levels of access may be interpreted in terms of household water security: the no access level corresponds to no water security; the basic access level to basic household water security; the intermediate access level to effective water security; and the optimal level to optimal water security, with quantity, quality and continuity of supply all likely to be adequate for domestic water needs.

2.2. Current water withdrawals for domestic supply

Current water withdrawals for domestic supply in the sub-region are estimated at about 2.29 billion m3 (2.29 km^3), constituting about 4.5% of the total withdrawals (Table 20). Across the IGAD sub-region, the average annual per capita water withdrawal for domestic supply is about 11.1 m3 which is equivalent to 30 litres per capita per day. There are, however, wide variations between countries:

- Two countries – Djibouti (21.1 m^3) and Sudan (27.8 m^3) – have annual per capita withdrawals that are or about twice the sub-regional average. These are, respectively, equivalent to about 58 litres and 76 litres per person per day and above the intermediate access level.

- In Kenya (10.6 m^3) and Uganda (10.4 m^3) annual per capita withdrawals are close to the sub-regional average and above the basic access level of 7.3 m^3, but still far below the intermediate access level of 18.3 m^3.
- Three countries – Eritrea (6.4 m^3), Ethiopia (4.2 m^3) and Somalia (3.5 m^3) – have annual per capita withdrawals that are well below the average for the sub-region. These countries are almost on the border line between no or very low access on the one hand, and basic access on the other.

2.3. Projections of domestic water withdrawals

Projections of domestic water withdrawals for the medium term (2030) and the long term (2050) were made based on certain rules-of-thumb assumptions as follows:

1) For medium term projections of domestic supply:

- For Eritrea, Ethiopia and Somalia where current annual per capita withdrawals are below 10 m^3, (i.e. below basic access level) the 2010 figures have been doubled to obtain the per capita withdrawals for 2030, which are then multiplied by the 2030 population of the respective countries to obtain the total annual withdrawals for the sector.
- For Kenya (10.6 m^3) and Uganda (10.4 m^3) that are at the 10 m3 level in 2010 (above basic but below intermediate access), their 2010 annual per capita withdrawals are increased by a factor of the population growth from 2010 to 2030 in order to obtain the 2030 per capita withdrawals. These are then multiplied by the respective populations in 2030 to obtain total annual sector withdrawals.
- For Djibouti and Sudan that are already at or above the 20 m^3 target in 2010, these figures have been maintained for 2030 and also 2050.

2) For long term projections of domestic supply:

- For Ethiopia and Somalia, the 2030 per capita withdrawals are still less than 10 m^3; to obtain their 2050 withdrawals, their 2030 figures are again doubled.
- For Eritrea, Kenya and Uganda where the 2030 per capita withdrawals are above 10 m^3 but less than 20 m^3, the 2030 figures are increased by a factor of the population increase to obtain their 2050 annual withdrawals.
- For Djibouti and Sudan the 2010 per capita withdrawals, already more than 20 m^3, continue to be applied in the 2050 projections.

This approach has been used to avoid making unrealistically high percentage increases of water projections for these countries. This approach also avoids the likely pitfalls in attempting to separate the projections for the urban and rural populations. These countries are very poor and the kind of economic, technological and structural changes that can propel substantial increases in domestic water use patterns are likely to be very slow in coming.

Table 22 summarises the projections for the domestic sector in 2030 and 2050. The Table shows that total domestic withdrawals will increase from about 2.29 km^3 in 2010 to 5.25 km^3 in 2030 and to 10.3 km^3 in 2050, i.e. by 229% and 197% respectively. Population will have increased by 165% between 2010 and 2030, and by 136% between 2030 and 2050, meaning that the increases in per capita water use will be slightly ahead of population increase. Across the sub-region, average annual per capita withdrawal for domestic supply will increase from 11.1 m^3 in 2010 to 15.5 m3 in 2030 and to 22.3 m^3 in 2050. One of the implications of these projections is that governments in the sub-region must be committed to enhance the drive towards increased access by the population to clean water resources. The MDGs for most of the countries will hopefully have been achieved well before 2050, and substantial gains also made towards better sanitation facilities.

Country	2030 Domestic Withdrawals						2050 Domestic Withdrawals				
	Population (millions)			Withdrawals			Population		Withdrawals		
	2010	2030	% Change 2030-50	Annual Per Capita WITH.	Annual total WITH	% change of total WITH from 2010 to 2030	2050	% Change 2030-50	Annual Per Capita WITH	Annual total WITH	% change of total WITH from 2030 to 2050
	mill	mill	%	Dom m^3	Dom mill m^3	Dom %	mill	%	Dom m^3	Dom mill m^3	Dom %
	1	2	3	4	5	6	7	8	9	10	11
Djibouti	0.83	1.18	142%	21.1	24.9	142%	1.58	134%	21.1	33.3	134%
Eritrea	5.24	7.38	141%	12.8	94.5	283%	10.8	146%	18.6	200.9	213%
Ethiopia	79.8	133.33	167%	8.4	1,120.00	336%	173.8	130%	16.8	2,919.80	261%
Kenya	38.61	61.5	159%	16.8	1,033.20	252%	85.4	139%	23.4	1,998.40	193%
Somalia	9.34	15.01	161%	7	105.1	318%	23.65	158%	14	331.1	315%
Sudan	40.9	61.98	152%	27.8	1,723.00	151%	75.9	122%	27.8	2,110.00	122%
Uganda	31.68	59.19	187%	19.4	1,148.30	350%	91.3	154%	29.9	2,729.90	238%
Total	**206.4**	**339.57**	**165%**	**15.5**	**5,248.90**	**229%**	**462.43**	**136%**	**22.3**	**10,323.40**	**197%**

Note: WITH = Withdrawal.

Table 22. Projections of Domestic Withdrawals in 2030 and 2050.

2.4. Domestic water withdrawals in transboundary basins

Table 23 shows estimates of domestic withdrawals for each transboundary basin for the years 2010, 2030 and 2050 as products of the population in those years and the respective per capita annual estimates.

The Table shows that the total current annual withdrawals for the domestic sector are 348.5 million m^3 across the basins. The domestic water withdrawals from the basins constitute about 15% of the sub-region's domestic sector in 2010, 16% in 2030 and 17% in 2050. Total withdrawals for domestic requirements will increase from 0.35 Km^3 in 2010 to 0.86 Km^3 in 2030 and to 1.8 Km^3 in 2050.

One important limitation of this approach to estimating and projecting domestic water withdrawals at basin level is that the per capita annual sectoral withdrawals from different countries are averaged and applied to the same basin. Yet these parameters are derived from the total withdrawals contributed by water resources from other basins[11] in the different

11. The most important basins include the Nile River basin, which is the main contributor to the sub-region's water resources

Basin	2010 Withdrawals			2030 Withdrawals			2050 Withdrawals		
	Popn Millions	Annual WITH Million m³	Per capita WITH m³/yr	Popn Millions	Annual WITH Million m³	Per capita WITH m³/yr	Popn Millions	Annual WITH Million m³	Per capita WITH m³/yr
Ayesha	0.22	0.87	3.93	0.37	2.18	5.89	0.58	4.56	7.86
Gash-Baraka	1.41	11.96	8.48	2.00	25.44	12.72	3.91	66.31	16.96
Danakil	1.71	7.73	4.53	2.78	18.88	6.79	4.54	41.13	9.06
Juba-Shebelle	28.05	149.21	5.32	46.13	368.12	7.98	72.29	769.17	10.64
Ogaden	8.70	33.79	3.88	14.30	83.23	5.82	22.52	174.76	7.76
Turkana-Omo	22.87	144.82	6.33	37.66	357.39	9.49	58.83	744.79	12.66
Total	62.96	348.38	5.53	103.24	855.24	8.28	162.67	1,800.72	11.07
% Change	0%	0%	0%	164%	245%		158%	210%	

TABLE 23. Domestic water withdrawals in transboundary basins.

countries. This biases the basin estimates either upwards or downwards. The problem is compounded in the Ayesha, Danakil and Ogaden basins which are known to be dry basins with highly variable run-off of short durations both in time and space.

Despite these methodological shortcomings, the trend of the projected basin level withdrawals reveals that: (i) annual domestic withdrawals across the sub-region will increase by 245% in 2030 from 0.348 Km³ in 2010 to 0.855 Km³ in 2030, and by 210% from 0.855 Km³ in 2030 to 1.800 Km³ in 2050. The population of the basins will have increased by 164% and 158% respectively. Thus the increase in water withdrawals will outpace the increase in population. This implies that the governments of the sub-region will accelerate investments to ensure increased supply of water for domestic use.

2.5. Coverage of domestic water supply

Access and coverage are important targets and are defined in terms of the percentage of the population within reach of an improved water source. Access standards in the IGAD countries vary between 0.2 Km and 0.5 Km in the urban areas and between 1 Km and 1.5 Km in the rural areas. This definition relates primarily to "access" and should not be taken as evidence that 20 litres per capita per day is a recommended quantity for domestic use. Access and coverage are spatial dimensions and therefore the information is subject to (i) changes in the number of watering points and (ii) changes in population size. WHO/UNICEF categorizes the following water supply sources for the purpose of monitoring and evaluating progress towards meeting the MDG on clean drinking-water.

Improved drinking water source	Unimproved drinking-water source
Piped water into dwelling, yard or plot Public tap or standpipe Tube well or borehole Protected dug well Protected spring Rainwater collection	Unprotected dug well Unprotected spring Cart with tank or drum Tanker truck Surface water (river, lake, dam, pond, stream, canal, irrigation channel) Bottled water

TABLE 24. Sources of domestic water supply.

An improved drinking-water source is one that by the nature of its construction adequately protects the source from outside contamination, in particular with fecal matter (WHO/ UNICEF JMP 2010). Improved encompasses three dimensions of water security: proximity, quantity and quality. Technology broadly defines whether the source meets the criteria of being improved (UNDP HDR, 2006).

Table 25 shows the progress that has been made towards greater access to improved water sources in the IGAD sub-region, with a 15% increase in the population accessing improved sources of water since 1990. The sub-region lags behind the rest of the world, with only 58% of the population having access to improved sources of drinking water compared to the access of 87% and 84% respectively for the world and for the developing countries.

Country	Access to Improved Water sources: % of Population						
	1990			2008			% Increase/ Decrease 1990-2008 (Total Access)
	Urban	Rural	Total	Urban	Rural	Total	
Djibouti	80	69	77	98	52	92	15
Eritrea	62	39	43	74	57	61	18
Ethiopia	77	8	17	98	26	38	21
Kenya	91	32	43	83	52	61	18
Somalia	-	-	-	67	9	30	16
Sudan	85	58	65	64	52	57	-8
Uganda	78	39	43	91	64	68	25
Total			48.00			58.14	15

TABLE 25. Access to Improved Sources of Drinking-water: 1990 and 2008.

Some retrogressive developments have occurred in some countries. In Kenya for example, while the proportion of the rural population accessing improved water sources increased from 32% in 1990 to 52% in 2008, there was a decrease in the proportion of urban populations having access to improved water sources, from 91% in 1990, to 87% in 2000, 83% in 2008, and 60% in 2010. This is attributed to the aging and poorly maintained water delivery infrastructure and high urban population growth. In Sudan access to improved sources of drinking-water declined from 65% (85% urban; 58% rural) in 1990, to 61% (73% urban; 55% rural) in 2000 and to 57% (64% urban; 52% rural) in 2008.

Sudan is among the few countries to have experienced declining safe water access levels in the past decade. In the North, there is great variation: 79 and 47 percent of the population have improved water access in urban and rural areas, respectively. Approximately 40 percent of urban and 60 percent of rural populations do not have access to a minimum of 20 litres of water per person per day within a distance of 1,000 metres, and the differential between access in rural and urban areas has increased considerably.

