SOCIO-ECONOMIC DEVELOPMENT AND BENEFIT SHARING PROJECT [SDBS]

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Infrastructure and Food Security in the Nile Basin Region: A Case Study from Ethiopia, Kenya and Sudan

ETHIOPIA

PROJECT ID Number: P075952

NILE BASIN INITIATIVE
Initiative du Bassin du Nil

PMU, SOCIO-ECONOMIC DEVELOPMENT & BENEFIT SHARING PROJECT
NILE BASIN INITIATIVE

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Acronyms

AAU	Addis Ababa University
AfDB	African Development Bank
ANC	Antenatal Care
BCM	Billion cubic meters
CBR	Crude Birth Rate
CDR	Crude Death Rate
CHWs	Community Health Workers
CSA	Central Statistical Agency/Authority
DA	Development Agency
DHS	Demographic and Health Survey
DPPC	Disaster Prevention and Preparedness Commission
DRC	Democratic Republic of Congo
FAD	Food Availability Decline
FAO	Food and Agriculture Organization
FDRE	Federal Democratic Republic of Ethiopia
FED	Food Entitlement Decline
FGDs	Focus Group Discussions
FMoH	Federal Ministry of Health
FP	Family Planning
FY	Fiscal Year
GDP	Gross Domestic Product
GER	Gross Enrollment Ratio
GOs	Governmental Organizations
HDI	Human Development Index
HDR	Human Development Report
HEP	Hydro Electric Power
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
IDR	Institute of Development Research
IFPRI	International Food Policy Research Institute

IMF	International Monetary Fund
IMR	Infant Mortality Rate
K.shs.	Kenyan Shillings
KIHBS	Kenya Integrated Household Budget Survey
KCBS	Kenya Central Bureau of Statistics
MDGs	Millennium Development Goals
MoFED	Ministry of Finance and Economic Development
MoI	Ministry of Information
NBI	Nile Basin Initiative
NEPAD	New Partnership for Africa's Development
NER	Net Enrollment Ratio
NGOs	Non-Governmental Organizations
OECD	Organization for European Countries Development
PASDEP	Plan for Accelerated and Sustainable Development to End Poverty
PHC	Primary Health Care
PIs	Participating Institutions
PLWHA	People Living With HIV/AIDS
PMU	Project Management Unit
PNC	Postnatal Care
PPP	Purchasing Power Parity
PRA	Participatory Rural Appraisal
PSNP	Productive Safety Net Programme
SAM	Social Accounting Matrix
SDBS	Socio-economic Development and Benefit Sharing
SDIs	Service Delivery Institutions
SIDA	Swedish International Development Agency
SPSS	Statistical Package for Social Scientists
SSGO	Southern Sudan Government Office
SVP	Shared Vision Programme
UN	United Nations

UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNECOSOC	United Nations Economic and Social Council
UNICEF	United Nations Children's Fund
VCT	Voluntary Counseling and Testing
WDI	World Development Institute
WFP	World Food Programme
WHO	World Health Organization
WMS	Welfare Monitoring Survey

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Executive Summary

The Nile Basin has been cited among the most food insecure regions in Sub-Saharan Africa. Although the degree varies from one riparian state to another, the problem has persisted for a long time. Food insecurity is explained by multiple factors, including rapid population growth, diminishing land holdings, lack of on-farm technological innovations, lack of off-farm income sources, climatic shocks, resource degradation, bad governance and inefficient policies, widespread epidemics (e.g. malaria, tuberculosis), poor physical infrastructure and conflicts.

The roles of infrastructural services in the food security of households, communities and regions, however, have not been adequately studied. The hitherto existing food security studies have so far focused on the role of household socioeconomic and resource characteristics on household food security. In this study, two important infrastructures that affect food security in Ethiopia, Kenya and Sudan were considered. These are water supply schemes and irrigation, and health infrastructure. The selection of these two types of infrastructure is based on the severity of the problems affecting the region, e.g. HIV/AIDS pandemic, lack of access to safe potable water and undeveloped irrigation. Thus, the central purpose of the study is to assess the status of the aforementioned infrastructures and food security and the relations thereof in the Nile Basin with emphasis on Ethiopia, Kenya and the Sudan.

The conceptual framework of the study has been based on the assumption about the two-way relationships between infrastructure and food security at household level. On the one hand, access to sufficient infrastructure on a sustainable basis will help in the various dimensions of food security, while, on the other, people with better standard of living and secured livelihoods will demand more infrastructural services. Data and information pertaining to food security situations and status of domestic water supply, irrigation and health in Ethiopia, Kenya and Sudan have been collected from various secondary sources. Within Ethiopia, three regions that fall within the Ethiopian portion

of the Nile Basin, namely, Amhara, Oromia and Tigrai, were purposively selected. Checklists were prepared to gather quantitative and qualitative data in all the three study regions in Ethiopia. The study employed descriptive and inferential statistical techniques to analyze the data.

The findings of the study have shown that the populations of all countries in the Nile Basin region, except Egypt, suffer from high levels of malnutrition and all but Uganda are net importers of cereals. Thus, food production is a determinant factor in food security status in most of the countries of the Nile Basin region. Food security status in the three regions of Ethiopia is low and varies considerably from zone to zone and region to region. This implies the need for food security strategies that can address the problem in each region so as to improve food security level and reduce food security disparities among the zones and regions. The food security situation in Kenya is characterized by seasonal food insecurity in rural areas before the start of the harvest and acute food insecurity in the semi-arid and arid regions. Population growth, land holding, improper resource use and deregulation and commercialization play a significant role in determining food availability in Kenya. The food security situation in Sudan over the last two decades has often required food aid. Acute malnutrition rate, rainfall fluctuations, declining agricultural sector growth and deterioration in the traditional rain-fed agriculture are evidently seen in the country.

With the exception of Egypt and Sudan, the agricultural sector provides the substantial bulk of employment opportunities for populations in the Nile Basin countries. The percentage of agricultural land developed through irrigation in the Basin is generally low except in Egypt and to some extent in the Sudan. The existing water infrastructure in Ethiopia, Kenya and Sudan is not sufficient to meet domestic water-use demand. The case study results in Ethiopia have indicated the pivotal role that irrigation agriculture can play in the attainment of food security in the country. Generally, there is direct relationship between water infrastructure and food security in all the case study countries.

Although the relations between water and food security indices vary across regions in Ethiopia, the bi-variate correlation results have in general terms

shown that the number of water schemes in a zone has a positive moderate impact on food security in Oromia and Tigrai; the density of water schemes has also some moderate effect on food security in Oromia and the degree of water accessibility to users also has some moderate effect on levels of food security. When irrigated land per capita becomes higher, the number of food insecure population decreases and vice versa. This shows, among other things, the pivotal role that irrigation agriculture can play in the attainment of food security in the region.

The multivariate regression analysis that was carried out to assess the degree of relationships between two independent variables (food security indices - percentage of food insecure population and per capita grain production) and a set of independent variables (water infrastructure indices – percent of rural population having access to potable water, number of water schemes per 10,000 population, irrigated land per capita) yielded varied results for the regions studied in Ethiopia. Two of the set of water indicators (percentage of rural population accessed to potable water and irrigated land per capita) explained the bulk of the variations (98%) in the percentage of food insecure population in Amhara Region. The same explanatory variables have also explained 92% of the variations in the per capita grain production in the same region. In the second case study region in Ethiopia, viz. Oromia, the explanatory variables (four water infrastructure indices) explained about 47% of the variations in the percentage of food insecure population, leaving aside a residual value of 53%. The results have not been different for the variations in per capita grain production in Oromia, with only 52% being explained by the water infrastructure indices. Lastly, in Tigrai Region, the percentage of rural population having access to potable water and irrigated land per capita explained 75% of the variations in the percentage of food insecure population, while the same two explanatory variables explained 92% of the variations in per capita grain production.

The health and water service status and food security level in the three case study countries in the Nile Basin Region are generally low, with considerable

disparity among regions and sub-regions. This situation calls for more effort to improve the access to safe water, health and food security, taking into account the inequality among sub-regions and regions in each country.

Health workers and health facilities to population ratios are low and vary from one zone to another in the sample study countries. This situation requires strong interventions in terms of training medical manpower and expansion of health facilities at various levels. Devising appropriate incentive systems to curb brain-drain is also essential. Health services provided in the case study countries vary from region to region and from zone to zone, pointing out the disparity in the level of services. This again calls for extra effort to expand the scope and level of health services in all regions and sub-regions of Ethiopia, Kenya and Sudan. The inequality in the service levels also demands more attention.

The bi-variate correlation and regression analyses for Ethiopia have shown a few significant health service indices that are associated with food security indicators. These health services that need investment/intervention attention in all the study regions are deliveries attendance with skilled personnel, health post coverage and family planning. Antenatal care is also an important service that may deserve attention.

The policy recommendations made with regards to the relations between water infrastructure and food security that can have policy implications on the water and food sector policies for the three case study countries in the basin include upgrading and expanding irrigation agriculture; adopting integrated food security and infrastructural development; addressing geographic and demographic disparities in the distribution of water infrastructure; maintenance of the existing water schemes; and increasing water coverage. Similarly, the policy recommendations on the relations between health infrastructure and food security in the case study countries that can have policy implications include prioritizing health services expansion, adopting integrated approach for food security and infrastructure development and expansion of participatory healthcare and community-based preventive strategy. Besides, a sub-section has been devoted to spell out the implementation strategies

Section A

Main Report

1

Introduction

With the intent to implement the socio-economic development and benefit-sharing project, the participating institutions (PIs) representing the nine Nile Basin countries met in Kampala on June 26, 2006 and identified five clusters and their corresponding lead PIs and members. The clusters included water/natural resources management, food security, benefit-sharing, cross-border trade and energy. Of the five clusters, Ethiopia has been assigned to serve as a lead PI for the benefit-sharing cluster and opted to be a member in both the water/natural resources management and food security clusters. The concept note for the benefit-sharing cluster and the country reports for the food security and water/natural resources management clusters have been submitted on time to the project management unit and the PIs. In addition, the reports for the SDBS project launching workshop and Benefit Sharing Cluster Meeting as well as the scoping study results have been submitted to the PMU and the PIs. During the October 2007 Nile Trans-boundary Development Network Forum, an agreement was reached among the PIs to come up with relevant Nile-based socio-economic research themes based on their scoping study results. Accordingly, nine thematic areas were selected, of which IDR/AAU was assigned to write a proposal and undertake research on a theme titled: "Infrastructure and Food Security in Ethiopia and the Nile Basin Region". This final draft report is an outcome of the research that has been undertaken to assess the status of water and health infrastructure, and food security in Ethiopia, Kenya and the Sudan and the linkages thereof.

The Nile is a trans-boundary river flowing through various climatic zones[1] (FAO, 1997) in ten African countries[2]. The Nile River is fed by two main river

1 The sources are located in humid regions, with an average rainfall of over 1000 mm per year. The arid region starts in Sudan, which can be divided into three rainfall zones: the extreme south of the country where rainfall ranges from 1200 to 1500 mm per year; the fertile clay-plains where 400 to 800 mm of rain falls annually; and the desert northern third of the country where rainfall averages only 20 mm per year. Further north, in Egypt, precipitation falls to less than 20 mm per year.

2 Burundi, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda are the Nile riparian states.

systems: the White Nile, with its sources in the Equatorial Lakes Plateau[3], and the Blue Nile, with its sources in the Ethiopian highlands. The total catchment area of the White and Blue Niles covers an area of 3.1 million km^2 or 10% of Africa's landmass. The estimated length of the Nile River is over 6,800 km, making it the longest river in the world flowing from south to north encompassing 35 degrees of latitude (refer to the Nile Drainage Basin Map in Annex IV, Figure 4).

The Nile Basin has been cited among the most food insecure regions in Sub-Saharan Africa. Although the degree varies from one riparian state to another, the problem has persisted for a long time. Food insecurity is explained by multiple factors, including rapid population growth, diminishing land holdings, lack of on-farm technological innovations, lack of off-farm income sources, climatic shocks, resource degradation, bad governance and inefficient policies, widespread epidemics (e.g. malaria, TB), poor physical infrastructure and conflicts (Degefa 2005; FAO 2007). The same sources have indicated that the Nile Basin countries have experienced food insecurity over several decades. Food insecurity is highly related to the poor performance of the agricultural sector in general and the smallholder agriculture in particular. For instance, poor infrastructure and weak marketing system have contributed to food insecurity in the Sudan (ibid). FAO (2005) also reported that food insecurity in northern Uganda has been caused primarily by poor market infrastructure. In similar ways, infrastructure influences food security in Ethiopia. The same source indicated that various factors such as inadequate infrastructure; limited investment in rural areas; high rate of HIV prevalence; lack of improved technology and poor market integration have worsened the state of food security in Ethiopia.