Access to water and sanitation is especially limited in Southern Sudan, which bears an estimated 70 percent of the world's remaining Guinea Worm disease burden. Rural safe water coverage is estimated at 25-30 percent; in Southern towns coverage is around 60 percent. The population per water point ranges from 1,000 to 64,000, and average water collection journeys in un-served areas are up to 8 hours.

2.6. Situation of sanitation coverage

An improved sanitation facility is one that hygienically separates human excreta from human contact. Sanitation coverage is presented as a four-step ladder that includes the proportion of the population: (i) practicing open defecation; (ii) using an unimproved sanitation facility; (iii) using a shared sanitation facility; and (iv) using an improved sanitation facility (WHO/UNICEF JMP 2010).

Improved sanitation	Unimproved sanitation
Flush or pour-to-flush to piped sewer system, septic tank, pit latrine Ventilated improved pit (VIP) latrine Pit latrine with slab Composting toilet	Flush or pour-to-flush to elsewhere Pit latrine without slab Bucket Hanging toilet or hanging latrine

In the IGAD sub-region only 29% of the population has access to improved sanitation, compared to 31% of the population in Sub-Saharan Africa. Djibouti has the highest access at 61.67% and Ethiopia the lowest at 8%.

Progress in meeting MDG sanitation targets:

The IGAD sub-region as a whole is not on track to meet the MDG target of increasing access to sanitation by 2015. With the exception of Djibouti where the proportion of the population that have access to improved sanitation is within the 50-75% range (at 56%), the rest of the countries (Eritrea, Ethiopia, Kenya, Somalia, Sudan and Uganda) are below the 50% mark. Even then, despite Djibouti having the highest proportion of population with access to improved sanitation, this has been declining since 1990, i.e. from 66% (73% urban; 45% rural) in 1990, to 63% (69% urban; 30% rural) in 2000, and to 56% (63% urban; 10% rural) in 2008. Progress toward meeting MDG sanitation targets is very minimal with a flat or decreasing trend between 1990 and 2008 in all the IGAD member states. Progress in the use of improved sanitation is undermined by high population growth, especially in urban centres, which puts a strain

Country	% of popn with access to improved sanitation 1990	% of popn with access to improved sanitation 2008	% increase/ decrease 1990-2008
Djibouti	66	56	-10
Eritrea	9	14	5
Ethiopia	4	12	8
Kenya	26	31	5
Somalia	-	22	1
Sudan	34	34	-
Uganda	39	48	9
Total	29.6	31	2.57

Table 26. Percentage access to improved sanitation.

on water resources, infrastructure used to deliver water and sanitation infrastructure and facilities.

2.7. Issues of inequality and inequity

The urban-rural discrepancies in access to improved drinking-water are particularly striking: While 82% of the urban population have access to improved water sources, only 45% of the rural population have access. The rural population without access to improved sources is over five times that in the urban areas. The rural-urban discrepancies are particularly striking in Uganda, Ethiopia and Djibouti, where the proportion of the population that had access was between 91 -100% in 2008 compared to 50 – 75% in the rural areas. In Kenya it was between 76 -90% in urban areas compared to 50 - 75% in rural areas, while in Sudan, Eritrea and Somalia it was between 50 -75% in urban areas compared to less than 50% in rural areas, except Eritrea which had rural access of between 50 -75%. On the whole, in urban areas the increase in coverage is barely keeping pace with population growth.

Piped water on premises and other improved sources: Only 4% of the rural population have piped water on their premises. In contrast, in urban areas 46% of dwellers use water piped to their households. Between 1990 and 2008, more than 23 million people in the IGAD-sub-region gained access to piped water on premises. This is a 4% increase which, though seemingly modest, is impressive since piped water on premises represents the highest rung of the drinking water ladder where health gains are maximized. However, the growth in the population with access to other improved sources was double the growth in the population with piped connections on premises.

A large segment of the population (42%) still uses unimproved drinking water sources: Unimproved water sources constitute the lowest rung of the drinking water ladder. Forty two percent of the IGAD population (86 million people) consumes water from unimproved sources. However, though this figure is still large, it represents a 10% reduction since 1990, that is, from 52% to 42% in 2008.

Country	1990			2008		
	Urban	Rural	Total	Urban	Rural	Total
Djibouti	20	31	23	2	48	8
Eritrea	38	61	57	26	43	39
Ethiopia	23	92	83	2	74	62
Kenya	9	68	57	17	48	41
Somalia	-	-	-	33	91	70
Sudan	15	42	35	36	48	43
Uganda	22	61	57	9	36	33
Total	**21**	**59**	**52**	**18**	**55**	**42**

Table 27. % of population using unimproved sources of water.

Overall, use of unimproved sources of drinking water in rural and urban centres has declined since 1990. The proportion of the urban population using unimproved sources of water declined by 3%, from 21% in 1990 to 18% in 2008. The proportion of the rural population also declined, by about 4% from 59% in 1990 to 55% in 2008. Only Sudan did not register any improvements in this area. The proportion of people using unimproved sources of water actually increased from 35% in 1990 to 43% in 2008. In Kenya, although there was marked improvement in rural areas, the situation has worsened in urban centres since 1990, that is, from 9% in 1990 to 17% in 2008.

Proximity: Time to collect drinking-water: The available evidence indicates that the quantity of water that households collect and use is primarily dependent on accessibility (as determined by both distance and time). Research has shown that those spending more than half an hour per round trip progressively collect less water, and eventually fail to meet their families' minimum daily drinking-water needs. Additionally, the economic costs of having to make multiple trips per day to collect drinking water are enormous. This is compounded by over-crowding at the water collection points.

Country	% people who use improved drinking water source more than 30 minutes away		
	Urban	Rural	Total
Uganda	28	43	41
Ethiopia	12	15	18
Kenya	2	17	14
Somalia	9	6	7

Source: WHO, UNICEF Progress on Sanitation and Drinking Water, 2010 Update.

Table 28. % of urban and rural populations using improved drinking water sources over 30 minutes away (round-trip).

In the IGAD sub-region, more than a quarter of the population spends more than half an hour per round trip to collect water, as one third of drinking-water sources that are not piped on premises need a collection time of more than 30 minutes. The proportion of the population spending half an hour or less, or more than half an hour, to collect water from an improved source, or using water from an improved source, is indicated in the table below.

Water Source	Urban %	Rural %	Total %
Unimproved source	18	55	42
Improved source >30 min water collection	10	18	17
Improved source <30 min water collection	26	23	19
Piped on premises	46	4	22

Table 29. Proportion of population spending half an hour or less or more than half an hour, to collect water from an improved source, or using water from an improved source (IGAD Sub-region).

Source: WHO, UNICEF Progress on Sanitation and Drinking Water, 2010 Update.

3. IRRIGATION WATER WITHDRAWALS

3.1. Irrigation potential and current withdrawals

All the countries of the IGAD sub-region recognise the potential of irrigation as a means to substantially raise agricultural productivity and improve their food security situations. Yields from irrigated agriculture can be higher than non-irrigated agriculture by a factor of three or more times. This has been demonstrated in Ethiopia, Kenya and Sudan. In Sudan, for instance, output from irrigation constitutes about 60% of total agricultural output, while in Kenya it is about 18% of total agricultural output. Most of the countries have therefore plans for expanding irrigated agriculture as well as rain-fed agriculture.

These attractions of irrigated agriculture are, however, tempered by a number of limiting factors: (i) the high cost of developing modern irrigation systems (especially infrastructure) which would deliver water efficiently; (ii) the poor performance of public irrigation systems, most of which have had their infrastructure run-down; (iii) resulting from this, the high losses of water (low irrigation efficiencies) in almost all the irrigation schemes; and (iv) weak institutional and policy frameworks for effective irrigation development. Thus, while irrigation has a high potential, the realisation of this potential will be severely constrained not only by the financial and human resource costs but also by inadequate water to meet the needs of additional irrigation expansion.

The scenarios of future development of irrigation water withdrawals in the sub-region are closely intertwined with plans for overall agricultural sector development. In each country the plans are informed by a number of factors including the ones listed above. The more realistic approach would be for the MAM-TWR project to examine the different scenarios with the policy makers and experts of the member states.

This study makes broad approximations of the important parameters of irrigation water requirements. The basic parameters are given in Table 30. To estimate irrigation water requirements, it is necessary to first obtain estimates of the reference evapotranspiration rates (ETo) as well as precipitation of the irrigated areas of each basin during the crop season. Precipitation (at say the 75% level of probability)[12] is subtracted from ETo to obtain the net evapotranspiration (NET) requirements of the crops. This NET is what is used as an indicator of the amount of irrigation water that crops need to obtain their full yield potential.

	2010 Population (millions)	Net Irrigated Area (NIA) (1,000 ha)	Annual Irrigation Intensity (AII) %	Gross Irrigated Area (GIA) (000 ha)	Total Annual Irrigation Withdrawals m^3	Withdrawals/ Ha of Gross Irrigated Area m^3/ha/yr	Per Capita Withdrawals m^3/yr
	1	2	3	4	5	6	7
Djibouti	0.83	1.0	81%	0.8	10.2	12,750	12.3
Eritrea	5.24	21.6	189%	40.8	574.7	13,424	109.7
Ethiopia	79.80	289.5	189%	547.2	4,455.8	8,143	55.8
Kenya	38.61	114.6	200%	229.2	1,987.2	8,670	51.5
Somalia	9.34	200.0	57%	114.0	3,071.8	26,945	328.9
Sudan	40.90	1,884.0	104%	1,959.0	35,917.2	18,334	878.2
Uganda	31.68	14.4	200%	28.8	110.5	3,837	3.5
Total	**206.40**	**2,525.1**	**117%**	**2,919.8**	**46,127.4**	**15,798**	**223.5**

Note: The AIIs and NETs for this report were adopted from Seckler et al in World Water Demand and Supply, 1990 to 2025, (IWMI Research Report 19, 1998).

Table 30. Estimates of Irrigated Withdrawals per Hectare (2010).

Column 2 (Col 2) of Table 30 gives the net irrigated areas of each country. These are the areas reported in national or international literature as being equipped for irrigation for at least one year. Col 3 gives estimates of the annual irrigation intensity – the degree of multiple cropping on the net irrigated areas. In Djibouti and Somalia this is shown as less than 100%; this may be due to discrepancies in the reported net irrigated area in the database, or there is not enough water to provide full irrigation. Col 4 gives the gross irrigated areas, which is

12. This would mean that the precipitation level should be obtained at least in 3 out of every 4 years.

a product of Col 2 and Col 3. Col 5 gives gross annual water withdrawals for irrigation, while Col 6 gives withdrawals per hectare of gross irrigated area, in terms of cubic meters.

3.2. Projections of irrigation withdrawals

Two possible scenarios were considered under both the medium-term (2030) and the long-term (2050) projections. The scenarios are meant to provide food for thought about future water needs of the sector. They are not the only scenarios that may be considered; other may be applied where data is available: for instance, different scenarios of population trends, crop yields, changes in dietary habits, etc.

1) Irrigation scenarios for 2030

Scenario 1 assumes no change in the present irrigation effectiveness and that per capita gross irrigated areas will be the same in 2030 as in 2010. The projected 2030 irrigation withdrawals under this scenario are obtained by multiplying the 2010 withdrawals by the population growth of each country. This results in Somalia and Sudan exceeding their net irrigation potential areas. To avoid this situation, the increases in net irrigation areas were restricted to 120% and 140% respectively for Somalia and Sudan. Total projected irrigation withdrawals in 2030 under this scenario are 65.53 Km^3, an increase of 142% from the current 46.13 Km^3 (Table 31 and Table 32).

Scenario 2 assumes that countries begin to actively increase the irrigation effectiveness of their programmes, to at least 50% on a sustainable basis by 2030. The 2030 projection of irrigation withdrawals for this scenario is obtained by first multiplying the net irrigated areas (NIA) of each country by the irrigation intensity to obtain the gross irrigated areas (GIA). The GIAs are then multiplied by the respective NETs (net evapotranspiration) and the population growth. Dividing this product by 100 gives the 2030 total crop water requirements in Km3. Diving this amount by the assumed country/basin irrigation efficiencies (50%) gives the total irrigation withdrawals required to meet the crop water requirements.

2) Irrigation scenarios for 2050

Scenario 1 assumes a continuation of the 2030 scenario 2, with the per capita gross irrigated area remaining the same. In this scenario, the 2050 withdrawals are obtained by multiplying the 2030 scenario 2 withdrawals by the population increase of each country, subject to: (i) Djibouti’s net irrigated area capped not to exceed 2,000 ha (the total irrigation potential is 2,400 ha); and (ii) the net and gross irrigated areas of Somalia and Sudan are maintained at their 2030 levels.

Scenario 2 introduces further improvements in the irrigation efficiency from 50% to at least 60% in 2050. It is envisaged under this scenario that countries will prioritise both technology and management improvements in all existing and planned irrigation developments. Some of the measures that countries can implement to achieve this include: (a) introducing water-saving technologies such as canal lining, gravitation through pipes and storage in overhead tanks to facilitate the use of drip irrigation technologies; (b) introducing appropriate pricing structures measured against water use, and staggered planting regimes to reduce demand peaks. In addition, low cost technologies for rain-water harvesting and management, including smallholder drip irrigation systems, improved soil and water management practices, can be employed to reduce risks due to the unpredictability of rainfall.

The results of these irrigation scenarios are summarised in Table 31. The details are given in Table 32. The following points may be noted from these results:

- Under scenario 1 assumptions, total withdrawals for irrigation will increase by 142% in 2030 or to 65.6 km3 from the current 46.13 km^3, and by a further 113% from 65.6 km^3 in 2030 t0 73.9 km^3 in 2050.
- Under scenario 2, total irrigation withdrawals are seen to decline quite significantly: first to 95% of the current 2010 withdrawals in 2030, and to 87% of the 2030 withdrawals in 2050. These declines are predicated upon countries investing substantially in new technologies and management systems for improved water use management in irrigation programmes. The improvements in water use management would, however, need to extend to rain-fed agriculture practices in order to achieve the best or optimum results.

Country	2010 WITH. Km^3	2030 WITHDRAWAL		2050 WITHDRAWAL.		
		Scenario 1	Scenario 2	Scenario 1	Scenario 2	
					At 60%	At 70%
Djibouti	0.01	0.02	0.02	0.02	0.02	0.02
Eritrea	0.57	0.81	0.68	0.99	0.72	0.62
Ethiopia	4.46	7.44	11.90	15.47	16.05	13.76
Kenya	1.99	3.16	2.32	3.22	1.72	1.48
Somalia	3.07	3.64	1.74	3.64	1.42	1.22
Sudan	35.92	50.29	27.04	50.29	17.85	15.30
Uganda	0.11	0.21	0.20	0.31	0.21	0.18
Total	**46.13**	**65.57**	**43.90**	**73.94**	**37.99**	**32.58**

Source: Derived by the consultant.

TABLE 31. Summary of Scenarios of Irrigation Withdrawals (in Km^3).

3.3. Basin level irrigation withdrawals

The data needed to estimate accurately the current and future water withdrawals at the basin level was not easily available. As in the case of the national and sub-regional levels, only broad indicative assessments are possible at this stage of the study. Table 33 provides estimates of current withdrawals by basin and country. The data on the irrigated areas are from the FAO Global Irrigation Map 2007 (see Table 16 in Chapter 3). The annual irrigation intensity (AII) and the gross irrigation water withdrawals in cubic meters per hectare (W/Ha/yr) are national estimates that are assumed for the respective basins as well. The per hectare gross withdrawals in cubic meters include withdrawals for livestock requirements.

One of the major difficulties in projecting basin irrigation withdrawals is that they are shared by two or more countries with different parameters which are estimated at national level only. Additional assumptions (rough rules of thumb) were therefore needed to generalize and apply these parameters to the basins. Table 34 summarises these parameters.

Country	2030 Projections									2050 Projections								
	Population		Scenario 1			Scenario 2				Population		Scenario 1			Scenario 2			
	No. millions	% change 2010-2030	NIA 000 Ha	GIA 000 Ha	With drawal mill. m^3	NIA 000 Ha	GIA 000 Ha	% irrig. effec.	with drawal km^3	No. millions	% change 2030-2050	NIA 000 Ha	GIA 000 Ha	with drawal km^3	NIA 000 Ha	GIA 000 Ha	% irrig. effec.	with drawal km^3
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Djibouti	1.18	142%	1.40	1.14	14.48	1.40	1.14	50%	0.02	1.58	134%	1.99	1.61	0.02	1.99	1.61	60%	0.02
Eritrea	7.38	141%	31.94	60.36	810.33	31.94	60.36	50%	0.68	10.80	146%	39.13	73.96	0.99	39.13	73.96	60%	0.62
Ethiopia	133.33	167%	484.03	913.81	7,441.19	484.03	913.81	50%	11.90	173.80	130%	1,005.18	1,899.80	15.47	1,005.18	1,899.80	60%	13.76
Kenya	61.50	159%	182.22	364.43	3,159.65	182.22	364.43	50%	2.32	85.40	139%	185.98	371.95	3.22	185.98	371.95	60%	1.48
Somalia	15.01	161%	236.80	135.00	3,636.93	236.80	135.00	50%	1.74	23.65	158%	236.80	134.98	3.64	236.80	134.98	60%	1.22
Sudan	61.98	152%	2,637.60	2,743.10	50,292.07	2,637.60	2,743.10	60%	27.04	75.90	122%	2,637.60	2,743.10	50.29	2,637.60	2,743.10	60%	15.30
Uganda	59.19	187%	26.94	53.85	206.64	26.94	53.85	40%	0.20	91.30	154%	40.14	80.27	0.31	40.14	80.27	60%	0.18
Total	**339.57**	**166%**	**3,600.93**	**4,271.69**	**65,561.29**	**3,600.93**	**4,271.69**	**50%**	**43.91**	**462.43**	**136%**	**4,146.82**	**5,305.67**	**73.94**	**4,146.82**	**5,305.67**	**60%**	**32.58**

Note: The scenario 2 withdrawals for both 2030 and 2050 were arrived at as follows:

- *First obtain the Gross Irrigated Area (GIA) by multiplying the net irrigated area (NIA) by the irrigation intensity shown in Table 30.*
- *Then multiply the GIA by the NET (net evapotranspiration) – the figures for the NET are obtained from Seckler, et all, in World Water Demand and Supply, 1990 to 2025: Scenarios and Issues (not included in this report).*
- *Then divide the product of (GIA x NET) by 100 to obtain the total crop water requirements in km3. This amount is then divided by the assumed irrigation efficiency to obtain the total irrigation withdrawals.*

TABLE 32. Medium and long-term projections of irrigation withdrawals – 2030 and 2050 scenarios.

Basin		Country							
		Djibouti	Eritrea	Ethiopia	Kenya	Somalia	Sudan	Uganda	Total
	AII	81%	189%	189%	200%	57%	104%	200%	
	W/Ha/yr	14,444	14,875	9,531	7,417	28,640	18,593	1,091	94,591
Ayesha	NIA	0	0	0	0	0	0	0	0
	GIA	0	0	0	0	0	0	0	0
	IWW	0	0	0	0	0	0	0	0
Danakil	NIA	0	4,756	4,756	0	0	0	0	9,512
	GIA	0	8,989	8,989	0	0	0	0	17,978
	IWW	0	133.711	85.67	0	0	0	0	219.39
Gash-Baraka	NIA	0	5,057	0	0	0	13,677	0	18,734
	GIA	0	9,558	0	0	0	14,224	0	23,782
	IWW	0	142.18	0	0	0	264.47	0	406.64
Juba-Shebelle	NIA	0	0	48,783	7,134	142,814	0	0	198,731
	GIA	0	0	92,200	14,268	81,404	0	0	187,872
	IWW	0	0	878.76	105.83	2,331.41	0	0	3,315.99
Ogaden	NIA	0	0	1,721	0	23,429	0	0	25,150
	GIA	0	0	3,253	0	13,355	0	0	16,608
	IWW	0	0	31	0	382.49	0	0	413.49
Turkana-Omo	NIA	0	0	46,953	9,720	0	0	0	56,673
	GIA	0	0	88,741	19,440	0	0	0	108,181
	IWW	0	0	845.79	144.19	0	0	0	989.98
TOTAL	NIA	0	9,813	102,213	16,854	166,243	13,677	0	308,800
	GIA	0	18,547	193,183	33,708	94,759	14,224	0	354,421
	IWW	0	275.89	1,841.23	250.01	2,713.90	264.47	0	5,345.49

Note: AII = Annual Irrigation Intensity; W/Ha/yr = Gross Irrigation Water Withdrawal in cubic meters per hectare; NIA = Net Irrigation Area; GIA = Gross Irrigated Area; IWW = Irrigation Water Withdrawal, in Million m^3 per year.

TABLE 33. Current estimates of irrigation withdrawals by basin and country (million m^3).

Basin	Population Growth					Annual Irrigation Intensity	NET
	2010	2030		2050			
	millions	millions	% Change	millions	% Change		
Ayesha	0.22	0.37	168%	0.58	157%	-	-
Gash-Baraka	1.71	2.78	163%	4.54	163%	189%	0.40
Danakil	1.41	2.00	142%	3.91	196%	127%	0.36
Juba-Shebelle	28.05	46.13	164%	72.29	157%	95%	0.33
Ogaden	8.70	14.30	164%	22.52	157%	66%	0.40
Turkana-Omo	22.87	37.66	165%	58.83	156%	191%	0.30
Total	62.96	103.24	164%	162.67	158%	-	-

TABLE 34. Summary of key parameters used in basin level projections.

Projections were made based on the following assumptions:

a) To obtain withdrawals under scenario 1 in 2030 and 2050: (i) the 2010 withdrawals were multiplied by the population growth of the individual basins to obtain the 2030 withdrawals;

(ii) the 2030 scenario 2 withdrawals were multiplied by the population growth in 2050 to obtain the 2050 withdrawals.

b) To obtain scenario 2 withdrawals in 2030 and 2050, the procedure is: multiply the gross irrigation areas by the NET and by the population growth; divide the product obtained by 100, and then divide the result by the relevant assumed irrigation effectiveness.

Table 35 summarises the irrigation withdrawals in 2010, 2030 and 2050. The Table reveals the following:

- Under scenario 1, the total basin level withdrawals would increase from 5.35 Km^3 in 2010 to 6.95 Km^3 in 2030 and to 8.09 Km^3 in 2050.
- Under scenario 2, which assumes implementation of improved technologies and water management, the total withdrawals would slightly reduce below current levels: to 5.07 Km^3 in 2030 and 5.28 Km^3 in 2050.
- There is an implied expansion of irrigation areas in the basins: from 0.31 million ha in 2010 to 0.40 million ha in 2030 and to 0.49 million ha in 2050. Main expansions are expected in Juba-Shebelle and Turkana-Omo.
- The contribution of the transboundary basins to the overall sub-regional irrigation withdrawals is about 12%, and the contribution to the total irrigation area is also about 12%.

4. LIVESTOCK WATER REQUIREMENTS

The livestock population of the IGAD sub-region is characterised by large herds and a wide variety of species. The combined number of the various species is almost twice the human population. The impacts of the livestock sector on the water resources of the sub-region can therefore be very large indeed. Livestock water use and contribution to the trend of water depletion is high and growing. An increasing amount of water is therefore required to meet growing water requirements in the livestock production process, from feed production to product supply.

An evaluation of various data sources was made, starting with the national reports. It was clear that accurate and up to date data on livestock numbers and distribution was not adequate to support a comprehensive assessment of water withdrawals. In fact, water withdrawals for livestock is normally not reported separately but is included in the irrigation or domestic withdrawals.