The Ethiopian population is highly dependent on subsistence agriculture for its food and income. Both chronic and seasonal food insecurities affect a large segment of the population. According to the report of the World Bank (2005), 45 % of the rural population in Ethiopia lives below the poverty line. During the 2002/03 food crisis, about 22% of Ethiopians (14.3 million) were

3 Burundi, Rwanda, Tanzania, Kenya, Zaire and Uganda

in need of food aid. As reported by Disaster Prevention and Preparedness Commission (2004), domestic food production meets on average only about 88 % of the food demand in the country, the remaining being a gap to be covered from various sources like food aid and food imports.

The roles of infrastructural services in the food security of households, communities and regions, however, have not been adequately studied. The hitherto existing food security studies have so far focused on the role of household socioeconomic and resource characteristics on household food security. Similarly, most previous studies have focused on the impacts of climatic shocks (e.g. drought, flood), land degradation and regional instability on food security. For the purpose of this study, two important infrastructures that affect food security in Ethiopia, Kenya and Sudan in the Nile Basin Region are selected. These are water supply schemes and irrigation as well as health infrastructure. The selection of these two types of infrastructure is based on the severity of the problems affecting the region, e.g. HIV/AIDS pandemic, lack of access to potable water and undeveloped irrigation. Thus, the central objective of this study is to assess the status of the aforementioned infrastructures and food security and the relations thereof in the Nile Basin with emphasis on Ethiopia, Kenya and the Sudan.

This main report is subdivided into six sub-sections. Following the introduction, the second sub-section reviews pertinent literature on water and health infrastructures and their relationships to food security. The third sub-section presents the conceptual framework of the study, sources of data and methods of data analyses. Sub-section four will give highlights on the socio-economic characteristics of the Basin in general and that of Ethiopia, Kenya and Sudan in particular, while sub-section five discusses the status and relationships of food security and water and health infrastructures in the three selected countries. The last sub-section wraps up the discussion by making concluding remarks and recommendations.

2

Review of Related Literature

Food security has been in the public eye for a long time. Recently, Maxwell (2001) argued that food security began to make a serious impact on the development debate in the 1970s. It must also be acknowledged that interest in this basic thematic issue has waxed and waned over time partly in response to the evolution of thinking about development and partly because of changes in the nature of food problem in the world. Meanwhile, there have been changes in thinking about food security itself - a gradual shift from concerns about issues of global and national food supply to household and individual access to food. Generally, there have been shifts in theoretical perspectives on food security from food availability decline to vulnerable livelihood. In light of these changes, this part of the report aims to throw light on some of the perspectives that would enable a better understanding of food security.

Food security ideas have evolved from a phase when food shortage was seen as a problem of food scarcity at national and international levels in the early 1970s to the current stage where it is understood as an outcome of livelihood vulnerability at household and individual levels. The emergence of the concept of food security very relates much to the policy concerns towards combating increasing malnutrition and famine at the global level. The issue of food security has, therefore, become central to academic research, resulting in the formulation of food security theories with different perspectives. Indeed, there have been considerable shifts in thought and concerns regarding food security over the last several decades. An understanding of these shifts is vital to pursue further investigation on food security. In what follows, these paradigm shifts on food security will be elaborated.

2.1 Shift from macro to micro levels

The first paradigm shift emphasized a change of focus from macro to micro levels, i.e. from international and national levels to households and

individuals. After the First World Food Conference that was held in Rome in 1974, the main emphasis of nations shifted towards increasing domestic food production and/or on creating favorable situations which can enable them to easily import food to bridge the gaps. The United Nations (quoted in Maxwell, 2001:14) defined the concept of food security in 1975 as follows: "Availability at all times of adequate world food supplies of basic foodstuffs … to sustain a steady expansion of food consumption … and to offset fluctuations in production and prices". According to this definition, a nation that can make sufficient food available from domestic production, imports or a combination of the two is regarded as attaining food security. In conjunction with the above-stated definition, the Food Availability Decline (FAD) approach argues that a decline in food availability may be attributed to various factors, specifically demographic (rapid population growth, diminishing per capita livelihood resources, land fragmentation and competition over resources) and natural hazards, including droughts, floods and pests.

2.2 Shift from "food first" perspective to livelihood perspective

The second paradigm shift has focused on the long-term resilience of livelihoods. Whereas the first shift took place largely in the period spanning 1975-85, the second one occurred mainly after 1985 as driven by observation of the African famine of 1984-85 (Devereux & Maxwell 2001: 18). The shift from 'food first' to 'livelihood' perspectives has been triggered by four important situations:

(i) Many empirical observations on food insecurity have shown that food security victims focus on long-term objectives (sustaining livelihood) rather than attaining the short-term fulfillment of immediate food scarcity;

(ii) People's responses to food shortages have delved into a variety of coping strategies, an understanding of which requires dealing with specific contexts;

(iii) The emergence of the application of an analogy of concepts of environmental management, i.e. 'sensitivity' and 'resilience', in explaining the situations before, during and after food crisis for households; and

(iv) The quest for a holistic understanding of peoples' opportunities, constraints and the interrelations (interactions) between context, access to assets and institutions resulting in either desirable or undesirable livelihood outcomes.

2.3 Shift from objective indicators to subjective perceptions

The third paradigm shift has exhibited changes from an objective to a subjective approach. This shift has identified three important explanations for the need to move from quantitative measurement of food security to subjective (qualitative) perceptions: first, practical problems related to recommending a standardized amount of calorie and micro-nutrients; second, cultural and food preference differences; and third, human dignity and quality of entitlement. In the poverty literature (Townsend 1974 cited in Devereux & Maxwell 2001), there has been a distinction between 'the conditions of deprivation,' referring to objective analysis, and 'feelings of deprivation,' related to the subjective analysis. The notions of nutritional adequacy and the omission of qualitative aspects from the quantitative measures of food security have hence led some researchers to stress the subjective dimension of food security.

In summary, the aggregate effect of the three paradigm shifts has been manifested through significant changes made in the food security agenda since the mid-1970s (ibid: 21). A definition of food security by Maxwell (2001) could capture the subjective perception of vulnerable people and entitlement in terms of food quantity and quality:

> A country and people are food secure when their food system operates in such a way as to remove the fear that there will not be enough to eat. In particular, food security will be achieved when the poor and vulnerable, particularly women, children and those

> living in marginal areas, have secure access to the food they want. Food security will be achieved when equitable growth ensures that these groups have sustainable livelihoods; in the meantime and in addition, however, food security requires the efficient and equitable operation of the food system (Maxwell 1991: 22).

The discussions on the three major shifts in thinking and concerns on food security shed some light on the studies of food security. However, the above-mentioned theories are not comprehensive enough to deal with all the factors involved in explaining risks. As stated earlier, FAD, FED and political economy theories have different backgrounds, assumptions and perspectives on food security. None of them offers comprehensive explanations for food insecurity crisis. The former two approaches have a more economic focus, as they place more emphasis on food rather than on making people central to the issues under discussion. On the other hand, the political economy theory deals with 'power' dimension. In sum, in spite of the paradigm shifts on food security, some important explanations for household food security, particularly on the variables related to the social and cultural characteristics of people, need to be given more emphasis.

Household food security can also be framed within availability, access and utilization dimensions. Households can secure their access to food mainly through producing or purchasing, transfer or in all ways, as well as through the increasing individual's capacity of efficient utilization or consumption of sufficient and nutritionally balanced food. An efficient health service is brought in here as a factor that enhances food security via its role of keeping up an individual's health status which plays a key role in improving food utilization. It is assumed that people with adequate access to health services (health education and advice, medical diagnosis and treatments, and medicines) and water supply are productively employed and food secure.

Infrastructure refers to basic facilities, services and installations such as water schemes, irrigation systems, transportation and communication systems, power lines and public institutions needed for the functioning of a community or society (FAO, 2007). These infrastructures connect rural areas to the urban,

regional and global economies. Hence, improvements in infrastructure play decisive roles in propelling development processes. Infrastructure can broadly be divided into two categories: physical and socio-economic. The former includes water supply, irrigation systems, roads, communication, storage, credit and market facilities while the latter educational and health services. Physical and socio-economic infrastructures are essential elements that contribute to improving the food security of rural people through the enhancement of labor productivity and commercialization; the reduction of transaction costs; and facilitating trade and exchange. For instance, the food security strategy of Ethiopia emphasizes the importance of infrastructural services in improving food security (FDRE, 2002). Similarly, the strategy has identified HIV/AIDS, malaria and water-borne diseases as the major health problems that deserve attention for they reduce and/or debilitate the productivity of people thereby placing a huge burden on society.

Access to safe drinking water reduces the exposure of people to a variety of diseases that obstruct the intake and utilization of food. In addition, easier access to safe water reduces the time of hauling water by women thereby increasing their productivity and status. At the sub-Saharan African level, only two to three percent of the surface and ground water resources available are used to meet the different needs. Not much progress towards long-term reliable food security can be achieved unless Africa attains a minimum level of capacity to develop and manage its surface and ground water resources (UNDESA, 2006).

Evidence indicates that a wide range of diseases, such as malaria, HIV/AIDS and TB, adversely affect food security (UNICEF 2006). Poverty increases the vulnerability to infections and the transmission of diseases. Of the aforementioned diseases, HIV/AIDS affects the economically active population by exposing them to worsening and widespread food insecurity. This is manifested mainly through debilitating the capacity of people to produce and/or to purchase food. Health status of individuals has a two-way interaction with food security. On the one hand, good health status of individuals contributes to sufficient and efficient utilization of adequate food,

improves food availability via its positive effect on labor productivity, minimizes productive time loss due to illness, and enables money saving which otherwise could be used for health care. On the other hand, consumption of sufficient and nutritionally balanced food contributes to improvement of health status and productivity of individuals and families.

Efficient delivery of institutional services plays a significant role in improving economic performance and food security. In many economies, the state plays a major role in establishing institutionalized infrastructural services because it has a comprehensive power over the legitimate use of coercion to enforce rules (Eggertson, 1990). Furthermore, service delivery is a key locus for the evolution of the state's relationship to its citizenry. The very legitimacy of the state depends on how well service delivery institutions (SDIs) meet the demands of citizens (Paul, 1998).

In this context, the institutional capability of the state would take a far-reaching role in facilitating and improving health and water service delivery with great implications on food security of households and communities. An important dimension of service delivery is institutional arrangements for governing the design, delivery, and regulation of services. An appropriate institutional arrangement is based on inherent characteristics, like measurability and information access of the goods to be delivered. The other important dimension of service delivery is government's ability to increase the efficiency and effectiveness of service delivery. Efficiency and effectiveness of service delivery is the function of the congruency between institutional good practice options, which is derived from goods and country characteristics. Typical country characteristics consist of political, state and social institutions (i.e. country's institutional endowments), which shape, *inter alia,* political readiness to reform (Levy and Spiller, 1996; Haggard and McCubbins, 1997).

Social scientists have now come to a consensus that health can serve as an important index of human development. Health defined as the state of complete physical, mental, social and spiritual wellbeing and not merely absence of diseases and infirmity, proves to be a major contributor to the

level of quality of life. It goes without saying that the basic objective of human development is to improve the quality of life. Healthy population plays a key role in achieving the developmental activities as health helps to improve the productivity of mankind both directly and indirectly. Generally, poor socioeconomic status (poverty and food insecurity) and poor health status together make a vicious cycle wherein poverty brings (in) inadequate nutrition, unhealthy environment and sickness causing low productivity and food insecurity. It is estimated that 70-75 % of all the deaths of children below five years of age in the developing countries are associated with three categories of diseases – infections spread through human excreta, airborne infections and malnutrition. All these can, in turn, be associated with poor socioeconomic status of the poor.

The most challenging problem for African policy makers is lowering the transaction costs that poor African farmers face to buy fertilizers and other agricultural inputs (IFPRI 2007). Large-scale public investments in rural areas are crucial for the enhancement of food security. For instance, in India, public investments in agricultural research & development as well as roads generated the highest and second-highest returns to poverty reduction, respectively, while in China they generated the second and third highest returns after education.

FAO (2002) indicated that the markets in Africa and the Nile Basin Region remain undeveloped and inefficient due to a number of factors, which include, among others, inadequate storage and transport infrastructure and lack of strong supporting institutions and instruments that can enable producers to manage marketing and price risks. Likewise, NEPAD (2006) stated that the vast majority of African farmers have limited access to inputs, including fertilizers, improved seeds and pesticides. Normally, farmers are compelled to travel long distances to get agricultural inputs. As a result, they pay prices two to four times higher than their counterparts in industrialized countries.