In these circumstances, a reassessment of the water requirements for livestock was made which simplifies the parameters for assessing water requirements for the different species of animals. These are summarised as follows:

- Cattle, goats, sheep and camels have been converted to TLU (Tropical Livestock Unit) equivalents as follows: camels – 1.6 TLU; cattle – 0.7 TLU; and goats/sheep – 0.1 TLU. One TLU is equivalent to an animal of 250kgs live-weight on maintenance, and is assumed to require water intake of 30 litres per day (or an annual per capita requirement of 11 m^3).

Basin	2010 Withdrawals			2030 Withdrawals						2050 Withdrawals					
				Scenario 1			Scenario 2			Scenario 1			Scenario 2		
	NIA 000 Ha	GIA 000 Ha	WITH Km³	NIA 000 Ha	GIA 000 Ha	WITH Km³	GIA 000 Ha	Irrigation Eff.	WITH Km³	NIA 000 Ha	GIA 000 Ha	WITH Km³	GIA 000 Ha	Irrigation Eff.	WITH Km³
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ayesha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Danakil	9.51	17.98	0.22	9.51	17.98	0.22	17.98	50%	0.23	9.51	17.98	0.38	17.98	60%	0.20
Gash-Baraka	18.73	23.79	0.41	26.59	33.77	0.58	33.77	50%	0.34	26.59	33.77	0.67	33.77	60%	0.40
Juba-Shebelle	198.73	188.79	3.32	239.83	227.84	4.02	227.84	50%	2.47	280.7	266.67	3.87	266.67	60%	2.30
Ogaden	25.15	16.60	0.41	30.14	19.89	0.50	19.89	50%	0.26	30.14	19.89	0.41	19.89	60%	0.21
Turkana-Omo	56.67	108.25	0.99	93.46	178.50	1.63	178.50	50%	1.77	145.79	278.47	2.76	278.47	60%	2.17
Total	**308.79**	**355.41**	**5.35**	**399.53**	**477.98**	**6.95**	**477.98**	**50%**	**5.07**	**492.73**	**616.78**	**8.09**	**616.78**	**60%**	**5.28**
% Share of Sub-region	12.2%		10.5%	11.1%		10.6%			11.5%	11.9%		10.9%			16.2%

Table 35. Irrigation water withdrawals in transboundary basins in 2010, 2030 and 2050.

- Equines (horses, asses, mules, donkeys) are not converted to TLU equivalents (not being ruminants) and their requirements for water are assumed to be 25 litres per day per head, or annual per head requirement of 9 m^3.
- Pigs are also not converted to TLU equivalents, and are assumed to require about 14 litres per day per head, or 5 m^3 per head per year.

Table 36 groups the different species for purposes of estimating current livestock requirements. The requirements do not include for poultry and other small domestic animals as the data was not available. The water requirements in the Table provide broad magnitudes of requirements for the sector when systematically estimated and not lumped with other sectors.

Table 37 summarises the projections of water needs of animals, which will increase from 1.77 Km^3 to 2.88 Km^3 in 2030 and to 3.86 Km3 in 2050. The projections assume that the increase in the number of livestock is proportional to the increase in the human population. This means that population growth will be the principal driver of demand for livestock products, and not increased per capita income. The present per capita consumption of products is assumed to remain the same.

It should be noted that these estimates are indicative. An accurate estimation of water requirements for the livestock sector needs to take into account several factors, including the natural and anthropogenic factors that drive water demand. The data requirements and analysis procedure involves assessment of the following which must be focused at the basin and sub-basin level in particular, but also broadened at national and sub-regional level: (i) types, numbers and ownership of livestock; (ii) livestock production systems: livestock only systems and mixed livestock/crop systems; (iii) management systems for different species of livestock and implications for water resources supply and demand: i.e. free range including communal and pastoralist systems, intensive and semi-intensive systems, environmental impacts of the different systems, management of cattle movements – stock routes and infrastructure along stock routes; and (iv) major constraints limiting livestock production: i.e. grazing land and range and pasture resources, pests and diseases (and control methods), water resources – types and sources, accessibility, livestock concentration around sources, environmental impacts, Infrastructure and other constraints.

Country	Livestock Nos. by Group (000)									Total Water req
	Bovines	Small ruminants	Camels	Total TLUs		Equines		Pigs		
	No. 000	No. 000	No. 000	Equiv. No	Water req. mill m^3	No. 000	Water req. mill m^3	No. 000	Water req. mill m^3	million m^3
Djibouti	40	640	70	204	2.24	7	0.06			2.30
Eritrea	1,960	3,840	76	1,878	20.66					20.66
Ethiopia	49,300	46,900	760	40,416	444.58	12,570	113.13	38,100	190.50	748.21
Kenya	13,000	24,300	1,006	13,140	144.54	302	2.72	304	1.52	148.78
Somalia	5,350	25,800	7,000	17,525	192.78	45	0.41	4	0.02	193.21
Sudan	41,400	94,200	4,400	45,440	499.84	777	6.99			506.83
Uganda	11,400	46,500		12,030	132.33	18	0.16	3,200	16.00	148.49
Total	**122,450**	**242,180**	**13,312**	**130,633**	**1,436.97**	**13,719**	**123.47**	**41,608**	**208.04**	**1,768.48**

TABLE 36. Estimates of current livestock water requirements – Year 2010.

Source: Livestock numbers are from national reports.

Country	Medium Term (2030) Projections				Long-term (2050) Projections			
	Total TLUs Ruminants	Equines Nos	Pigs Nos	Total water req.	Total TLUs Ruminants	Equines Nos	Pigs Nos	Total water req.
	(000)	(000)	(000)	million m^3	(000)	(000)	(000)	Million m^3
Djibouti	290	10	-	3.28	389	13	-	4.40
Eritrea	2,648	-	-	29.13	3,866	-	-	42.53
Ethiopia	67,495	20,992	63,627	1,249.52	87,744	27,290	82,715	1,624.37
Kenya	20,893	480	483	236.56	29,041	667	671	328.81
Somalia	28,215	72	6	311.05	44,580	114	9	491.46
Sudan	69,069	1,181	-	770.39	84,264	1,441	-	939.87
Uganda	22,496	34	5,984	277.69	34,644	52	9,215	427.63
Total	**211,106**	**22,769**	**70,100**	**2,877.62**	**284,528**	**29,577**	**92,610**	**3,859.07**

TABLE 37. Medium and long-term projections of livestock water requirements -2030 and 2050.

5. INDUSTRIAL WATER USE

Industrial water use essentially applies to manufacturing and mineral extraction processes and can be estimated from data on the production of various industrial commodities using some standards such as water–product ratios, or the ratio of water use to the population engaged in manufacturing, amongst others. Water-product ratios are highly variable among industrial plants depending, among other things, on the particular plant processes, costs of water, and recycling. The ratio of water use to the population engaged in manufacturing is also used to estimate the requirements.

Almost all the national reports reviewed concluded that reliable data was not available to enable an accurate and systematic assessment of industrial water use in the sub-region[13]. Data on current water withdrawals have been sourced and gleaned from various sources (FAO, World Bank, UNESCO, etc.). These show that current total withdrawals for industry are about 0.63 Km^3. The highest withdrawals are indicated for Sudan (0.38 Km^3) and Kenya (0.81 Km^3). Annual per capita withdrawals in these countries are respectively 9.3 m^3 and 4.7 m^3, which are above the sub-region's average of 3.1 m^3. Per capita withdrawals for Eritrea (0.2 m^3), Ethiopia (0.3 m^3), Somalia (0.2 m^3) and Uganda (1.6 m^3) are extremely low and reflect the very low levels of industrialisation in these countries.

In projecting withdrawals for the medium and long-term, a basic annual per capita requirement is assumed to be 10 m^3. The 2030 annual per capita withdrawals are obtained by doubling the 2010 annual per capita withdrawals. Except for Sudan, the results obtained are still less than 10 m^3, and hence doubled again to obtain the 2050 estimates. The Sudan 2030 figure is maintained even in 2050. The 2050 results still show that, except for Kenya (18.8 m^3) and Sudan (18.6 m^3), all the countries in the sub-region will continue to draw less than 10 m^3 of water for industrial use on a per capita basis (Table 38).

Total annual water withdrawals for the industrial sector are projected to increase from about 0.63 km^3 in 2010 to 2.01 km^3 in 2030, an increase of 317%. Between 2030 and 2050, withdrawals are projected to reach 3.84 km^3, an increase of 191%. Annual per capita withdrawals will increase from 3.1 m^3 in 2010 to 5.9 m^3 in 2030 and to 8.3 m^3 in 2050. Thus, by 2050 the minimum annual per capita target of 10 m^3 will still have not been reached by the sub-region as a whole. But Kenya (18.8 m^3) and Sudan (18.6 m^3) will have exceeded the target. Low industrial water withdrawals are partly associated with low energy especially electricity usage since, as countries develop, electricity sector increasingly dominates industrial water use. High water withdrawals in Kenya and Sudan are mainly related to more usage of thermal rather than hydro-power plants in electricity production.

6. SUMMARY OF KEY FINDINGS

This chapter has been devoted almost exclusively to analysing water withdrawals in key sectors in current and future scenarios. Table 39 gives a summary of current and future water withdrawals by country, and also shows these withdrawals as percentages of total renewable water resources (TRWR).

13. Kenya had estimates for 41 districts including five major urban centres but these were global figures not separated by type of industry.

Country	2030 Industrial Withdrawals						2050 Industrial Withdrawals				
	Population (millions)			Withdrawals			Population		Withdrawals		
	2010	2030	% Change 2010-30	Annual Per Capita WITH	Annual total WITH	% change of total WITH from 2030 to 2050	2050	% Change 2030-50	Annual Per Capita WITH	Annual total WITH	% change of total WITH from 2030 to 2050
	mill	mill	%	Ind m³	Ind million m³	Ind %	million	%	Ind m³	Ind million m³	Ind %
	1	2	3	4	5	6	7	8	9	10	11
Djibouti	0.83	1.18	142%	0.0	0.0	0%	1.58	134%	0.0	0.0	0%
Eritrea	5.24	7.38	141%	0.4	3.0	231%	10.8	146%	0.8	8.6	287%
Ethiopia	79.8	133.33	167%	0.6	80	381%	173.8	130%	1.2	208.6	261%
Kenya	38.61	61.5	159%	9.4	578.1	321%	85.4	139%	18.8	1605.5	278%
Somalia	9.34	15.01	161%	0.4	6.0	300%	23.65	158%	0.8	18.9	315%
Sudan	40.9	61.98	152%	18.6	1,152.80	304%	75.9	122%	18.6	1,411.70	122%
Uganda	31.68	59.19	187%	3.2	189.4	379%	91.3	154%	6.4	584.3	308%
Total	**206.4**	**339.57**	**165%**	**5.9**	**2,009.30**	**317%**	**462.43**	**136%**	**8.3**	**3,837.70**	**191%**

Note: WITH = Withdrawal.

Table 38. Projections of industrial withdrawals in 2030 and 2050.

Country	TAWR		Total Withdrawals at % of Total AWR									
			2010		2030				2050			
					SC 1		SC 2		Sc 1		SC 2	
	Km³	% share	Km³	% of TAWR	Km³	% of TAWR	Km³	% of TAWR	Km³	% of TAWR	Km³	% of TAWR
Djibouti	0.3	0.11	0.03	10.0	0.05	16.7	0.05	16.7	0.06	20.0	0.06	20.0
Eritrea	6.3	2.07	0.63	10.0	0.94	14.9	0.81	12.9	1.24	19.7	0.97	15.4
Ethiopia	122.0	40.06	5.56	4.6	9.89	8.1	14.35	11.8	20.22	16.6	20.80	17.0
Kenya	30.7	10.08	2.74	8.9	5.01	16.3	4.17	13.6	7.15	23.3	5.65	18.4
Somalia	14.7	4.83	3.30	22.4	4.06	27.6	2.16	14.7	4.48	30.5	2.26	15.4
Sudan	64.5	21.18	37.94	58.8	53.94	83.6	30.69	47.6	54.75	84.9	22.31	34.6
Uganda	66.0	21.67	0.64	1.0	1.83	2.8	1.82	2.8	4.05	6.1	3.95	6.0
Total	304.5	100.0	50.84	16.7	75.72	24.9	54.05	17.7	91.95	30.2	56.00	18.4

Table 39. Summary of Overall Water Withdrawals to 2030 and 2050 by Country.