Infrastructure intersects with all the Millennium Development Goals (MDGs). This is especially so in the areas of health and education. UNECOSOC (2007) argued that transport, for example, facilitates access to health care and

education, eases the staffing problem and improves access to rural clinics and schools. Electricity is essential for certain operations (e.g. delivering vaccines which require refrigerated storage) and reduces the direct risks of alternative heating and lighting methods, as well as favoring hygienic practices by reducing the cost of boiling water.

There are very close linkages between infrastructure and food security. The majority of poor people in the Nile Basin live in rural areas. They depend on agriculture for their livelihoods. Farmers in the Basin are experiencing slower growth in cereal yields and this trend is projected to continue in the coming decades. Some of the contributing factors for the sluggish state of cereal production include insufficient investment in agricultural research and modern technology, inadequate extension services linking researchers and farmers, insufficient or improper use of inputs, poorly functioning markets, and lack of appropriate infrastructures (Pinstrup-Anderson & Pandya-Lorch, 2001).

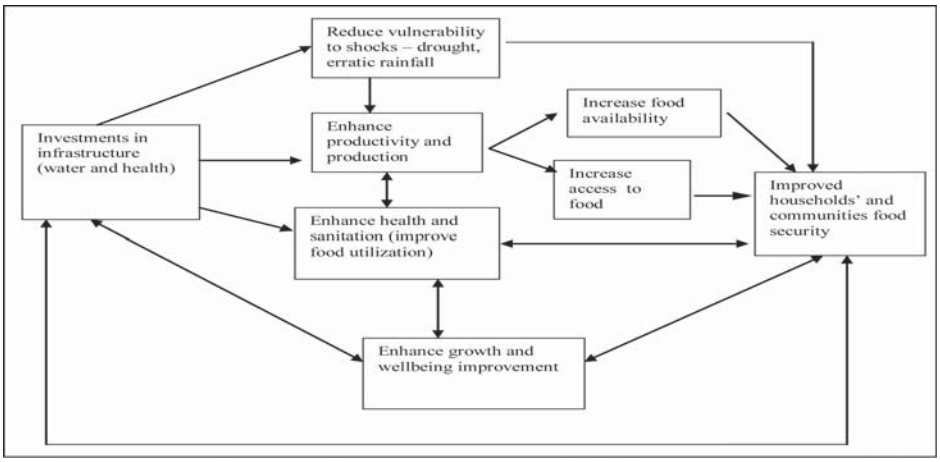
3

Conceptual framework and methodology

3.1 Conceptual framework

It is important to identify the multiple dimensions of the relations between infrastructure and food security and to define the magnitude and directions of their interconnections. To this end, the research team employed the analytical framework shown in Figure 3.1. We assume that there are two-way relationships between infrastructure and food security at household level. Access to sufficient infrastructure on a sustainable basis will help in the various dimensions of food security: reducing vulnerability to shocks (drought, erratic rainfall, rainfall variability); increasing food availability and access (increasing productivity and income); and enhancing the utilization components by improving the health and sanitation situations. These, in turn, enhance the well-being and food security status of people. People with better standard of living and secured livelihoods will demand more development in infrastructure.

Figure 3.1: Conceptual framework to examine the interrelationships between infrastructural services and food security



Source*: prepared by the authors, 2008*

3.2 Sources of data and methods of analyses

The IDR-SDBS research team has reviewed pertinent literature in light of the issues under investigation. Data and information pertaining to food security situations, status of domestic water supply and irrigation and health infrastructure in Ethiopia, Kenya and Sudan have been collected from various secondary sources. Within Ethiopia, we have purposely selected three regions, namely, Amhara, Oromia and Tigrai, because all of them fall within the Ethiopian portion of the Nile Basin. About one-half of the Amhara Region and one-third of Oromia are drained by the headwaters and tributaries of the Blue Nile (Abbay) River. Similarly, about four-fifths of Tigrai Region is drained by the main trunk and tributaries of the Atbara (Tekezzie) River and its tributaries (refer to Figures 1, 2 and 3 in Annex IV). Checklists were prepared to gather data (both quantitative and qualitative) in all the three study regions in Ethiopia (refer to Annex I).

The study employed descriptive and inferential statistical techniques to analyze the data. These include, *inter alia*, descriptive statistics such as frequency tables, means and percentages, and inferential statistics such as, bi-variate correlation analyses to see the strength and direction of the relationships between pairs of variables and multivariate regression analyses to assess the extent to which water and health indices are related to food security indices. The quantitative analyses have been carried out by employing the SPSS 15.0 software.

In addition, in the context of another project a qualitative case study research was conducted in four villages in Oromia Region to assess the relationship between water supply and food security (Degefa and Tesfaye, 2008). The methods used to obtain the data included household surveys and PRA methods. The latter included focus group discussions (FGDs), case study households, and key informant interviews with the elderly, development agents, health extension workers and NGO representatives. The household survey covered 32 households from each of the study villages. Thus, a total of 128 households comprising 87.5% male-headed and 12.5% female-headed households have been considered.

4

Socio-economic characteristics of the Basin countries

About 160 million people live in and around the Nile River while 300 million (40% of Africa's population) live in the ten riparian states. The population is projected to increase to 800 million people by the year 2050. Due to a history of instability, rapid population growth, and environmental degradation, the region is characterized by wide spread poverty with six of the ten countries ranked in the category of low human development index (HDI) and the remaining four within the lower half of the medium human development range (see Table 1). Though the average per capita Gross Domestic Product (GDP) of the region is around US$ 1,300, only three of the countries are above this average indicating substantial variations in economic development. Hence, six of the Nile Basin states are among the world's poorest countries in terms of HDI ranks, HDI value and GDP per capita. Hereunder, the socio-economic characteristics of the three selected Nile riparian states, namely Ethiopia, Kenya and Sudan, will be deliberated upon.

4.1 Ethiopia

The Federal Democratic Republic of Ethiopia (FDRE) is located between 3^0 N and 14^0 N latitude and 33^0 E and 48^0 E longitude. It shares international borders with Sudan to the west and north-west, Kenya to the south, Somalia to the east and southeast, Eritrea to the north and Djibouti to the east. The total area of the country is 1.14 million square kilometers, of which 0.7% is covered by water bodies (Microsoft Encarta Corporation, 2006). According to the Ethiopian Ministry of Information (2005), the country has three principal climatic zones:

(a) tropical rainy region, at an altitude of over 2500 meters above sea level;

(b) dry climatic region of hot lowland lying below 1500 meters above sea level; and

(c) warm temperate wet region lying between 1500 and 2500 meters above sea level. Moreover, Ethiopia's mean annual rainfall ranges from less than 100 mm in its northeastern parts, to an excess of 2800 mm in its southwestern parts.

Table 4.1: Human Development Indicators

HDI rank		HDI value (2005)	GDP per capita (PPP US$) 2005	Population living below $1 a day (%) (1990-2005)	Population living below $2a day (%)1990-2005
	Medium Human Development [average]	[0.698]	[4,876]		
112	Egypt	0.708	4,337	3.1	43.9
147	Sudan	0.526	2,083	NA	NA
148	Kenya	0.521	1,240	22.8	58.3
154	Uganda	0.505	1,454	NA	NA
	Low Human Development [average]	[0.436]	[1,112]		
157	Eritrea	0.483	1,109	NA	NA
159	Tanzania	0.467	744	57.8	89.9
161	Rwanda	0.452	1,206	60.3	87.8
167	Burundi	0.413	699	54.6	87.6
168	Democratic Republic Congo	0.411	714	NA	NA
169	Ethiopia	0.406	1,055	23.0	NA

Source: *UNDP, Human Development Report 2007-2008*
NA- not available

The country has a federal system with nine regional states - Afar, Amhara, Oromia, Somali, Tigrai, Benishangul-Gumuz, Southern Nations Nationalities and People's Region (SNNPR), Harari and Gambella - and two city administration councils, viz., Addis Ababa and Dire Dawa. The country has a bicameral parliament consisting of the House of Representatives and the House of Federation. Poverty and hunger, instigated and exacerbated by conflicts and natural disasters have remained the country's endemic social and economic problems for most of the second half of the 20th century and the

first decade of the present century. In spite of tremendous efforts, Ethiopia is still among the poorest developing countries with an annual average per capita income of US$180 in 2005/06 (UNECOSOC, 2007: 3).

The country has a total projected population of 79,221,000 for July 2008, of whom 65,996,000 (83.3%) reside in rural and 13,225,000 (16.7%) in urban areas (CSA, 2008: 21). This makes the country the second most populous in Sub-Saharan Africa next to Nigeria (CSA, 2005).[4] The country has a predominantly rural population with a substantial majority of Ethiopians (83.8%) living in rural areas. The population is considered 'young'[5] with a little more than 51% below 18 years and less than three percent (2.7%) 65 years and above.[6] The sex ratio at birth for Ethiopia is 1030 male(s)/1000 females. The population is growing at an estimated rate of 2.31%[7] with a birth rate of 37.98 births/1,000 and a death rate of 14.86 deaths/1,000 population in 2006. The population is expected to reach 81.3 million in 2009/10, 100 million by 2018 and 130 million by 2030. Life expectancy at birth is 54.4 years for the total population, 53.4 years for males, and 55.4 years for females.[8] The total fertility rate is 5.22 children per reproductive age women.

Ethiopia's economy is dominated by rain-fed subsistence agriculture, which accounts for more than 40% of GDP, 60% of exports, and 80-85% of employment. The country has been one of the poorest in the world with per capita income below 180 USD and where about 44 % of the population lives below the poverty line. Since 1991, Ethiopia has pursued a market-oriented development strategy. The government has embarked on a cautious programme of economic reform, including trade liberalization, privatization of public enterprises and streamlining the bureaucracy. Ethiopia's reform programme has achieved some success in stabilizing the economy and facilitating the transition to a free market system.

4 The latest census for which figures are available was performed in 1994; this figure is the July 2006 official estimate. The CIA World Fact Book (2006) puts the population at 74,777,981 while UNICEF (mid-2005) estimates are 77,431,000.

5 According to the latest official reports issued in 2006, an estimated 43.7% of the population is believed to be between 0-14 years, 53.6% 15-64 years, and 2.7% 65 years and above.

6 UNICEF, 2007: Around 39,792,000 of the estimated total population of 77,431,000 or around 51.4% are reported to be below 18 years.

7 The total fertility rate is 5.22 children born per woman with a birth rate of 37.98 births/1,000 and a death rate of 14.86 deaths/1,000 population (2006)

8 45.5 UNDP 2004 and 46 UNICEF 2003

The country's development strategy has focused on agricultural development as the catalyst for economic growth. From 1998-2002, the country achieved an annual average economic growth rate of about 4.2% and the annual inflation rate averaged 0.4%. In the fiscal year 2002/03, GDP fell by 3.8 percent and inflation rose by 15.1 percent, mainly due to decline in agricultural output by 12.2 percent caused by a severe drought. Agricultural output had recovered somewhat during the 2003/04 crop year due to favorable weather situation. The Government of Ethiopia and IMF estimated that the economy has registered a growth rate of 11.6% and the agricultural sector grew by 18.9% in Fiscal Year 2003/04 (MoFED, 2005). The growth registered during the last three years (2005 -2007) averaged 10.7 percent (MoFED, 2006). The largest contributor to GDP growth was agriculture, which accounted for approximately 46.3% of the total GDP in 2006/07. Similarly, the industrial and service sectors contributed to the GDP by 13.4% and 41.2% respectively (FRDE, 2007).

Ethiopia's favorable economic performance in recent years has significantly contributed to poverty reduction and progress towards the Millennium Development Goals (MDGs). This strong growth performance resulted in real per capita income increase at 7 percent per annum. However, this has been accompanied by rising inflation, with consumer prices increasing at 19 percent as late as February 2007. Despite improvements in the economic situation in the country, a recent report indicated that 23% of the population of the country still lives on less than one USD a day (Government of Ethiopia & UNICEF, 2007). According to the same report, income per capita in Ethiopia is also one of the lowest in the world at around 160 USD. The HDI for 2007/08 ranked Ethiopia 170 out of the 177 countries while the Human Poverty Index rank for Ethiopia was 92. The 2007/08 HDR ranked Ethiopia 169th with HDI value of 0.406. Moreover, the HIV/AIDS pandemic has had substantial negative impact on the already vulnerable population and the economy. Ethiopia ranks among the most heavily affected countries in terms of national adult prevalence rate and the number of people living with HIV/AIDS. The national HIV prevalence rate in 2005 was estimated at 3

% among males and 4% among females, while there were an estimated 1.32 million PLWHA.