Table 40 analyses the withdrawals by the main-water using sectors (domestic, industry, irrigation and livestock) under scenarios 1 and 2 (see section 4.3 for discussion of scenarios).

6.1. Emerging scenarios of future water demand

The findings reveal, among other things, emerging trends of water withdrawals and water sharing by main water-using sectors that have important implications for policy analysts and decision makers. Figures 7A and 7B portray these scenarios at the sub-regional level.

Sector	2010 Withdrawals		2030 Withdrawals				2050 Withdrawals			
			SC 1		SC 2		SC 1		SC 2	
	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%
Domestic	2.29	4.50	5.25	6.93	5.25	9.71	10.32	11.22	10.32	18.42
Industry	0.63	1.30	2.01	2.65	2.01	3.72	3.84	4.18	3.84	6.86
Agriculture	**47.90**	**94.20**	**68.45**	**90.42**	**46.79**	**86.57**	**77.80**	**84.60**	**41.85**	**74.72**
- Irrigation	46.13	90.70	65.57	86.61	43.91	81.24	73.94	80.40	37.99	67.83
- Livestock	1.77	3.50	2.88	3.81	2.88	5.33	3.86	4.20	3.86	6.89
Total	**50.82**	**100.00**	**75.71**	**100.00**	**54.05**	**100.00**	**91.96**	**100.00**	**56.01**	**100.00**
% total AWR	16.7%		24.9%		17.8%		30.2%		18.4%	

Table 40. Current and future water withdrawals by sector and shares of each sector.

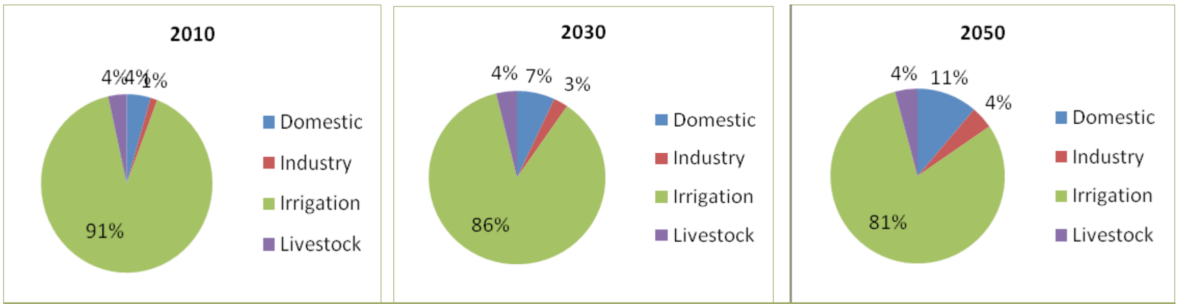


Figure 7A. Scenario 1

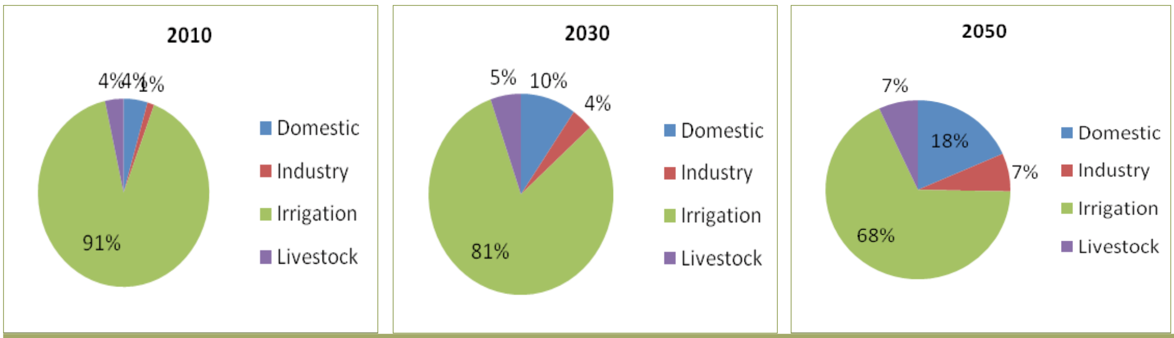


Figure 7B. Scenario 2

It can be observed from the analysis that, firstly, while overall water withdrawals (water use) will increase in the medium term (2030) and long-term (2050), the share of domestic supply will increase more dramatically: (i) under scenario 1 from 4.5% in 2010 to 6.9% in 2030 and to 11.2% in 2050; and (ii) under scenario 2 from 4.5% in 2010 to 9.7% in 2030 and to 18.4% in 2050. This will reflect a major structural shift in water sharing by the major sectors and is expected to reflect: (i) substantial efforts of governments in the sub-region to accelerate access to potable water, and (ii) efforts to raise the level of household water security to intermediate level as a minimum.

Secondly, the share of industry and livestock will also increase, and will reflect efforts of governments to accelerate industrialisation and better targeting of improved water supply for the livestock sector as a strategy for livestock development in the sub-region. Thirdly, the overall share of agriculture water will decline over the years under all scenarios, on account of the rapidly increasing share of domestic supply and industry and, more importantly, due to the declining share of irrigation withdrawals. The decline in the irrigation withdrawal is predicated upon measures to improve water use efficiency in irrigation schemes. This is expected to be achieved through improvements in irrigation technologies and management.

The future trend and scenarios of water demand in the sub-region are principally driven by the population dynamics and agricultural production processes. Because of the imperative to substantially increase agricultural productivity to meet rising food demand, the expansion of irrigated agriculture as well as improved management of water in rain-fed agriculture will become an urgent policy consideration in the sub-region. The implied expansion of irrigated agriculture by the countries of the sub-region is analysed in Table 41.

6.2. Looming water scarcity

Country	2010	2030		2050	
	000 Ha	000 Ha	% Increase	000 Ha	% Increase
Djibouti	1.00	1.40	140%	1.99	142%
Eritrea	21.60	31.94	148%	39.13	123%
Ethiopia	289.50	484.03	167%	1,005.18	208%
Kenya	114.60	182.22	159%	185.98	102%
Somalia	200.00	236.80	118%	236.80	0%
Sudan	1,884.00	2,637.60	140%	2,637.60	0%
Uganda	14.40	26.94	187%	40.14	149%
Total	2,525.10	3,600.93	143%	4,146.82	115%

Source: Derived by the consultant.

Table 41. The implied increase in net irrigated areas by country.

The findings reveal that water scarcity is looming over the sub-region and will become a serious constraint to any future plans for economic and social development. Table 42 shows the trend of per capita availability of water in the sub-region measured in terms of IRWR and TRWR. The standard indicator of water scarcity establishes a per capita availability threshold of 1,700 m3/year above which scarcity is considered rare or localised. Below 1,000 m3/year, per capita water supply begins to hamper human and socioeconomic development; and at less than 500 m3/year water availability becomes a primary constraint to life. Countries of the sub-region will be critically water stressed by 2030, and the situation will reach life-threatening levels by 2050.

Figure 8 illustrates, graphically, the water scarcity situation at the sub-regional level. Substantial declines in per capita water resources (IRWR and TRWR) are indicated.

Country	Water Resources			2010			2030			2050		
	IRWR km³/yr	ERWR km³/yr	TRWR km³/yr	Popn Mill	IRWR m³/yr	TRWR m³/yr	Popn Mill	IRWR m³/yr	TRWR m³/yr	Popn Mill	IRWR m³/yr	TRWR m³/yr
Djibouti	0.3	0	0.3	0.83	361	361	1.18	254	254	1.58	190	190
Eritrea	2.8	3.5	6.3	5.24	534	1,202	7.38	379	854	10.80	259	583
Ethiopia	122.0	0	122.0	80	1,529	1,529	133.33	915	915	173.80	702	702
Kenya	20.7	10.0	30.7	38.61	536	795	61.50	337	499	85.40	242	359
Somalia	6.0	8.7	14.7	9.34	642	1,574	15.01	400	979	23.65	254	622
Sudan	30.0	34.5	64.5	40.90	733	1,577	61.98	484	1,041	75.90	395	850
Uganda	39.0	27.0	66.0	31.68	1,231	2,083	59.19	659	1,115	91.30	427	723
TOTAL	220.8	83.7	304.5	206.40	1,070	1,475	339.57	650	897	462.43	477	658

TABLE 42. IGAD Sub-Region - Looming Water Scarcity Per Capita Resource Availability: IRWR & TRWR.

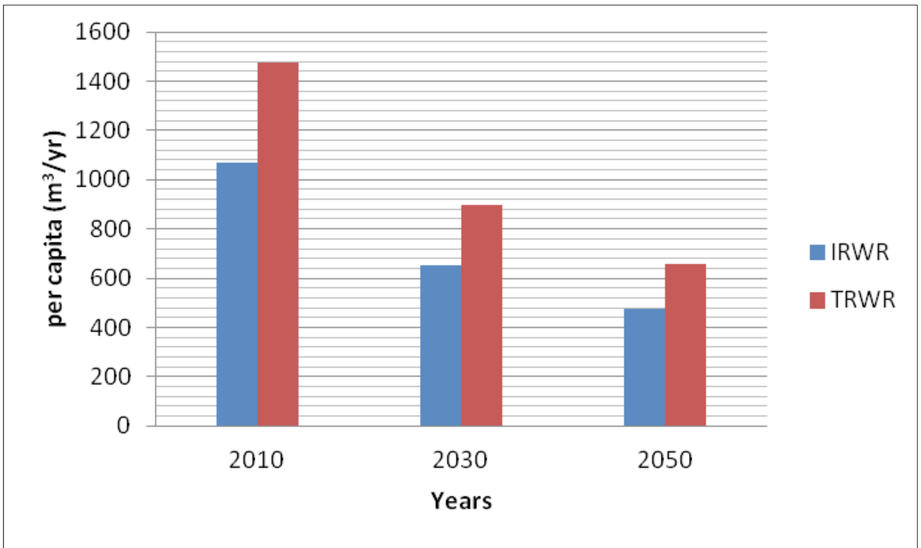


FIGURE 8. Trend of per capita resource availability

Table 43 shows another supply-side approach, based on the UN indicator that establishes 40% as the threshold of total water withdrawals as a percent of IRWR or TRWR above which countries would be considered as water-scarce. Some countries (Sudan and Somalia) are already overdrawing their water resources, while others will be heading the same way by or even before 2050. It is apparent that countries may be able to minimise the threat of water over-withdrawals by implementing measures to manage water resources more efficiently, especially in agriculture.

Both Table 43 and Figure 9 show that: (i) the sub-region will already be above the 40% threshold by 2050 based on the consideration of IRWR only and without effective and efficient demand management of water resources especially in agriculture; and (ii) the sub-region is much better off if it moves increasingly towards cooperative management of its total water resources (TRWR) rather than individual countries depending on IRWR.

Country	IRWR		2010 WITH		2030 WITH				2050 WITH			
					SC 1		SC 2		SC 1		SC 2	
	Km³	% IRWR	Km³	% IRWR	Km³	% IRWR	Km³	% IRWR	Km³	% IRWR	Km³	% IRWR
Djibouti	0.3	0.1	0.103	10.0	0.05	16.7	0.05	16.7	0.06	20.0	0.06	20.0
Eritrea	2.8	1.3	0.63	22.5	0.94	33.6	0.81	28.9	1.24	44.3	0.97	34.6
Ethiopia	122.0	55.3	5.56	4.6	9.89	8.1	14.85	12.2	20.22	16.6	20.8	17.0
Kenya	20.7	9.4	2.74	13.2	5.01	24.2	4.17	20.1	7.15	34.5	5.65	27.3
Somalia	6.0	2.7	3.30	55.0	4.06	67.7	2.16	36.0	4.48	74.7	2.26	37.7
Sudan	30.0	13.6	37.94	126.5	53.94	179.8	30.69	102.3	54.75	182.5	22.31	74.4
Uganda	39.0	17.7	0.64	1.6	1.83	4.7	1.82	4.7	4.05	10.4	3.95	10.1
TOTAL	220.8	100.1	50.84	23.0	75.71	34.3	54.04	24.5	91.96	41.6	56.01	25.4

TABLE 43. Trend of Water Withdrawals: % of IRWR by Country.

Key: SC 1, SC 2 = Scenarios 1 and 2, respectively.

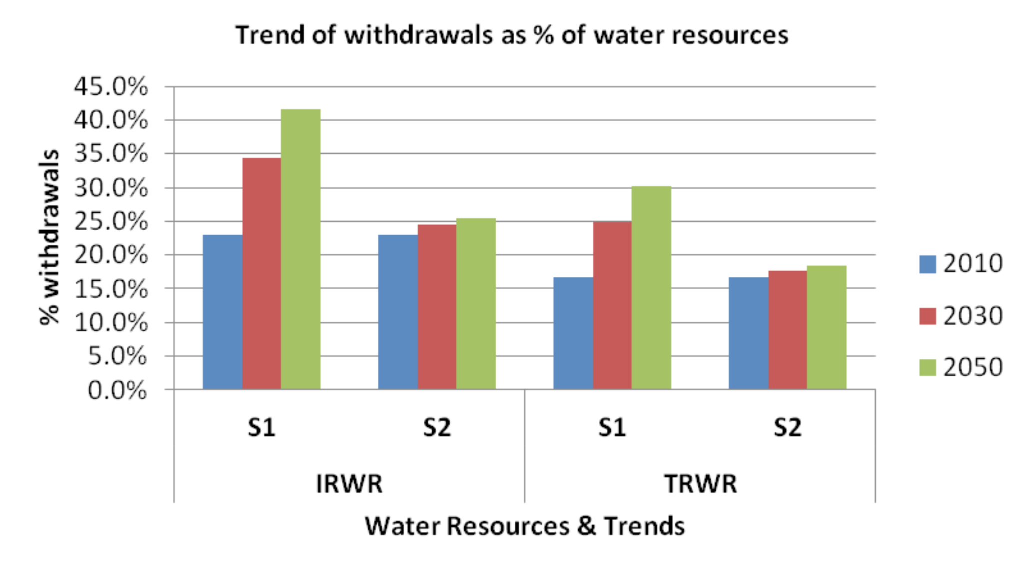


FIGURE 9. Trend of withdrawals as % of water resources.

5

CONCEPT NOTE ON WATER DEMAND MANAGEMENT

1. CONCEPTUAL FRAMEWORK

1.1. The context

Competition for water exists at all levels and is forecast to increase with increased demands for water in all countries of the sub-region. By 2050, the sub-region's population will be living in areas of high water stress. Water management in the sub-region is deficient in performance, efficiency and equity. Water use efficiency, pollution mitigation and implementation of environmental measures fall short in most sectors. Access to basic water services – for drinking, sanitation and food production – remains insufficient across the sub-region, and more than 300 million people – 65% of the population – may still be without access to adequate sanitation in 2050.

Increased competition for water and shortcomings in its management to meet the needs of society and the environment calls for enhanced societal responses through improved water management. Challenges include wise planning for water resources; evaluation of availability and needs in watersheds; possible needs for reallocation or additional storage; the need to balance equity, efficiency and ecosystem services in water use; the inadequacy of legislative and institutional frameworks and the increasing financial burden of ageing infrastructure. Substantial efforts are needed in regulation, mitigation and management, primarily through community consultation and cross-sectoral policy involving the private sector.

The traditional response to the pressures on water availability has been to solve the problem by increasing supply – by developing new sources and expanding and increasing abstractions from existing ones. This supply-driven approach is increasingly unsustainable, and attention is switching rapidly towards more efficient and equitable demand management approaches. Demand management is a process that involves using water more efficiently and equitably, improving the balance between present supplies and demand, and reducing excessive use of water.

1.2. Framework for water demand management

Demand management, which is using water more efficiently, is but one of water management instruments within a broader framework of sustainable water resources management, also known as the integrated water resources management (IWRM) approach. This framework is divided into (i) the enabling environment, (ii) institutional structure, and (iii) management instruments[14].

Enabling Environment	Management instruments
Enabling Environment • Policies – setting goals for water use, protection and conservation • Legislative framework – defining the rules needed to achieve policies and goals • Financing and incentive structures – allocating financial resources to meet water needs. **Institutional structure** • Creating an organizational framework – understanding resources and needs • Institutional capacity-building – developing human resources.	**Management instruments** • Water resources assessment – understanding resources and needs • Plans for IWRM – combining development options, resource use and human interaction • Demand management – using water more efficiently • Social change instruments – encouraging a water-oriented civil society • Conflict resolution – managing disputes and ensuring the sharing of water • Regulatory instruments – determining equitable allocations and water use limits • Economic instruments – valuing and pricing water for efficiency and equity • Information management and exchange – improving knowledge for better water management.

TABLE 44. IWRM Framework and Key Change Areas.

Source: Global Water Partnership (GWP), 2004, and adopted from UNESCO WWDR 2..

The integrated and holistic approach to water resources management is a response to the much criticised, sector by sector approach to water management (e.g. domestic/ municipality, irrigation, industry, energy, etc). The approach promotes not only cross-sectoral cooperation but also the coordinated management and development of land, water (surface water and groundwater) and other related resources, so as to maximise the resulting social and economic benefits in an equitable manner, without compromising ecosystem sustainability. The socioeconomic dimension of the approach focuses on human concerns by taking full account of the following, amongst others:

- Stakeholders participation in water resources management, especially recognising and ensuring representation of the interests of women, the youth and the poor;
- Multiple uses of water and the range of people's needs;
- Integrating water plans and strategies into the national planning process and water concerns into all government policies and priorities;
- The compatibility of water-related decisions taken at a local level with a country's national goals and objectives; and
- The water quantity and quality needs of essential ecosystems so that they are properly protected.

14. UNESCO: World Water Development Report 2, 2006.

It is also important in formulating demand management strategies to incorporate international and regional goals for water resources often negotiated at UN meetings, conferences and summits, etc, for which governments have made commitments. Thus, demand management strategies cannot be formulated in isolation of international and regional water policies and legal frameworks. Such international and regional frameworks also help countries with low human and financial capacities in the vital areas of policy formulation and implementation of effective water policies.

1.3. Potential for water savings

One must start from the premise that a large share of water to meet new demand can come from water saved from existing uses through comprehensive reform of water policy. Such reform is not often easy; because both long-standing practice and cultural and religious beliefs have treated water as a free good and because entrenched interests benefit from the existing system of subsidies and administered allocations of water. The concept of water as an economic resource, subject to scarcity and dependent upon national management, was not universally shared until perhaps in recent times. Much of the resource planning of national governments therefore tended to ignore water in part due to a number of specific properties[15] of water which have contributed to the tendency to inappropriate water policy, and which combine to frustrate attempts at national planning of water resources.

Wrongful and wasteful uses of water are some of the consumer attitudes or behaviours which frustrate the achievement of savings in water use. Information campaigns and consumer education becomes an important tool in this regard. In addition, economic incentives (e.g. water-metering and judicious use of tariff systems) that discourage wasteful use can be put to good effect.

Water losses are high in the current access and delivery systems of all the countries. Potential savings can be achieved by replacing old water fittings with new, more efficient ones in domestic and industrial systems. Fixing leaks in urban water distribution systems, where up to 60% or more of water supplied can be lost through unrepaired leaks, offers much potential.

Overall irrigation efficiencies (the product of irrigation system efficiency and field application efficiency) in the sub-region are generally very low, ranging from 20-30 percent (FAO 1986). In Sudan, efficiencies tend to be somewhat higher, 70% in clay soils. In Kenya and Uganda, on the other hand, overall efficiencies range from 50-60 percent in schemes where sprinkler systems are used (otherwise overall efficiencies are very low in these countries – about 30% in Kenya and 10% in Uganda). These low water use efficiencies are often cited as evidence that very large savings in water use can be obtained. However, it must be stressed that these water use efficiencies are derived from individual system evaluations rather than from basin-wide assessments. Unmeasured downstream recovery of «waste» drainage water and recharge and extractions of groundwater can result in actual basin-wide efficiencies substantially greater than the nominal values for particular systems.

15. E.g. water is ubiquitous and it is fundamentally assumed that it exists; also water is a renewable resource (through its hydrologic cycles) and it is considered as a common resource.

2. STRATEGIES FOR DEMAND MANAGEMENT

The types of policy instruments available for demand management include the following:

a) Enabling conditions, which are actions to change the institutional and legal environment in which water is supplied and used. Policies here include reform of water rights, privatization of utilities, and laws pertaining to water user associations.

b) Market-based incentives, which directly influence the behaviour of water users by providing incentives to conserve on water use, including pricing reform and reduced subsidies on urban water consumption, water markets, effluent or pollution charges and other targeted taxes or subsidies.

c) Non-market instruments, including restriction, quotas, licenses, and pollution controls.

d) Direct interventions, including conservation programs, leak detection and repair programs, and investment in improved infrastructure.

The precise nature of water policy reform, and the policy instruments to be deployed, will vary from country to country depending on underlying conditions such as level of economic development and institutional capability, relative water scarcity, and level of agricultural intensification. Additional research is required to design specific policies within any given country. However, some key elements of a demand management strategy are the following.

2.1. Demand management for surface irrigation

Surface water can be conserved by improving the management of administrative water allocation mechanisms, by using volumetric water prices, or by establishing markets in tradable water rights.

Administrative reforms. Administrative reforms include modification of water distribution methods (such as shifting from continuous flow to rotational flow water allocation) and institutional reform of public irrigation bureaucracies. Institutional reform of public irrigation agencies has received increasing attention in recent years and holds considerable promise for long-term progress in improving system performance.

Water rights, markets, and prices. The primary alternative to quantity-based allocation of water is incentive-based allocation, either through volumetric water prices or through markets in transferable water rights.

The empirical evidence shows that farmers are price responsive in their use of irrigation water. The four main types of responses to higher water prices are use of less water on a given crop, adoption of water-conserving irrigation technology, shifting of water applications to more water-efficient crops, and change in crop mix to higher-valued crops (Rosegrant, Gazmuri Schleyer, and Yadav 1995; Gardner 1983). The choice between administered prices and markets should be largely a function of which system has the lowest administrative and transactions costs.

Devolution of water rights from centralized bureaucratic agencies to farmers and other water users has a number of advantages. The first is empowerment of the water user, by requiring user consent to any reallocation of water and compensating the user for any water transferred. The second is security of water rights tenure provided to the water user. If well defined rights are established, the water user can benefit from investing in water-saving technology. Third, a system of marketable rights to water induces water users to consider the full opportunity cost of water, including its value in alternative uses, thus providing incentives to economize on the use of water and gain additional income through the sale of saved water. Fourth, a properly managed system of tradable water rights provides incentives for water users to internalize (or take account of) the external costs imposed by their water use, reducing the pressure to degrade resources.