According to the DHS of Ethiopia (2005), the overall prenatal mortality rate that was 52 still births per 1,000 live births in 2000 declined to 37 still births per 1000 live births in 2005. Despite such improvements, one in thirteen children born in Ethiopia do not survive to celebrate their first birthday, and one in every eight children die before their fifth birthday. Moreover, there are significant regional variations in infant and under five mortality rates that reflect regional disparities, urban rural differences and educational and wealth variations. At country level, the share of children that suffer from stunting (chronic malnutrition) and wasting (acute malnutrition) stood at 47% and 11%, while 38% were under weight in 2004 (CSA, 2005). Both DHS and WMS results have shown that rural children are consistently more stunted, underweight and wasted than their urban counterparts. Nutritional status also varies greatly by region. The WMS report showed a consistent decline in malnutrition rate over time; with a considerable decrease in stunting in both urban and rural areas. For instance, the rate of stunting fell from 58% in 1996 to 30% in 2004 in urban areas and from 67% to 48% in rural areas (CSA, 2004).

The number of primary schools that was 10,394 in 1996/97 grew to 16,078 in 2004/05, which is an increase of 54.7%. In 2005/06, the number of primary schools reached 19,412, showing an average annual growth rate of 12.6%. Out of the new primary schools, more than 85% were constructed in the rural areas and the remaining 15% in urban areas. As a result of wider availability, the primary school enrollment reached 11.4 million in 2004/05. The GER at national level has been increasing continuously, reaching 91.7% in 2006. However, the regional gap in the GER and NER at primary level is still very wide, especially in terms of girls' participation. The 9.6 percentage point in gender disparity of NER in 2004/05 at the national level was lowered to 8.5 percent in favor of boys in 2005/06. The gender gap was in favor of girls only in two regions, namely Addis Ababa and Tigrai.

The number of senior secondary schools grew from 455 in 2001/02 to 835 in 2005/06 with an annual growth rate of 16.4%. In 2005/06, 1,066,423 students

were enrolled in secondary 1st cycle (grades 9-10). Out of the total enrollment, 387,707 (36.4%) were girls. In 2006/07, the national GER at secondary level reached 36.2% for first cycle and 5.3% for second cycle following a trend of annual increases. In the last six years (2001/02-2006/07), the GER at the first cycle of secondary (9-10) showed an increase of 16.3 percent (23.3 for boys and 12.7 for girls). A similar increase was observed in the second cycle of secondary school though with more limited rate. However, the gender gap increased in favor of boys except in 2006/07 which showed a decrease of 0.1%. The NER of the first cycle of secondary (9-10) reached 13.2% in 2005/06 showing a 5.8% increase in five years. Despite these improvements, the gender gap has shown a continuous increase except for 2005/06.

4.2 Kenya

Kenya is located on the equator at Africa's east coast sharing borders with Somalia, Ethiopia, Sudan, Uganda, Tanzania and the Indian Ocean. The country has a total surface area of 59,195,800 ha, of which water surface forms 1,123,000 ha and land makes up 58,072,800 ha (refer to Table 4.2). It has a climate ranging from tropical to temperate largely depending on the altitude. Kenya has been described as one of "the cradles of humanity" after the discovery of some of the earliest evidence of man's ancestors in the Great Rift Valley. Kenya is also noted for ethnic diversity which has produced a vibrant culture which at times also becomes a source of conflict.

Table 4.2: Key socio-economic indicators

Land area, thousands of km²	580
Population, thousands (2007)	37,538
GDP per capita, USD at constant 2000 prices (2007)	456
Life expectancy (2007)	54.1
Illiteracy rate (2007)	11.8

Source: *AfDB and OECD, African Economic Outlook Kenya, 2008*

The first census in Kenya, which was carried out in 1948, estimated the national populations at 5.4 million while the 1999 census at 28.7 million (Government

of Kenya, 2008). The population is currently estimated to be 38.3 million and is projected to increase to 42.4 million in 2012. The average population growth rate increased significantly from 2.5 per cent per annum in 1948 to a peak of 3.8 per cent in 1979 and then declined to 2.9 per cent per annum in 1999 (refer to Table 4.3). Accordingly, population density in Kenya increased from 19 to 49 people per square kilometer in 1969 and 1999. Similarly, the crude birth and death rates declined from 50 and 25 per 1000 population in 1948 respectively to 41.3 and 11.7 in 1999.

Table 4.3: Kenya demographic indicators

Period	1948	1962	1969	1979	1989	1999
Total Fertility Rate	6.0	6.8	7.6	7.9	6.6	5.0
Crude Birth Rate (CBR)	50.0	50.0	50.0	52.0	48.0	41.3
Crude Death Rate (CDR)	25.0	20.0	17.0	14.0	11.0	11.7
Infant Mortality Rate (IMR)	184.0	Na	118.0	104.0	66.0	77.3
Annual Growth Rate	2.5	3.0	3.3	3.8	3.3	2.9
Life Expectancy	35.0	44.0	49.0	54.0	60.0	57.0

Source: *Kenya Central Bureau of Statistics, 2007*

After independence from Britain in 1963, the overall performance of the Kenyan economy has been marked by negative per capita growth. However, the Kenyan economy has recovered over the period spanning 2003-2007 through economic and structural reforms. According to official figures, real Gross Domestic Product (GDP) grew steadily from 3.0 percent in 2003 to 7.0 percent in 2007 (refer to Table 4.4). As can be seen in the table, the macro-economic growth between 2003 and 2007 had been translated into improved welfare for Kenyans with improvements in gross savings, gross capital formation and government revenue and grants. Conversely, the budget balance, current account balance and the external public debt have shown a downward trend while inflation, exchange rate, exchange reserves and public debt have shown insignificant changes.

According to the 2005/2006 Kenya Integrated Household Budget Survey (KIHBS), national absolute poverty declined from 52.3 percent in 1997 to

46.1 percent in 2005/06.[9] In rural areas, overall poverty declined from 52.9 percent to 49.1 percent, while in urban areas, poverty declined from 49.2 percent in 1997 to 38.8 percent in 2005/06.

Table 4.4: Kenya - key economic indicators

Indicators	2003	2004	2005	2006	2007
Real GDP growth (%)	3.0	4.9	5.8	6.1	7.0
Gross savings (% of GDP)	9.9	13.2	10.8	14.5	13.6
Gross capital formation (% of GDP at mp)	15.8	16.1	18.6	20.2	17.2
Consumer price inflation (avg. annual % change)	9.8	11.6	10.3	16.6	9.8
Government revenue and grants (% of GDP)*	19.9	21.1	21.5	21.2	21.3
Central government budget balance (% of GDP)[1]	-0.4	0.1	-3.5	-3.3	-6.2
Current Account balance (US$m)	146.2	-137.0	-260.6	-529.0	-1155
Exchange rate (end of period, Ksh per USD)	75.9	79.2	76.4	69.6	62.7
Foreign exchange reserves (months of imports)	4.2	3.4	3.3	3.7	4.1
Domestic public debt (% of GDP)	26.8	25.3	23.4	23.2	22.1
External public debt (% of GDP)	37.7	36.6	32.2	24.6	21.7

Source: *World Bank, Kenya: Country Brief, September 2008*

There has been additional progress with respect to other dimensions of social development over the past years. For example, net primary education enrolment was only 80 percent in 2003, but has since increased to about 87 percent in 2006 (with an equal enrolment ratio between boys and girls). In 2004, only about 60 percent of primary students completed their education compared to about 78 percent in 2006. The fight against HIV/AIDS has shown a decline of prevalence rate from over 11% to 6.1% during the last 5 years. Moreover, access to clean water and sanitation has shown improvements.

9 While this decline in poverty compares well with other sub-Saharan African countries, it can still be considered high in comparison to neighboring countries such as Tanzania (about 36 percent) and Uganda (about 31 percent).

The KIHBS Survey projected that about 16.7 million Kenyans, 84 percent of whom are living in rural areas, are poor. According to the 2005/2006 survey, the lowest incidence of rural poverty was recorded in Central province (30.3 percent), followed by Nyanza (47.9 percent, Rift Valley (49.7 percent), Eastern (51.1 percent), Western (53.2 percent), Coast (69.7 percent), and North Easter province (74.0 percent). Thus, despite the impressive gains in economic growth, poverty remains a major challenge and inequality remains high. Moreover, it is feared that the post-election crisis in early 2008 may reverse the achievements that have so far been made in poverty reduction.

The regional and district level inequality implied by the poverty data finds an almost parallel reflection in nutritional indicators of food security status. While the prevalence of undernourishment based on consumption data is reported at 51 percent at the national level, there are significant variations across income levels, rural-urban residence and among regions (KNBS, 2006). Undernourishment is higher among rural residents (almost 60%) than urban residents (40%) at the national level with the lowest level recorded in the capital, Nairobi. An even higher variation in levels of undernourishment is observed among the provinces with Central, Coastal and Eastern provinces recording less than the national average while Rift Valley, Western and Nyanza Provinces register higher levels of prevalence. Similar inter-regional trends are also reported for indicators of dietary energy with the highest levels of acquired and consumed dietary energy evidently seen among the population of Nairobi, other urban areas and the Central and Eastern regions (ibid).

In summary, Kenya is characterized by extreme economic inequality (Jorgenson, 2005) with the richest 10% of households earning 56 times more than what the poorest 10% earn (Kenyan Ministry of Planning & SIDA, n.d.). This has been translated into substantial disparities in access to food across income groups as well as demographic profiles in the country. Higher income groups living in urban centers and rural areas in the Central and Eastern provinces are generally more food secure while food insecurity is severe among rural residents in the Rift Valley, Western and Nyanza Provinces.

4.3 Sudan

Sudan is the largest country in Africa (almost as large as the European Union) covering an area of 2.5 million square kilometers (km^2) and has a special geopolitical location bonding the Arab world to Africa south of the Sahara. It is bordered by the Red Sea to the north-east and it shares common borders with nine countries: Eritrea and Ethiopia to the east; Kenya, Uganda, and the Democratic Republic of Congo to the south; Central African Republic, Chad and Libya Arab Jamahiriya to the west and Egypt to the north.

Sudan is generally flat with some mountains found in the eastern and western parts (Jebel Marra, the Red Sea Hills, Nuba Mountains, and Imatong Hills). Its main physical features are the alluvial clay deposits in the central and eastern part, the stabilized sand dunes in the western and northern part and the red ironstone soils in the south. Sudan has over 800 km of coastline along its north-eastern border, providing access to the Red Sea.

Sudan has a tropical sub-continental climate, which is characterized by a wide range of variations extending from the desert climate in the north through a belt of summer-rain climate to an equatorial climate in the extreme south. The average annual rainfall is 416 millimeters (mm), ranging between 25 mm in the dry north and over 1,600 mm in the tropical rain forests in the south.

According to the 1993 population census, around 35 million people live in Sudan. It is projected to reach 45.6 million by the year 2015 (see Table 4.5). The population growth rate is estimated at 2.6 percent, which is slightly above that of sub-Saharan Africa average of 2.1 percent (World Bank, 2008). The urban population in Sudan that was limited to 18.9% in 1975 grew to 40.8% in 2005. It is also projected to reach 49.4% by 2015. Sudan's demographic profile in 2005 also showed a high fertility rate (4.8%), higher percentage of population aged 15 and below (40.7%) and lower portion of the population aged 65 years and above (3.5%).

Although endowed with rich natural resources, Sudan remains comparatively underdeveloped primarily as a result of protracted civil strife and poor

economic management. The economy showed a limited response to reform packages during the 1980s and early 1990s. In recent years, the economic situation has improved due to new flows of revenue from oil exports and agriculture supported by favorable weather.

Table 4.5: Demographic trends in Sudan

Population, total (millions), 1975	16.8
Population, total (millions), 2005	36.9
Population, total (millions), 2015	45.6
Population, annual growth rate (%), 1975-2005	2.6
Population, annual growth rate (%), 2005-15	2.1
Population, urban (% of total population), 1975	18.9
Population, urban (% of total population), 2005	40.8
Population, urban (% of total population), 2015	49.4
Population under age 15 (% of total population), 2005	40.7
Population under age 15 (% of total population), 2015	36.4
Population aged 65 and older (% of total population), 2005	3.5
Population aged 65 and older (% of total population), 2015	4.1
Fertility rate, total (births per woman), 1970-75	6.6
Fertility rate, total (births per woman), 2000-05	4.8

Source: *UNDP, Human Development Index 2007-2008*

Gross Domestic Product (GDP) of the Sudan that was US$17.8 billion in 2003 grew to US$ 27.5 billion in 2005 (see Table 4.6). In 2005, Sudan's income per capita was US$ 810 (WDI, 2006). From 2000-04, the economy grew at 5-6%, increasing to 8% in 2005. The main export from Sudan is oil. The Sudanese economy continues to grow at a fast pace. Real economic growth, estimated at 10 percent in 2007, is among the highest in Africa.

Table 4.6: Economic performance of Sudan

GDP (current US$ billions), 2005	27.5
GDP, PPP (current international $ billions), 2005	75.5
GDP per capita, PPP (2005 international $), 2005	2,083
GDP per capita, annual growth rate (%), 1975-2005	1.3
GDP per capita, annual growth rate (%), 1990-2005	3.5
GDP per capita, highest value (2005 PPP US$), 1975-2005	2,083
GDP per capita, year of highest value	2005
Consumer price index, average annual change in (%), 1990-2005	41.8
Consumer price index, average annual change in (%), 2004-05	8.5

Source: *UNDP, Human Development Index 2007-2008*

Due to the various intra-state conflicts prevailing in Sudan, statistical data are scanty most particularly in the southern parts. However, all available data indicates that poverty across the country is deep and widespread. Moreover, recent growth has not been all-inclusive and has apparently contributed to increasing inequality. Sudan's disadvantaged regions (including Darfur, the South and the East) are among the poorest in the world, though Khartoum and the Northern states along the Nile River showed better performance than the sub-Saharan Africa average. Food security is a major preoccupation in southern Sudan as well as parts of the north.

5

Findings and Discussion

5.1 Food security status

Although high levels of food insecurity in the Nile Basin Region are evident, the country level profiles differ. Table 5.1 shows the situation in the ten countries of the Nile Basin Region along food security indices.

Table 5.1 indicates that the populations of all countries in the Nile Basin Region, except Egypt, suffer from high levels of malnutrition. This implies a very high level of food insecurity across the region with an exceptionally high prevalence of undernourishment reaching up to and beyond two-thirds of the population in three of the countries, namely Burundi, DRC and Eritrea. The levels of stunting among children in terms of both weight and height similarly indicate high levels of food insecurity in all Nile Basin Region countries with the exception of Egypt.

Table 5.1: Food security in the Nile Basin Countries

Country	Population undernourished (% of total) [2002/04]	Under-five children with under-weight for age (%) [1996-2005]	Under-five children with under-height for age (%) [1996-2005]	Infants with low birth weight (%) [1998-2005]
Egypt	4	6	24	12
Uganda	19	23	45	12
Sudan	26	41	48	31
Kenya	31	20	36	10
Rwanda	33	23	48	9
Tanzania	44	22	44	10
Ethiopia	46	38	51	15
Burundi	66	45	63	16
Congo (DRC)	74	31	44	12
Eritrea	75	40	44	10

Source*: UNDP, HDR 2007-2008, 2008*

Generally, food insecurity in the Nile Basin Region has been attributed to a number of factors including the unavailability of food, low purchasing power, unbalanced intra-household food distribution and disruptions caused by conflict. According to FAO (2004), all the countries of the Nile Basin Region, except Uganda (during some years), are net importers of cereals (Hamza & Mason, 2004). Thus, in the context of low economic development levels, the production of food items is likely to be a determinant factor in food security status at least for most and probably for all of the countries of the Nile Basin Region. The role of agriculture in creating income with which to access the food market is also likely to be a significant factor in food security.

Table 5.2: Agricultural sector indicators for Nile Basin Countries

Country	% Growth of Agricultural Production Per Capita (2001-2006)	% Growth of Food Production Per Capita (2001-2006)	Daily Calorie Supply		
			2000	2003	2004
Burundi	5.6	5.6	2,957	3,070	3,114
Congo (DRC)	-3.7	-3.6	1,655	1,605	1,560
Egypt	0.1	0.1	3,337	3,350	3,286
Eritrea	NA	NA	NA	NA	NA
Ethiopia	2.6	2.8	1,803	1,855	1,840
Kenya	2.5	0.9	2,147	2,166	2,149
Rwanda	0.8	1.0	2,026	2,103	2,173
Sudan	1.1	-1.2	2,258	2,258	2,311
Tanzania	-0.7		1,938	1,955	1,963
Uganda	-2.1	-2.2	2,327	2,377	2,348

Source: *African Development Bank, Selected Statistics on African Countries, 2008*
NA – not available

The above table provides a picture of these roles of the agriculture sector parallel to food security indicators (see Table 8). The growth of agricultural production per capita between 2001 and 2006 varied between a high of 5.6% for Burundi and a low of -2.1% for Uganda. The picture was more or less identical for percentage growth of production per capita in the same span

of time. There were also three Nile riparian states, namely, DRC, Ethiopia and Tanzania, which showed a steady daily calorie supply of less than 2000 between 2000 and 2004. The food security situations in the three case study countries will be discussed hereunder.

5.1.1 Ethiopia

The Ethiopian population is highly dependent on subsistence agriculture for its food and income. Both chronic and seasonal food insecurities affect a large segment of the population. According to the report of the World Bank (2005), 45% of the rural population in Ethiopia lives below the poverty line. During the 2002/03 food crisis, about 22% of Ethiopians (14.3 million) were in need of food aid. As reported by Disaster Prevention and Preparedness Commission (DPPC) [2004], domestic food production meets on average only about 88 % of the food demand in the country, the remaining being a gap to be covered from various sources like food aid and food imports.

According to FAO report (2006), about fifteen million people in Ethiopia face food insecurity that is either chronic or transitory in nature with around five to six million people falling into the chronically food insecure category[10] . The majority of the food insecure population lives in the rural areas. The causes include sub-optimal levels of agricultural technology, high population growth rates, and underdeveloped rural infrastructure. The low level of agricultural technology is characterized by low use of fertilizers, high-yielding crop varieties and irrigation systems. Recurrent drought and the accompanying degradation of the natural resource base and political instability as well as wars have also contributed to the persistence of poverty and frequency of food insecurity in Ethiopia. Since agriculture employs 85 percent of the population, developing the agriculture sector would help in poverty reduction and the ensuing food security of the majority of the Ethiopian people.

10 These are people who have lost the capacity to produce or buy enough to meet their annual food needs even under normal weather and market conditions. The remaining ten million are vulnerable, with a weak resilience to any shock. Under any emergency circumstances, the likelihood of these people falling back into food insecurity is high.

Food security level is measured by using a number of indicators. Direct measure is the percentage of food insecure population while indirect indicators used in this study are the proportion of PSNP (Productive Safety Net Programme) beneficiaries to total rural population of zones/region, per capita grain production (proxy measure for agricultural performance) and per capita cultivated land (rural population basis) as shown in Table 9. In 2007, the estimated food insecure population was 22.0% in Amhara Region, 4.8% in Oromia Region and 11.7% in Tigrai Region (Table 9). In the same year, the proportions of PSNP beneficiaries were 22% in Amhara, 12.6% in Oromia and 39.3% in Tigrai. The cultivated land per capita in 2007 was 0.21 ha each for Amhara and Oromia Regions and 0.40 ha for Tigrai.

Table 5.3: Food insecurity status in the study regions, Ethiopia (2007)

Item	Amhara	Oromia	Tigrai
Food insecure population, %	22.0	4.8	11.7
Grain production per capita, Kg	279.3	332.8	485.5
Cultivated land per capita in rural areas, ha	0.21	0.21	0.40
Proportion of PSNP beneficiaries to total rural population, %	22.0	12.6	37.0

Source: *Compiled by the authors from national and regional statistics reports*

In terms of grain production per capita in 2007, the highest rate was observed in Tigrai Region followed by Oromia and Amhara, in that order. The intra-regional patterns of food security status are given as annexes (Annex II – ic, iic and iiic).The results have shown that Wag-Hemera had the highest proportions of food insecure population (38.2%) and (PSNP) beneficiaries (35.9%) in Amhara Region. On the other hand, Awi Zone was observed to have neither food insecure households nor PSNP beneficiaries. In Oromia Region, the zone that had the highest proportion of food insecure population was Borena (15.2%) while West Harerghe registered the highest proportion of PSNP beneficiaries (34.1 %). The lowest proportion of food insecure population (0.2%) was recorded in East Wollega Zone. Similarly, the zone with the highest proportion of food insecure population in Tigrai Region was

Central Zone (12.8%), while the highest proportion of PSNP beneficiaries was recorded in Eastern Zone (59.7%). On the other hand, Southern Zone registered the lowest percentage of food insecure population (9.9%), while in Western Zone there was no PSNP activity.

The above analysis of food security status in the three regions of Ethiopia has shown that food security status in general is low and varies considerably from zone to zone and region to region. This implies the need for food security strategies that can address the problem in each region so as to improve food security level and reduce food security disparities among the zones and regions.

5.1.2 Kenya

Kenya is a low income food deficit country that does not grow enough food to meet the needs of its growing population and lacks sufficient foreign exchange to address the shortfall through imports (UN-WATER, 2006). The agricultural sector in Kenya is characterized by rain-fed subsistence farming and pastoralist livestock production that are vulnerable to unstable rainfall patterns (EC & FAO, 2007). As a result, the food security situation is characterized by seasonal food insecurity in rural areas before the start of the harvest and acute food insecurity primarily due to droughts and/or floods in the semi-arid and arid regions (EC & FIVIMS, 2004 quoted by EC & FAO, 2007). According to a recent assessment by the Government of Kenya and the World Food Programme (2005), "there has been significant deterioration in household food security in most parts of north-eastern Kenya and in farming households in the south-eastern and coastal marginal districts"(ibid).

One of the indicators of vulnerability in the sector is the level of staple food imports, especially maize[11]. Though the country is self-sufficient in maize production during years of good rainfall, the major grain millers and the Government of Kenya import the staple food in most years to make up for domestic production shortfalls. These sources have to be supplemented by

11 Cereals, including maize, sorghum, millets, wheat and rice are the main food crops in Kenya. Maize is normally considered the main staple food.

emergency food assistance from international relief agencies during years of acute drought as happened between 1999 and 2003. During 2003, WFP contributed 60,000 metric tons of maize and around 30,000 metric tons of maize meal to the domestic supply ((UN-WATER, 2006). In addition, a total of 75,000 metric tons of maize were imported through millers from South Africa and other southern African countries to meet local production shortfall. All in all, Kenya imported more than 300,000 metric tons of maize per year in five of the past ten years with the largest volume of maize imports, i.e. 1.1 million metric tons, occurring in 1997.

With over 80 per cent of rural poor people living in higher-potential areas surrounding Lake Victoria and in the Mount Kenya region, population growth, land holding and resource use also play a significant part in determining food availability. Other factors that have contributed to food insecurity especially in the arid and semi-arid areas of Kenya include "… deregulation and commercialization, and increased reliance on the private sector … [that] … have reduced the scope or changed the nature of government interventions on behalf of the poor"(ibid). Another case in point is the increased incidence of communicable diseases such as STDs, TB, typhoid, and malaria as well as HIV/AIDS attributed to low per capita spending on health. The resulting disease burden has reportedly impacted upon the productivity of the agricultural sector which employs over 74% of the country's labor force.

Though much of the food security situation in Kenya may be explained in terms of availability constraints linked with low levels of agricultural performance in previous years, there are other underlying factors that need to be considered to get the whole picture, chief of which include problems of access to food due to inadequate market and transport infrastructure, low income and purchasing power. Irrespective of availability, poverty keeps more than ten million people, representing a third of the total population of Kenya, in a state of chronic hunger (FAO, 2005).

According to official studies, food insecurity has been worsened by rising poverty levels among the population in the 1990s. For example, the Welfare Monitoring

Survey of 1997 indicated that the poverty level rose from 47% in 1994 to 53% in 1997 in the rural areas and from 29% to 49% in urban areas over the same period. Available data also shows continuation of the trend with poverty levels reaching 56% at the national level by the year 2000. Currently, it is estimated that 58% (ibid) of the Kenyan population live below the poverty line.[12]

Available information sources including official reports show that more than 15 million Kenyans cannot meet the minimum of 2,250 kilocalories per day and more than 3 million are in constant need of relief (UN-WATER, 2006). The number of people considered food insecure, i.e. persons unable to get the bare minimum in nutritional requirements, amounts to around 40% of the total population in 2007. The number of malnourished children, a typical indicator of food utilization, is also reported to be very high. As is the case with access to food, indicators of food utilization at the national level mask substantial disparities among rural and urban residents as well as across regions. The findings of the Kenyan 2005/06 KIHBS indicated critical food poverty in urban centers as well as in the Central, Coastal and Eastern provinces. On the other hand, higher levels of food security have been reported for rural areas in the Western, Rift Valley and Nyanza provinces.