2.2. Demand management for groundwater

The problem of over-drafting of groundwater often occurs because individual pump irrigators have no incentive to optimize long-run extraction rates, since water left in the ground can be captured by other irrigators or potential future irrigators. To encourage rational exploitation of groundwater, the same types of policy instruments employed for surface water can be used. The three broad types of institutional arrangements for managing aquifers are quantity-based controls, prices and charges, and tradable water rights (or exchangeable permits) in stocks and flows of groundwater.

Quantity-based controls. Quantity-based control mechanisms include well and pump permits that grant the right to install and operate a well of a particular capacity, and pumping quotas that specify a fixed annual rate of extraction for each water user. Pumping permits for new wells may also impose size and spacing specifications to attempt to optimize extraction rates.

Prices and charges. Charging pumpers for water can also help control pumping rates. In theory, water prices can be set to include both the direct value of marginal product of the water and the externality cost imposed on other pumpers, thereby inducing each individual pumper to internalize the pumping externalities. Energy prices (for electricity, gasoline, and diesel) also influence the profitability and rate of pumping. Subsidies for energy that encourage overuse of groundwater should clearly be removed, but use of selective energy taxes to further reduce pumping rates is likely to cause inefficiencies in energy markets.

Managing groundwater in the real world. Government intervention to manage groundwater in the sub-region has proven to be difficult to implement, subject to corruption, and in many cases very costly. The most successful tube-well development has been through small-scale private investment, which is widely dispersed and difficult to monitor.

2.3. Privatization and user participation in irrigation

The importance of user participation in management of irrigation has been mentioned repeatedly. Involvement of farmers in the development and management of even large-scale irrigation systems is desirable from the project planning and design stage. Financial participation by future water beneficiaries in investment in new infrastructure would also be helpful. User participation in the approval and financing of infrastructure corrects inappropriate investment incentives in the public sector, which often lead to the construction of unprofitable infrastructure and continuing large capital and operating subsidies financed through tax revenues. Large subsidies in turn have often meant transferring resources from the poorest sectors of the population (who usually do not have subsidized water and who spend a large percentage of their incomes on sales or value-added taxes), to the better-off who receive subsidized water.

2.4. Reforming urban water systems

Urban areas can be important sources of water savings, and the primary locations for improving water quality. Almost all of the water utilized in the cities drains directly into the ocean salt sink without any reuse, so both reduced initial consumption and reduced wastage in the distribution system will be translated directly into real physical water savings (Seckler 1996). In most non-coastal cities in the sub-region, reuse of drainage water is also minimal because of the absence or poor quality of treatment facilities and what water is reused poses serious health hazards. Under these conditions, reduced consumption and transmission losses will also represent real gains in water availability.

The amount of water wasted and lost in urban distribution systems, homes, commercial establishments, and public facilities is often huge. Data on water losses in the large metropolitan areas of the sub-region are limited, but it is likely that water losses are comparable to those elsewhere in the developing world. Thus, fully 58 percent of supply was unaccounted-for water, consumed by «illegal» users and lost during distribution. The average level of unaccounted for water in World Bank-assisted urban water projects is about 36 percent. Although some of this unaccounted for water is unreported water use by public agencies or unauthorized private use, much of it is losses into the soil or salt sinks.

Pollution of water from industrial effluents poorly treated or untreated domestic and industrial sewage, runoff of agricultural chemicals, and mining wastes constitute a growing problem. The main contaminants found in water include detergents (soaps and solvents), pesticides, petroleum and other derivatives, toxic metals (for example lead and mercury), fertilizers and other plant nutrients, oxygen-depleting compounds (e.g. wastes from canneries, meat-processing plants, slaughterhouses, and paper and pulp processing), and disease causing agents responsible for hepatitis and infections of the intestinal tract such as typhoid fever, cholera, and dysentery (Anton 1993). Unsafe drinking water, combined with poor household and community sanitary conditions, is a major contributor to disease and malnutrition, particularly among children. Contaminated wastewater is often used for irrigation, creating significant risks for human health and well-being.

The poor performance of urban water systems is in significant part due to flawed policies. When incremental water can be obtained at low cost as a result of subsidies there is little incentive to improve either physical efficiency (by, for example, investment in pipes or metering) or economic efficiency (collection of water tariffs). Considerable evidence shows that the use of incentive-based policy instruments can achieve substantial water savings and improve the delivery of services, as well as water quality. These instruments have been used to raise efficiency and generate savings in urban water service and delivery, household water use, and industrial water use.

Urban water services. Urban water supply in most of the sub-region is controlled by theoretically independent public authorities. These authorities are often controlled by the government in essential matters, such as fee setting, personnel management, and investment policies and their privatization could reap substantial benefits. For example, privatization and the granting of secure water rights held by the urban water companies, together with an active water market, can encourage the construction and operation of improved treatment plants that sell water for urban use. Efficiency in urban water and sewage services would then be greatly increased with no significant impact on prices and the coverage of potable water could significantly rise in both urban and rural areas.

Despite the great potential for success of privatization in many cases, in much of the sub-region, it has proven difficult to even establish full autonomy for public water authorities, particularly for personnel, water tariffs, and investment programming and financing, due to the reluctance of governments to relinquish influence. Given these difficulties, it may be appropriate to adopt phased approaches to privatization of urban water services, using options such as concession arrangements, service or management contracts, or build, operate, and transfer schemes (World Bank 1994).

Household consumption. Removal of subsidies in urban water use can have dramatic effects on water use. An increase in the water tariff can result in a decrease in household demand for water. It is likely that this price responsiveness is typical for household demand in much of the sub-region, although evidence is limited. There have been few studies of household demand elasticities in the sub-region because water tariffs have generally been low, price changes have not been significant, and metering has been absent.

Industrial water use. Increased water prices, effluent charges, and pollution regulations have great potential to generate industrial water savings by promoting investment in water recycling and water conservation technology. These improvements can be achieved through the issuance of restrictive water licenses, the introduction of water-saving technologies, and subsidized financing for investment in water-saving processes.

A legal basis for controlling water pollution already exists in most IGAD countries, but the laws and regulations have mostly been unenforceable. The regulations give no consideration to the countries' economic, social, and technological conditions or implementation requirements, such as the institutional arrangements, availability of adequate funds, trained manpower, and sophisticated laboratories for analyses, monitoring, inspection and enforcement. More realistic regulations, preferably relying on incentives rather than restrictions, are urgently needed in the region to arrest the degradation of water quality.

2.5. Conservation through appropriate technology

If improved demand management introduces incentives for generating water savings, availability of appropriate technology will be an essential component for generating water savings. As the value of water increases, the use of more advanced technologies, such as drip irrigation utilizing low-cost plastic pipes, sprinklers, and computerized control systems, used widely in developed countries, could have promising results in the sub-region.

Any evaluation of the impacts of these technologies must take account of the difference between consumptive use of water and water withdrawals or applications. All of these advanced technologies can significantly reduce the amount of water applied to a field, but, to the extent that the saved water simply reduces the amount of drainage water that is reused, the actual water savings will be lower than the apparent efficiency gains. Nevertheless, if the scarcity value of water is high enough, appropriate use of new technologies appear to offer both real water savings and real economic gains to farmers.

Field application efficiencies in flood irrigation in the sub-region are typically in the range of 40-60 percent. High-pressure sprinklers save on drainage losses but may not reduce consumptive use because of the high evaporative losses. Modern low-pressure, downward-sprinkling systems, however, can reduce evaporation considerably. Surge irrigation can reduce water applications significantly. Instead of releasing water continuously down field channels, surge irrigation alternates between rows at specific intervals. The initial wetting of the channel partially seals the soil and allows water to be distributed more uniformly, reducing percolation, runoff, and evaporation. Drip irrigation offers perhaps the greatest potential benefits in real water savings. By directing water applications directly to the root zones, drip irrigation can significantly reduce field evaporation losses. Drip irrigation can also increase the productivity of water in areas already affected by salinity. Used in conjunction with tube-wells, these systems can lower water tables and leach salts below the root zone of plants (Seckler 1996).

2.6. Managing environmental water demand

Demand management instruments such as development of appropriate legal and institutional frameworks, regulatory policy, and incentive policies can promote environmental sustainability and water quality through recycling, reduction of excess water application in saline areas, and elimination of groundwater overdraft. In many of the critically important aspects of water resource strategy, the goals of water use efficiency and conservation, economic efficiency, and environmental sustainability are fully complementary.

As incomes grow in the sub-region, there will be significant increases in the demand for environmental «goods,» including demand for direct allocation of water for environmental purposes. The amount of water required to simply prevent salt water intrusion and to flush and dilute salts and pollutants from rivers and irrigation canals will also increase rapidly, particularly if countries fail to reform demand management policies. In addition to dealing with the environmental concerns arising from urban and industrial use of water, direct environmental demands for water will need to be accommodated, together with urban and agricultural water demands. The evidence shows that effective environmental protection policies can be designed, but in the final instance, in any society, how much environmental protection will be provided will be a matter of political choice and commitment.

3. THE ROLE OF WOMEN AND THE YOUTH

There exist major gender inequalities in access to water resources. For families without a drinking water source on the premises, it is usually women and children who go to collect water for drinking and cooking, and for productive activities occurring near home, such as livestock raising and home garden agriculture. This is almost the case in two-thirds of households, while in almost a quarter of households it is men who usually collect the water. In 12% of households, however, children carry the main responsibility for collecting water, with girls under 15 years of age being twice as likely to carry this responsibility as boys under the same age. The real burden on children is likely to be higher because in many households the water collection burden is shared, and children – though not the main persons responsible – often make several round trips collecting water. The distribution of water collection responsibility is 64% women, 24% men, 8% girls and 4% boys. Djibouti and Ethiopia have the highest percentage of women who are responsible for collecting water, at 90% and 84% respectively. In general, the benefits of piped water on premises are enjoyed only by the wealthiest member of society.

Poor access to water by women gives lower priority to work taking place at home, than in the fields and factories. Provision of water for drinking, cooking and home-based production is therefore undermined. This works against the health of the household and the livelihood activities of women. In areas of low water coverage women collect water from drains, ditches or streams that are often infected with pathogens and bacteria, causing severe illness or even death. Secondly, women's poor access to water often results in many hours spent collecting water each day. This reduces the time women might otherwise have for other activities and exposes them to sexual abuse and other forms of violence and leaves less time for girls to attend school.

In the past, most of the poor people and women were not well represented in the various levels of decision making. Women and children are among the poorest in society and are the most affected where water provision is inadequate. However, recent lessons from Africa and the rest of the world have demonstrated that increased participation by women in decision-making leads to better operation and maintenance of water facilities, better health for the community, greater privacy and dignity for women, more girls attending school and increased income opportunities for women. Today the new water policies and the accompanying water legislations provide for creation of water users' associations (WUAs) which are aimed at enhancing participation of users including women in decision making processes.

Increasingly countries are moving from water policies to practical gender main-streaming strategies. In Uganda, for instance, the golden indicator used with respect to gender at community level and within the water boards is defined as "the percentage of water users committees with at least one woman holding a key position."[16] This requirement is vigorously implemented under the Government's Water for Production Programme where both men and women are encouraged to be members of the Water Users Committees.

16. A key position refers to Chairperson, Vice Chairperson, Secretary or Treasurer.

In Ethiopia, the National Action Plan (NAP) on Gender is a core strategy under PASDEP in which “Unleashing the Potential of Ethiopian Women” forms one of the eight pillars. Some of the specific elements of the NAP include: (i) mainstreaming and articulating gender concerns in policy decision processes; (ii) strengthening gender analysis and overall gender sensitivity of the PASDEP monitoring and evaluation systems; and (iii) strengthening the institutional structure and functioning of the Ministry of Women Affairs, and identifying entry points/activities for enhancing gender mainstreaming across government policies and programmes.