5.1.3 Sudan

The staple cereals consumed in Sudan are sorghum and millet while wheat is consumed in the higher income urban areas. Though the per capita supply of basic cereals declined in the drought years of the early 1980s, the trend has stabilized since 1991 through increased production in the rain-fed sub-sectors. In spite of that, the food security situation in Sudan over the last two decades (1985-2005) has often required food aid. Ancute malnutrition rate varying between 19.5%-26% was recorded for the north and 32.4% for the south during the 1997-2001 periods (Sudan FMoH, 2003).

12 Poverty line is conceptualized as a minimum standard required by an individual to fulfill his or her basic food and non-food needs. The absolute poverty line has been set at K.Shs 2, 648 per adult equivalent per month in urban areas and at K.Shs 1,238 per adult equivalent per month in rural areas.

Agricultural sector growth rate has declined from 7.3% in 2002 to 5.2% in 2003 mainly due to the deterioration in the traditional rain-fed agriculture. An additional decline of 4.5% in 2004 was attributed to the poor performance of the mechanized rain-fed agriculture. Moreover, high levels of annual fluctuations mainly due to high rainfall variations characterize the production of cereals in Sudan. This has resulted in high levels of dependence on food aid. Food availability was also enhanced by increasing imports, especially of wheat and wheat-based foodstuffs. Though still comparatively small in terms of volume, rice imports are also on the rise.

In southern Sudan, cereal deficit in the urban and rural areas was projected to reach 84,293 tones in mid-2006, despite increased agricultural production in 2005. Based on food security and nutrition assessments undertaken in 2005, the FAO/WFP Mission estimated that food deficits affected around 6.7 million people, who required emergency food assistance amounting to 800,000 tones of assorted food items. The bulk of vulnerable groups as well as food deficits are indicated for the Greater Darfur Region accounting for about 45 percent of the total beneficiaries and 66 percent of the total food requirements. The requirements for southern Sudan were also substantial taking up around 20 percent of the total food requirements and hosting 31 percent of the total beneficiaries. Though not substantial in comparison with others, eastern Sudan also needed significant amounts of food aid. The amount reserved for other areas of Sudan is in anticipation of possible floods and conflict.

Although the annual average percentage change in per capita income has accelerated since the mid-90s, poverty remains the major source of food insecurity in Sudan with wide disparities between regions, urban and rural areas, and by gender. Moreover, with the possible exception of those directly involved in the oil sector and assistance provided by international organizations for services through the Government of Southern Sudan, income generation opportunities are very limited for the poor. Thus, despite improving the socio-economic context at the national level to produce and import food items, "… the highly skewed income and food distribution within the country and the

problems of physical and financial access to food due to war, displacement, economic isolation and limited purchasing power render millions of vulnerable people dependent on food assistance for their survival" (Guvele, *et al.,* 2003).

During 1993/94-1998/99, the national average calorie intake in Sudan increased from 2202 to 2391 per day, and the protein intake increased from 72 kg/year to 73.5 kg/year. However, the basic indicators of utilization of food in Sudan are very low across the parameters.

5.2 Water supply and irrigation status

The status of irrigation infrastructure, especially in the context of food security, is best assessed in terms of the scope of irrigation-fed agriculture rather than indicators of the forms and scope of physical infrastructure. This approach also has the advantage of accommodating the diversity in terms of size, e.g. small-scale irrigation schemes and large dams, as well as forms, e.g. surface and ground water sources. Moreover, the contribution of the agricultural sector in employment and as a source of income would be relevant in providing national contexts as well as in facilitating comparisons across countries (refer to Table 5.4).

Table 5.4: Irrigation indicators for Nile Basin Countries

Country	% of labor force in the agricultural sector	Total irrigated land ('000 ha)	Total agricultural land ('000 ha)	Irrigated land as % of agricultural land
Burundi	80-90	21	1,355	1.2
DRC	70-75	11	7,800	0.1
Egypt	42	3,291	3,422	100.0
Eritrea	-	21	565	3.7
Ethiopia	81	290	11,769	2.5
Kenya	80-90	103	5,212	2.0
Rwanda	80-90	9	1,470	0.6
Sudan	57	1,863	17,420	10.7
Tanzania	79	184	5,100	3.6
Uganda	78	9	7,350	0.1

Source: *FAO, Aquastat, 2005, and UNDP, Human Development Report 2007-2008*

With the exception of Egypt and Sudan, the agricultural sector provides the substantial bulk of employment for populations in the Nile Basin Region. Even in the two countries with lower proportion of population engaged in agriculture, the figures are still high. In terms of total irrigated land (over 3 million hectares) as well as in the percentage of agricultural land developed through irrigation (100%), Egypt has by far the most extensive irrigation infrastructure in the Nile Basin Region. Sudan has the second largest area of irrigated land accounting for a little more than ten percent of agricultural land in the country. While these figures are very low compared to the scope of irrigation in Egypt, they are still at least three times higher than the figures for the remaining countries which have almost insignificant levels of irrigation and presumably irrigation infrastructure. The lowest figures are reported for the Democratic Republic of Congo and Uganda where only 0.1% of the agricultural lands have been irrigated.

Domestic water supply is indicated in terms of the percentage of population having access to potable water. While this may be taken as access to treated drinking water, indicators of access to 'improved water sources' in the form of protected wells, boreholes, springs and shared public and private standpipes become important. Table 5.5 presents the domestic water supply coverage in the Nile Basin Region.

At the national level, indicators for access to improved water sources are comparatively high across countries with the exception of the Democratic Republic of Congo and Ethiopia. The highest levels of coverage are reported in Egypt with almost comprehensive coverage followed by Burundi, Rwanda and Sudan within five percentage point intervals. The remaining countries have reported levels around the sixty percent mark. However, the national figures mask wide gaps between rural and urban areas in all countries except in Egypt. Indicators for rural areas within countries are consistently low with the gap widening parallel to decreasing national level coverage.

Table 5.5: Water Supply indicators for the Nile Basin Countries

Country	Domestic water supply coverage (%)		Population using improved water source (%)	
	Rural	Urban	1990	2004
Egypt	94	96	94	98
Sudan	64	78	64	70
Kenya	31	87	45	61
Uganda	52	87	44	60
Eritrea	NA	NA	43	60
Tanzania	62	92	46	62
Rwanda	40	60	59	74
Burundi	61	96	69	79
DRC	26	89	43	46

Source: *FAO, Aquastat, 2005, and UNDP, Human Development Report 2007-2008*

Hereunder, the water supply and irrigation status in the three selected Nile riparian countries will be discussed.

5.2.1 Ethiopia

The social and economic circumstances prevailing today have made particular demands upon Ethiopia's water resource base and the environment, and its sustainability is threatened by human-induced activities. Over the years, these demands have intensified with the increase in population and concurrent growth of economic activities requiring water as an input for irrigated agriculture, hydropower generation, livestock keeping, industries, tourism, mining, domestic use, fisheries, wildlife and forestry activities. Water scarcity is perceived at many places due to unreliable rainfall, multiplicity of competing uses, degradation of sources and catchments. Water scarcity threatens food security, energy production, sanitation and environmental integrity and consequently there are water-use conflicts between sectors of the economy. There are also increasing challenges in managing the multiple transboundary watercourses that the country possesses and in strengthening water resources

management policy and legal and institutional frameworks. Inadequate regulations to monitor groundwater resources development has led to underutilization of the resources. Fragmented planning that is implemented following sectoral, regional or local interests aggravates this situation further.

Ethiopia possesses about twelve river basins having an annual surface run-off estimated at 123 billion m^3 and draining a total catchment area of 1,136,816 km^2 (for details refer to Table 5.6). Of the twelve rivers that emanate from Ethiopia, three of them, namely Blue Nile (Abbay), Atbara/Mereb (Tekezzie) and Sobat (Baro-Akobo) are the tributaries of the Main Nile. They account for 32.3% of the country's total catchment area and contribute about 69.8% of the annual volume of water. The most remarkable contribution in terms of volume of water comes from the Blue Nile (Abbay) River. It alone accounts for 43% of the annual flow in the country. About 70-80% of the annual flow of almost all rivers in Ethiopia is attributed to the heavy summer rains that occur between July and September. The ground water potential of the country is also reckoned at 2.6 billion m^3.

Table 5.6: Catchment areas and annual flows of Ethiopia's rivers

Name of the river	Catchment area (km^2)	Annual volume of flow (BCM)
Blue Nile (Abbay)	199,812	52.6
Atbara (Tekezzie/Mereb)	93,700	9.8
Sobat (Baro-Akobo)	74,100	23.2
Awash	112,700	4.6
Genalle-Dawa	171,050	5.8
Omo-Ghibe	78,200	17.9
Wabi Shebelle	200,214	3.1
Afar-Danakil	74,000	0.8
Rift Valley	52,740	5.6
Ogaden	77,100	0.0
Aisha	3,200	0.0
Total	**1,136,816**	**123.4**

Source: *Ethiopian Ministry of Water Resources, 2006/7*

People with access to clean and safe water in Ethiopia was 52.5% in 2007; sanitation services were negligible except in the capital, Addis Ababa and a handful of urban centers. About 5% of the potentially irrigable land of 3.7 million hectares was utilized. Similarly, only 2% of the hydropower potential of the country that is estimated at 30,000 megawatt or 162 GWH has so far been exploited.

In the three case study regions in Ethiopia, some 17,165, 202 people lived in the rural areas of the Amhara Region, 23,125,075 in Oromia and 3,927,135 in Tigrai in 2007. The number of water schemes in the three regions respectively was 16,556, 11,219 and 7,834. Of these schemes, 14% were dysfunctional in Amhara Region, 22.3% in Oromia and 13.6% in Tigrai (refer to Table 5.7). The number of water schemes per 10,000 population ranged between 19 in Tigrai and 5 in Oromia Regions. In the same year, the Amhara Region had 10 water supply schemes for every 10,000 people. Two of the study regions, namely Amhara and Oromia, had less water coverage compared to the national average and Tigrai. In fact, the percent rural population accessed to potable water in the latter (59.5) exceeded the national average (52.5) in 2007 (for details on zonal distribution of water infrastructure in the three case study regions in Ethiopia, refer to Annex II).

Table 5.7: Water facilities and access in the sampled regions in Ethiopia, 2007

Water supply indices	Amhara	Oromia	Tigrai
No. of water schemes	16556	11219	7834
% of dysfunctional water schemes	14.2	22.3	13.6
No. of water schemes/10,000 population	10.0	5.0	19.0
% of rural population accessed to potable water	32.7	30.7	59.5
Irrigated land per capita (m^2)	12.8	10.1	61.8
Irrigated land per capita for beneficiaries (ha)	0.31	0.42	3.27

Source: *prepared by the authors*

In Ethiopia where about 5% of the potentially irrigable land has been developed, the per capita irrigated land in the country and the study regions is

minuscule. In Amhara Region, the per capita irrigated land in 2007 was 0.31 m^2 while in Oromia the figure stood at 0.42 m^2. Such a size indicates, among other things, the limited use of irrigation in the regions. The figure for Tigrai (61.8m^2) was relatively better than the other study regions. When considering the irrigation beneficiaries separately (both individuals and cooperatives), the figure is not that high. It was confined to 0.31 and 0.42 hectares for Amhara and Oromia Regions respectively. Again here as in above, the irrigated land per capita for beneficiaries in Tigrai Region was relatively higher (3.27 ha) than the two sampled regions.

5.2.2 Kenya

The agricultural sector is an important part of the Kenyan economy. It is the main contributor towards household food and nutrition security, the main area of economic activity for the majority of the rural population and the source of 60% of total export earnings (Agricultural Sector Coordination Unit, 2006). Moreover, the sector contributed more than 27% to the national GDP in 2007.

However, the level of irrigated agriculture is very low in the country with only 2% of the potential irrigable land used so far. According to recent reports, an additional 800,000 ha could potentially be irrigated with available water resources in the country if existing management and operation issues are addressed (Annual Water Sector Review, 2008

Irrigation infrastructure in Kenya is generally confined to small scale rural schemes using furrow and basin irrigation that are not water efficient, require a lot of energy to spread the water and also result in high water losses. Currently, there are 26 large dams and about 3,000 small dams and water pans in the country with a storage capacity of approximately 124 million cubic meters. Dams in Kenya are used for a number of purposes which include water supply, hydroelectric power (HEP) and irrigation. Major dams also serve as sources of water supply for larger cities as well as flood control structures. Domestic use constitutes the second largest demand on water resources in Kenya next to

agriculture. However, the existing water infrastructure is insufficient to meet this demand, especially in rural areas where around 70% of the population has not yet been covered.