In summary, there are considerable national and regional differences in the involvement of women and the youth in the social, economic and political life of society. These differences relate to history, tribe and culture. Urban women have more work opportunities than rural women, particularly with respect to paid employment. Rural women generally participate more considerably in agricultural activities and particularly in the cultivation of food crops. The considerable differences in the situation prevailing in different parts of the individual countries, and between the different countries, make it difficult and unwise to generalise at this stage.

It is recommended that IGAD should undertake a specific survey of women’s situation with regard to access and utilisation of water in the sub-region. Such a survey would improve the data and information on the role played by women and the youth in water resources management. The survey would identify specific constraints, existing household technologies and knowledge which can aid practical designs of intervention.

6

CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS

The socioeconomic component of the MAM-TWR project has focused on creating an understanding of the water demand for various socioeconomic needs including quantified assessment of water use for domestic supply, agriculture, livestock, industry, recreation, ecology, etc. This was achieved, firstly, by detailed assessment of the key drivers of water demand in the sub-region, and secondly by projecting future water needs in various scenarios. Table 45 summarises the results of the preliminary quantification of total current and future water withdrawals in various scenarios. Though based on a limited set of scenarios (principally irrigation water use scenarios), the Table offers "a vision" of an emerging future competition for water and how this might be managed through adjustment in agriculture water use.

The following main conclusions may be made from this study:

Sector	2010 Withdrawals		2030 Withdrawals				2050 Withdrawals			
			SC 1		SC 2		SC 1		SC 2	
	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%
Domestic	2.29	4.50	5.25	6.93	5.25	9.71	10.32	11.22	10.32	18.42
Industry	0.63	1.30	2.01	2.65	2.01	3.72	3.84	4.18	3.84	6.86
Agriculture	**47.90**	**94.20**	**68.45**	**90.42**	**46.79**	**86.57**	**77.80**	**84.60**	**41.85**	**74.72**
- Irrigation	46.13	90.70	65.57	86.61	43.91	81.24	73.94	80.40	37.99	67.83
- Livestock	1.77	3.50	2.88	3.81	2.88	5.33	3.86	4.20	3.86	6.89
Total	**50.82**	**100.00**	**75.71**	**100.00**	**54.05**	**100.00**	**91.96**	**100.00**	**56.01**	**100.00**
% increase	100		149%		106%		121%		104%	

TABLE 45. Summary of current and future water withdrawals.

(1) Population growth as the primary factor: While several factors will drive the pressures on water resources, population and its dynamics will be the primary driver of all demands, including water demand. High population growth is outstripping the pace at which water resources are being developed to meet the various socioeconomic needs of the sub-region. Associated with this is the low and unbalanced funding of the water and sanitation sector, with the tendency to concentrate water infrastructure in the urban centres and giving lower priority to rural areas.

The water issues of the sub-region are exacerbated by the fact that over 75% of the sub-region is classified as ASAL – these areas which are mostly water stressed and have low agricultural potential.

The impact of population on water resources will be at two levels:

- At the level of domestic water supply where pressure will be exerted to provide more water from both existing and new water sources; and
- At the level of agricultural water withdrawals, primarily for irrigation but also for livestock – the increased demand for food will put pressure on agricultural resources including land and water.

(2) Adjustment of future water demand: While overall water withdrawals will increase, the share of agriculture will decline over the years on account of the rapidly increasing shares of domestic and industry sectors. This will result from a combination of: (i) measures to achieve the MDG goals for access to clean drinking-water in quantities that meet domestic water security needs; (ii) measures for accelerated industrialisation in the sub-region; and (iii) measures to improve water use efficiency in irrigation schemes.

(3) Food security concerns: The imperative to raise agricultural productivity to meet increased food demand will call for expansion of irrigated agriculture areas – under this study assumptions, the implied increase in net irrigated areas would be as shown below:

As rain-fed agriculture continues to occupy a commanding place in the overall production system of the sub-region and cannot be wholly replaced with irrigation, it will be equally imperative to continue to accord the priority it deserves as it will continue to account for

Country	2010	2030		2050	
	000 Ha	000 Ha	% Increase	000 Ha	% Increase
Djibouti	1.00	1.40	140%	1.99	142%
Eritrea	21.60	31.94	148%	39.13	123%
Ethiopia	289.50	484.03	167%	1,005.18	208%
Kenya	114.60	182.22	159%	185.98	102%
Somalia	200.00	236.80	118%	236.80	0%
Sudan	1,884.00	2,637.60	140%	2,637.60	0%
Uganda	14.40	26.94	187%	40.14	149%
Total	2,525.10	3,600.93	143%	4,146.82	115%

Table 46. The implied increase in net irrigated areas by country.

Source: Derived by the consultant.

over 50% of cereal production. However, the focus should change from area expansion to improved management of "green water" in rain-fed agriculture.

(4) Data limitations: Last but not least, the contribution of the socioeconomic component is intended to enhance the database on the water resources, and in particular the water uses for various purposes. This study has laid the foundation for future work in this direction. Data limitations were, however, paramount in achieving the aims of the socioeconomic component. The component could not effectively assess and analyse water use in the different components and sub-components of water-using sectors, which was the initial objective of the TOR. The initial separate assessment of the sectors revealed serious gaps in the level and availability of data on such key sectors as industry, livestock, environment, energy, tourism and wildlife, amongst others.

Despite these and other limitations, the overriding conclusion of the study is that, following these assessments the MAM-TWR project is in a better position to initiate a strategy and action plan for developing and building a comprehensive socioeconomic database on the transboundary water resources of the sub-region. This would improve the conceptual and empirical basis for planning and managing the water transboundary water resources of the sub-region.

2. RECOMMENDATIONS

(1) On population and its impacts on water demand: Institute the collection and sharing of data and information on the impacts of population growth on water resources of the transboundary basins in the sub-region; and advise member states and share data and information on population movements in transboundary basins including cross-border ASAL zones. Other measures are: (i) accelerate the MDG targets and quantitative access targets to realise household water security; (ii) invest in new water resources development, focusing in rural areas and the ASAL zones; including new technologies for securing water supply and sanitation such as water harvesting, storage and purification suited to poor households.

(**2) On adjustment of water demand and food security:** It is recommended: (i) that specific surveys be undertaken to update information on irrigation schemes in transboundary basins; (ii) that improved water use and management technologies be prioritised in existing and planned irrigation programmes; (iii) that while rain-fed agriculture will continue to play a crucial role in overall production, emphasis should be given to promoting technologies to improve water management in this sector; and (iii) that irrigation policies and programmes must be underpinned by effective and active research and extension support.

(3) On data and data sharing: It is recommended that: (i) the conceptual framework and findings of the socioeconomic component forms the basis of comprehensive baseline surveys of transboundary basins and sub-basins; and (ii) that the surveys should focus on an exhaustive collection of data on water users and their appropriate characterisation including domestic, agriculture, livestock, industry, environment, infrastructure, tourism & wildlife, etc. The benefits of data and information sharing should be actively promoted; such benefits include empowerment and improved negotiation capacity; enhanced inter-state relationships; and improved administrative routines – for instance planning and decision making, improved communications among linked groups, etc.

(4) On the role of women and the youth: It is recommended that to enhance the place and role of women and youth in water resources management, it is necessary first to identify the specific constraints and existing or new household technologies that can aid practical design of interventions.

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ANNEX : SOCIOECONOMIC COMPONENT DATA ANALYSIS AND MONITORING FRAMEWORK

Water-using Sectors	Components & Sub-Components	Sub-Component Elements/Data & Information Field – Assessed and analysed at basin, national & sub-regional level
1. Domestic	Domestic water supply Commercial, public institutions and municipalities supply Sanitation	• Water withdrawals • Urban and rural water users • Water supply coverage • Water for drinking, home keep and household production • Water supply sources and quality • Water production and water harvesting technologies • Unaccounted for water • Water and sanitation • Gender perspectives
2. Agriculture	Rain-fed agriculture Irrigated agriculture potential and water requirements	• Rain-fed & irrigated agricultural potential • On-going and planned irrigation scheme • Main crops grown under rain-fed and irrigation conditions and yields • Crop production and consumption patterns • Water requirements for irrigation • Sources and quality of irrigation water • Irrigation practices and technologies • Water use efficiency
3. Livestock	Livestock species	• Types, numbers & ownership of livestock • Livestock production & management systems • Water requirements for livestock • Sources of water for livestock • Factors limiting livestock production

Continued ➲

4. Industry	Manufacturing Mining/mineral extraction	• Defining industrial water use/demand • Classification of industrial establishments • Location of industrial establishments • Outputs and value added in industry • Employment in industrial establishments • Determinants of water demand
5. Infrastructure	Energy Transport – navigation, road, rail, etc	• Energy production (thermal and hydroelectric) • Numbers and types of energy plants (hydro, thermal, fossil) • Navigable stretches of water bodies • Nos. & types of water crafts, road & rail vehicles • Determinants of water use/demand • Water storage and delivery infrastructure
6. Tourism, Wildlife and Ecology	Tourism Wildlife Ecology	• Numbers and types of tourist facilities • Protected areas and wildlife stock (numbers, types) • Tourist flow • Ecology water requirements
7. Cross-cutting Areas	Sub-regional socioeconomic synthesis	• Population and demographic trends • Natural and agricultural resources • General economy • Sub-regional socioeconomic synthesis

Mapping, Assessment & Management of Transboundary Water Resources in the IGAD Sub-Region Project

II

SOCIOECONOMIC COMPONENT

Several socioeconomic challenges have underscored the analysis of the water resources of the IGAD Sub-region and their uses. The countries of the sub-region are in an era of serious water shortages, which raises the spectre of looming water insecurity and the prospect of intensified competition for water in the future. The main challenge for the sub-region is, among others, how the water resources will be managed to meet rising food demand while at the same time protecting access of the poor and vulnerable people to the water that sustains their well-being.

This report is based on national data which were significantly complemented and where necessary upgraded with complementary data and information from regional and international sources. To achieve the desired results more effectively, the study focused the assessment and analysis of water use in the most important water-using sectors (this was largely dictated by lack or inadequacy of data for the other sectors), namely water uses in the domestic, agriculture and industrial sectors.

Two models (Water Use Model and PODIUMSIM Model) were examined for potential application in the quantification, assessment and projection of water use. Both models provide tools for simulation of alternative scenarios of future water demand with respect to the variations of the key demand drivers. While the full application of the models was proscribed by insufficient data, they nonetheless provided the conceptual framework used in this study to work projections and scenarios of future water demand.

Key results of the socioeconomic component included, firstly the detailed assessment of the key drivers of water demand in the sub-region, and secondly the projections of future water needs in various scenarios.

While several factors will drive the pressures on water resources, population and its dynamics will be the primary driver of all demands, including water demand (Chapter 6). High population growth is outstripping the pace at which water resources are being developed to meet the various socioeconomic needs of the sub-region. Associated with this is the low and unbalanced funding of the water and sanitation sector, with the tendency to concentrate water infrastructure in the urban centres and giving lower priority to rural areas.

The water issues of the sub-region are exacerbated by the fact that over 75% of the sub-region is classified as ASAL – these areas which are mostly water stressed and have low agricultural potential.

This report made recommendations (i) on population and its impacts on water demand; (ii) on adjustment of water demand and food security; and (iii) on data and data sharing ■

Sahara and Sahel Observatory

Bd du Leader Y. Arafat, BP 31, 1080 Tunis Carthage, Tunisia
Tel. : (+216).71.206.633 - Fax : (+216).71.206.636
URL : www.oss-online.org - Email : boc@oss.org.tn

African Water Facility

Banque Africaine de Développement, BP 323 – 1002 Tunis(ia)
Tel. : (+216).71.103.971 - Fax : (+216).71.348.670
URL : www.africanwaterfacility.org - Email : africanwaterfacility.org

Intergovernmental Authority on Development

Avenue Georges Clemenceau, P.O. Box 2653 Djibouti
Tel. : (+253).354.050 - Fax : (+253).356.994
URL : www.igad.int