The most critical challenge for the water sector in Kenya is water scarcity. Kenya is chronically water scarce[13] with a limited natural endowment of fresh water. In addition to the scarcity, Kenya is highly vulnerable to rainfall variability, recurrent droughts and frequent floods. Demand is high and growing rapidly in many sectors of the economy. While drought aggravates the normally dire water scarcity situation, floods also devastate water infrastructure especially in low-lying areas. The overall result of these challenges has been manifested in catchments degradation, drying up of rivers, receding of lake levels, heavy siltation in dams reducing hydropower generation and water supplies; deterioration of water quality; increased water use conflicts due to competition on the available water resources; and damaged roads, railway lines, bridges, buildings and water intakes (UN-WATER, 2006):

5.2.3 Sudan

Irrigation infrastructure in Sudan is dominated by large-scale schemes, which provide water for a sizable proportion of the agricultural land. In fact, in terms of irrigated agricultural land, Sudan has the second most extensive infrastructure coverage in the Nile Basin Region next to Egypt. Still, irrigated land accounts only for 10% of the total agricultural land and a further irrigation potential is reported to be substantial. Table 5.8 lists the major irrigation schemes undertaken by the Sudanese Government. The total irrigated land in Sudan is estimated at 1,863,000 hectares. About half of the irrigated land is occupied by the Gezira and Managil schemes followed by the White Nile pump schemes (10%). The smallest irrigation scheme is Sennar Sugar that used only 0.7% of the irrigated land in the country.

13 Globally, a country is categorized as 'water stressed' if its annual renewable freshwater supplies are between 1,000 and 1,700 cubic meters per capita per annum and 'water scarce' if its renewable freshwater supplies are less than 1,000 cubic meters per capita per annum.

Table 5.8: Government irrigation schemes in Sudan

Schemes	Equipped area (ha)
Geizira and Managil	870,750
White Nile pump schemes	192,375
New Halfa	152,280
Rahad	121,500
Blue Nile pump schemes	112,590
Gash Delta (spate irrigation)	101,250
Northern pump scheme	41,715
Suki pump scheme	35,235
Tokar Delta (spate irrigation)	30,780
Guneid Sugar	15,795
Assalaya Sugar scheme	14,175
Sennar Sugar scheme	12,960
Khashm El Girba scheme	18,225
Other areas	143,370
Total	1,863,000

Source: *Food and Agriculture Organization, Water Profile of Sudan, 2008*

As indicated in Table 5.9, the total amount of water used annually in 2000 was 37,314,000 m^3. The consumption of water in Sudan was dominated by irrigation and livestock which accounted for 96.7% of the annual water use. The second largest user of water was the domestic sector (2.6%) followed by the industrial sector (0.7%).

Table 5.9: Water uses in Sudan, 2000

Water Use	$10^6 m^3/yr$	%
Irrigation + livestock	36,069	96.7
Domestic	987	2.6
Industry	258	0.7
Total	37,314	100

Source: *Food and Agriculture Organization, Water Profile of Sudan, 2008*

5.3 Relationships between water Infrastructure and food security

Water infrastructure, both domestic water supply and irrigation schemes, are inherently ingrained in the conception of food security. The importance of irrigation infrastructure to food security is more direct especially in the context of the agriculture-dominated economies of the Nile Basin countries. Better irrigation infrastructure means more land to cultivate and production cycles free from seasonal rains. These, in turn, could be translated into more food production, more income to buy food and more security from seasonal shocks.

Irrigation infrastructure in the Nile Basin Region is almost exclusively found in Egypt and Sudan with no significant irrigation schemes visible in the other countries. Since these two countries are among the three most food secure or least food insecure within the Region, a positive correlation between irrigation and food security is expected.

Ease of access to potable water has a twofold implication for productivity as an essential component of food availability and access. A community using unsafe water sources is sure to have low health status and subsequently low productivity. Time spent in seeking distant water sources would similarly result in productivity loss. Domestic water supply infrastructure is better developed across the Basin with more than 50% of the population living in eight of the ten riparian states (except Ethiopia and DRC) using improved water sources. However, there are rural-urban disparities in access to improved water sources within most of the Nile countries. The low level of domestic water supply infrastructures in rural areas in most Nile countries has significant impact on agricultural productivity and consequently on food security.

In the following sub-sections, the relationship between water infrastructure and food security will be discussed by considering Ethiopia alone and Kenya and the Sudan together.

5.3.1 Ethiopia

An attempt has been made to see the strength and direction of relationship between a pair of variables representing water infrastructure and food security for the three regions by using bi-variate correlation analysis. The later is by no means meant to indicate causal relationships but rather to identify corresponding relationships. The overall assumptions about the relationships between water infrastructure (both irrigation and domestic use) and food security indices are as follows:

(a) The higher the delivery of water for domestic use, the better will be the food security status and
(b) The higher the irrigated land per capita, the better the food security status. The results of the bi-variate analyses are given in Table 16 and the baseline data is affixed in Annex II.

As can be seen in Table 5.10, some of the bi-variate correlation results have shown conformity and others non-conformity with the direction of the assumed relationships between the pairs of variables. In conformity with the assumptions, inverse relationships have been observed between the following pairs of variables:

(a) Percentage of functional water schemes and food insecure population in two of the sampled regions, namely Oromia and Tigrai,
(b) The number of water schemes/10,000 population and percentage of food insecure population in Oromia Region,
(c) The percentage of rural population accessed to potable water and food insecure population in Oromia and Tigrai Regions and
(d) Irrigated land per capita and percentage food insecure population in Tigrai Region.

Similarly, in tandem with the assumptions, positive relationships have been recorded between the following pairs of variables:

(a) Percent of functional water schemes and per capita grain production in all the three sampled regions,

(b) The density of water schemes and per capita grain production in Amhara Region,

(c) The percent of rural population accessed to potable water and per capita grain production in Amhara and Oromia Regions, and

(d) Irrigated land per capita and per capita grain production in Amhara Region.

Table 5.10: Bi-variate correlation results between water infrastructure and food security indices, Ethiopia

Water infrastructure indices	% food insecure population			Per capita grain production		
	r values			r values		
	Amhara	**Oromia**	**Tigrai**	**Amhara**	**Oromia**	**Tigrai**
% of functional water schemes in a zone	0.99	-0.32	-0.35	0.95	0.20	0.46
The number of water schemes/10,000 population (density)	0.99	-0.44	-0.02	0.95*	-0.16	-0.81
% of rural population accessed to potable water	0.99	-0.29	-0.17	0.94*	0.56	-0.97*
Irrigated land per capita (ha)	0.99	-0.06	-0.83	0.95*	-0.28	-0.22

***** Correlation is significant at 0.01 level of significance

Source: *prepared by the authors*

Conversely, some of the directions of associations between pairs of variables are not in conformity with the assumptions. These include:

(a) The positive relationship exhibited between percentage food insecure population and all the four indices of water infrastructure in Amhara Region; these could possibly be due to measurement problems and data inconsistency,

(b) The inverse relationships recorded between the numbers of water schemes per 10,000 population and per capita grain production in Oromia and Tigrai Regions; irrigated land per capita and per capita grain production

in Oromia and Tigrai Regions; and rural population accessed to potable water and per capita grain production in Tigrai.

These unexpected relationships may probably be attributed to:

(a) Limited number of users of the available improved water schemes,
(b) The incompleteness of the household irrigation package, which falls short of providing other required inputs like improved seeds, fertilizers and effective extension advice.

In terms of the strength of relationships that exist between pairs of variables, the following results are obtained (refer to Table 5.11):

(a) 'very high' correlation values (above 0.94) have been obtained between the four individual water infrastructure indices and per capita grain production in Amhara Region,
(b) 'low' correlation values have been recorded between the percentages of functional water schemes and food insecure population in Oromia (-0.32) and Tigrai (-0.35) Regions; percentages of rural population accessed to potable water and food insecure population in Oromia (-0.29) and Tigrai (-0.17); and
(c) 'medium' correlation values have been obtained between percentages of functional water schemes and per capita grain production in Tigrai (0.46); and between percentage of rural population accessed to potable water and per capita grain production in Oromia (0.56).

Although the relations between water and food security indices vary across regions in Ethiopia, the bi-variate correlation results have in general terms shown that the number of water schemes in a zone has a positive moderate impact on food security in Oromia and Tigrai; the density of water schemes has also some moderate effect on food security in Oromia and the degree of water accessibility to users also has some moderate effect on levels of food security. When irrigated land per capita becomes higher, the number of the food insecure population decreases and vice versa. This shows, among other things, the pivotal role that irrigation agriculture can play in the attainment of food security in the region.

Besides the bi-variate analysis, an attempt has also been made to run multivariate regression analysis to assess the degree to which the two dependent variables, namely percentage of food insecure population and per capita grain production, are explained by a set of independent variables, viz. water infrastructure indices, in the three case study regions. The results of the study as illustrated in Annex II (iv) indicate that 98% of the variations in the percentage of food insecure population in Amhara Region is explained by the variations in the percentage of rural population accessed to potable water and irrigated land per capita. The regression coefficient values do, however, indicate that irrigated land per capita has more relative importance than percentage of food insecure population in explaining food security. In the same region, 92% of the variations in per capita grain production might be explained by percentage of rural population accessed to potable water and irrigated land per capita, with the latter having more influence than the former as indicated in the *beta weight* (regression coefficient) values.

In Oromia Region, a set of four water indices (percentage of rural population accessed to potable water, number of water schemes per 10,000 population, irrigated land per capita for all and for beneficiaries only) may explain about 47% of the variations in the percentage of food insecure population. In terms of relative importance as expressed by the regression coefficients, irrigated land per capita (for beneficiaries only) and number of water schemes per 10,000 population have more weight than the other two in explaining the variations in the percentage of food insecure population in the various zones of Oromia Region. Similarly, the same four water infrastructure indices, namely percentage of rural population accessed to potable water, number of water schemes per 10,000 population, irrigated land per capita (for all) and for beneficiaries only, have explained about half of the variations in percentage of food insecure population. Of these, the number of water schemes per 10,000 population and irrigated land per capita for beneficiaries have a more relative importance than the other two. The residuals in both cases are 53 and 48 percent, implying the existence of some more variables, besides what has

been included here, that can explain the variations in the percentage of food insecure population and per capita grain production, respectively.

Similarly, in Tigrai Region, three independent variables, namely, percentage of rural population accessed to potable water, irrigated land per capita (for all) and for beneficiaries only, might explain about 75% of the variations in the percentage of food insecure population in the zones. In here, the irrigation variable for the beneficiaries has more weight than others in explaining the variations in the percentage of food insecure population in the zones. A residual value of 25% implies the existence of some more variables that can influence the proportion of food insecure population in the region. On the other hand, 92% of the variations in per capita grain production may be explained by the variations in the percentage of rural population accessed to potable water and irrigated land per capita. The former is much more important in explaining the variations in per capita grain production among the zones than the latter.

The empirical study conducted in the context of another project by IDR Staff (Degefa and Tesfaye, 2008) has qualitatively assessed the degree of relationship between water supply and food security at a micro level in the eastern part of Ethiopia, namely East Hararghe Zone, by taking a sample of four villages, of which two had access to water schemes and the other two not. The results of the study have indicated that both sets of communities, i.e. those with and without access to water schemes, believed in the pivotal role water plays in their livelihoods. Almost all of them were of the conviction that lack of access to sufficient water adversely affects the food security status of their households. By the same token, 92% of the households who lack access to water schemes believed that the absence of water makes them vulnerable to drought; 93% attributed water as a factor lowering their agricultural production and productivity and all of them think that the dire search for water consumes their time and energy. Conversely, about 88% of the households who have water schemes in their vicinity asserted that their food security status and livelihoods has improved following water supply

interventions, most particularly in terms of improving the household health situations and in diversifying their sources of income. There were, however, divided responses when it comes to the role of water supply intervention in income increments and improvements in livestock productivity.

Inter-village variations in seasonal food shortages between those that have water schemes and those without have also been considerable. Abut 64% of the community members who have access to water schemes and 86% without water schemes have faced shortages in food items for a specified time of the year. Although the majority of the villagers faced food shortages during the summer, some villagers encountered the problem for half a year. In short, during the main rainy season (July-September) food scarcity is visible across the board in all the villages.

It should also be known that the role of water in food security attainment is subsumed in others, such as agricultural production and productivity and livestock raising. This could be demonstrated by the fact that 68% of the sampled respondents believed that their food insecurity is related to their inability to produce sufficient grains, 54% due to their inability to raise sufficient number of livestock and 45% due to the meager income they obtain from non-farm activities.

The importance of water in the attainment of food security and improvements in livelihoods has been underlined by the small farmers, development agents and health workers in all the study communities. In one of the study communities, the FGD panelists (men) equated 'water with life'. They stated that "people who will have better access to water and irrigation will definitely be food secure". Another informant in the same village stated: "proper land management is unthinkable without the availability of water". Similarly, a development agent from the nearby NGO, affirmed: "the availability of water, most particularly for irrigation, and the attainment of food security are closely intertwined". One elderly informant from one of the study villages also noted: "if NGOs and/or GOs develop water sources for irrigation use, we can produce three to four times a year. Consequently, we will become

not only food secure but net exporters of agricultural products". Similarly, all the informants, including the development agent (DA) in charge of the study village, ascertained the significance of water supply on crop production, product diversification, livestock raising, health improvements and food security.

Given these conditions/situations a good number of the villagers in the four communities suggested the following measures to improve their food insecurity situations: construction of big water supply schemes, expansion of irrigation agriculture, and the development of water points for livestock. Given the strong linkages that exist between water supply and sanitation and food security, the development of water schemes that could be used for multiple uses, namely irrigation, drinking, sanitation and livestock is imperative.

5.3.2 Kenya and Sudan

The correlation between low level of water infrastructure and low status of food security is more apparent in the two selected Nile countries, particularly in Kenya. As discussed in the previous section, the food security situation in Kenya is characterized by seasonal food insecurity in rural areas before the start of the harvest; and, acute food insecurity primarily due to droughts and/or floods in the semi-arid and arid regions. This is mainly a result of the fact that the agricultural sector in the country is characterized by rain-fed subsistence farming with only 2% of the agricultural land being irrigated. Thus, the low level of irrigation infrastructure in Kenya resulted in lower production and availability of food, in particular during drought seasons. It also resulted in low earnings from agricultural activities for the majority of the rural population, which in turn hampered their ability to access adequate food. It is estimated that intensified irrigation can increase agricultural productivity four-fold and, depending on the crops, incomes can be multiplied ten-times (Government of Kenya, 2008b).

In the case of the Sudan, the diverse agricultural sector and agro-ecological zones are potentially capable of producing outputs in excess of the country's

food needs. However, rural environments in Sudan, especially in the north, are plagued by drought while the bulk of the agricultural resources in the south remain unexploited. Moreover, the overall performance of the agricultural sector has been described as less than satisfactory, and generally below the population growth rate due to constraints related to deteriorating infrastructure and drought (IMF, 2002), among other things. Thus, there is significant correlation between the food security status and water infrastructure in Sudan.

The access to improved water sources for domestic use in Kenya is in favor of urban areas and biased against high poverty and low food security provinces. The gap between them is as high as 56 percent. Though the gap is narrower in Sudan than Kenya, the same bias against the peripheries, especially the south and northwest, is clearly observed in access to potable water for domestic use. Here the gap stands at 14%. These marginalized areas are also characterized by lower food security situation than urban and privileged areas in Sudan.

5.4 Health status in the Basin

Health infrastructure typically refers to the physical installations and facilities for the provision of health services such as health centers, clinics, hospitals, pharmacies and voluntary counseling and testing (VCT) centers. However, the concept of infrastructure inherently intersects with the scope, coverage, quality, and accessibility of services for which the installations and facilities are intended. In this context, important aspects of health infrastructure services may include availability of services, accessibility of the services to the intended beneficiaries/targets, adaptability of the services to their needs/priorities, and the quality of services.

Taking into account these parameters, the type and number of health institutions in a country may not always be preferred indicators of the status of 'health infrastructure' for a number of reasons. This is especially true for comparisons across countries since variations among health systems in terms

of quality, structure and nomenclature would pose inherent difficulties.[14] Even where the purpose is limited to profiling a single health system, the number of facilities is not likely to give us meaningful insight in the absence of more quantifiable linkages with the actual or potential service delivery. Thus, more quantifiable indicators such as the overall and per capita levels of expenditure in the health sector and the number of health personnel available per specified number of people are normally used along with the number and profile of health installations and facilities.

Table 5.11 shows the basic expenditure levels and number of qualified personnel to population in the ten Nile Basin countries. Indicators of access to improved water sources have also been included taking into account the linkages with health situation among the national populations. The overall picture emerging from examination of health service indicators for the countries of the Nile Basin Region indicates extremely low infrastructure for most countries. With the exception of Egypt, Uganda and Rwanda, per capita health expenditure in the countries is less than thirty dollars. Similarly, the ratio of physicians to population is extremely low with substantially less than ten physicians for a hundred thousand people in six of the ten countries and less than twenty in all but two. The inevitable conclusion is the very low levels of infrastructure, access and quality of health services in almost all countries in the Region. The following sub-sections will depict the health status in three of the Nile riparian states, namely Ethiopia, Kenya and the Sudan.

14 This does not, however, mean that the profile of health institutions is irrelevant. In fact, the structure of the health system as well as the number of facilities at the different levels may be indicative of priority and emphasis areas in the health sector.

Table 5.11: Health service indicators for the Nile Basin Countries

Country	Public expenditure on health (% of GDP) 2004	Private expenditure on health (% of GDP) 2004	Health expenditure per capita (PPP US$) 2004	Physicians/ 100,000 population (2000-2004)
Egypt	2.2	3.7	258	54
Sudan	1.5	2.6	54	22
Kenya	1.8	2.3	86	14
Uganda	2.5	5.1	135	8
Eritrea	1.8	2.7	27	5
Tanzania	1.7	2.3	29	2
Rwanda	4.3	3.2	126	5
Burundi	0.8	2.4	16	3
Congo (DRC)	1.1	2.9	15	11
Ethiopia	2.7	2.6	21	3

Source: *UNDP, Human Development Report 2007-2008*

5.4.1 Ethiopia

Provision of adequate health service to individuals, families and communities is one of the basic requirements in human development. The study regions in Ethiopia have a limited number of health facilities and personnel relative to their population size. The ratios of health professionals and health facilities to the population for the regions are far below the standard recommended by World Health Organization (WHO). Factors that aggravate poor health status in Ethiopia include widespread poverty, low educational level, especially among women, poor environmental conditions, poor access to safe water and poor organization and management of health institutions. Moreover, the high population growth aggravates the inadequacy of health services.

Currently, the health sector strategy and programs of the country in general focus primarily on preventive and preliminary (basic) curative health service packages. Recently the health sector of the regions and the nation launched health extension services and expanded primary health care units in order to give basic health services for all segments of the population.

Health status and health service are expressed in various ways. The following sections will discuss health status and health service level at zone and region level in Ethiopia. The dimensions of health service status considered in this study are facilities (infrastructure), manpower, and level of service coverage.

Indicators of health status

The health status of the population of the study regions and zones is measured by using various indicators. The major health status indicators at regional level are given in Table 5.12. As shown in the table, there is not much variation in male, female and average life expectancies among the study regions and the nation. They ranged between 52 and 56, which is lower than most developing countries and most of the Sub-Saharan African countries. Another useful indicator of the health status of human population is under-five child mortality. In the study regions, it ranged between 106 in Tigrai and 154 in Amhara Region, the national average being 123. Tigrai seems to show the lowest under-five child mortality rate. The overall health status of the case study regions is low requiring various interventions to improve the situation of specially child and maternal health and wellbeing.

Table 5.12: Major indicators of health status in the study regions, 2007

Health indicators	Amhara	Oromia	Tigrai	National
Average life expectancy at birth (years)	54.7	54.3	53.5	54.4
Male life expectancy at birth (years)	53.4	53.0	52.0	53.4
Female life expectancy at birth (years)	56.0	55.5	54.9	55.4
Infant mortality rate per 1,000 live births	94	76	67	77
Under-five child mortality rate per 1,000 surviving infants	154	122	106	123
Maternal mortality rate per 100,000 live births	NA	70	NA	673♣

Source: *Compiled by the authors from various statistical reports,*

- The data refers to 2004/05

Health workers and facilities in the study regions

There are different health services provided for the populations of the regions. The services are aimed to prevent and heal human diseases and illness, and to educate people in health care. These services are wide in their scope. The major resources required to provide the services are human power and physical infrastructure/facilities. The level or magnitude of health services are also dependent on the availability of, and access to, health education, medicines, and finance. The status of professional health workers and health facilities for the study regions and Ethiopia are discussed hereunder.

(a) Professional health workers

The quantity and quality of health workers is one of the key factors to provide effective and efficient health services. Recently, the government of Ethiopia and the regional governments of the study regions initiated health extension programs to provide health education and advice to families. The number of extension workers is also growing fast.

Table 5.13: Professional health worker to population ratios, 2007

Health worker	Amhara	Oromia	Tigrai	National	WHO
Physician (including general practitioners and specialists) to population ratio	NA	1:290,020	1:106,840	1:35,493	1:10,000
Nurses (of all types) to population ratio	NA	1:14,104	1:3,755	1:4,207	1:5,000
Health extension workers to population ratio	NA	1:7,914	1:4,969	1:8,434	1:4,369

Source: *Compiled by the authors from various statistical reports*

NA= not available

As given in Table 5.13, the ratio of physician to population in Oromia region was 1:290,020, which is significantly lower than the national average of 1:35,493, whereas the WHO standard is 1:10,000. Tigrai region showed the highest physician to population and health extension worker to population ratios.

The distribution of health workers across all the 22 zones and cities (17 zones and five cities) of the Oromia Region was explored. As shown in Annex III, Table 1, Jimma is the zone that recorded the lowest physician to population ratio (1:715,041), the highest physician to population ratio was registered in East Wollega Zone (1:116,230). Arssi recorded the lowest health extension worker to zonal population ratio (1:116,230), while Bale registered the highest health extension to zonal population ratio (1:5,683), implying the availability of a high number of health extension workers relative to its population. Better infrastructure, high level of training of local people in the area of medicine might have contributed to higher number of physicians relative to the population compared to that in other zones. Political attention and other unstudied factors might have contributed to higher number of health extension workers relative to zone population. Factors behind the variable nature of health professional to zone population require close investigation.

Similarly in Tigrai, low physician to zone population ratio (low number of physician relative to population) was registered in Northwestern Zone (1:250,367), while the highest physician to population ratio was recorded in Southern Zone (1:13,734), excluding Mekele Zone (Annex III, Table 2).

Generally, the health workers to population ratio is low and varies from zone to zone in the study regions, requiring strong interventions in terms of medical manpower training at various levels and devising appropriate incentive systems to curb brain-drain. Involvement of private investment in training institutions needs encouragement by also taking the quality of training into account.

(b) Health facilities

The other important dimension of health service status is the availability of sufficient number of health facilities/infrastructure (hospitals, health centers, health posts, and drug outlets) to deliver health services to all people efficiently. The assumption is that the higher the number of health facilities, i.e. the higher a health facility to population ratio, the higher would be the access of people to health services with improved opportunity of better health status and food utilization. Table 20 shows health facility to population ratios in

the study regions. Health center to population ratio in Oromia in 2007 was 1:140,625, while it was 1:25,000 at national (Ethiopia) level. For Amhara and Tigrai regions, health center to population ratio was 1:116,119 and 1:104,355, respectively. Tigrai Region seems to register relatively better health center to population distribution ratio than that in Amhara and Oromia Regions. Hospital to population ratio at zone level was on average 1: 1, 1687, 500, in Oromia, 1:3,924,827 in Amhara Region, 1:897,452 of Tigrai Region and 1: 1, 000, 000 at national level. Tigrai Region seems to have better zone hospital to population ratio compared to that at national level, Amhara and Oromia Regions. Tigrai has lowest population than Oromia and Amhara Regions.

Assessment of health center to population ratios in Amhara Region showed that West Gojam has the lowest ratio **(**1:175,996), indicating the low number of health centers in relation to the population (refer to Annex III, Table 3). North Shewa registered the highest health center to population ratio, showing a relatively better number of health centers in relation to the population size. With regard to distribution of health center to population in Oromia zones, it is found that the lowest ratio is observed in West Hararghe (1:196,258), the highest being in Bale zone (1:82,043). The distribution is of course related to the population size, in which case the population in Bale zone is relatively small (Annex III, Table 4). In Tigrai Region, the lowest health center to population ratio was registered in Northwestern zone (1:125,183) (Annex III, Table 5), while the highest ratio was recorded in Western zone (1:55,613).

Table 5.14: Health facilities to population ratios, 2007

Facility	Amhara	Oromia	Tigrai	National
Referral hospital	1:9,812,067 (2)	NA	NA	1:5, 000, 000
Zonal hospital	1:3,924,827 (5)	1: 1, 687, 500 (20)	1:897,452 (5)	1:1, 000, 000
District hospital	1:1,962,413 (10)	1:4, 500, 000 (11)	1:641,037 (7)	1:250,000
Health center	1:116,119 (169)	1: 140, 625 (197)	1:104,355 (43)	1: 25, 000
Clinics	1:51,643 (380)	1:17,666 (1,576)	1:97,549 (46)	-----
Health post	1:8,190 (2,396)	1:17, 164 (1,573)	1:10,761 (417)	1: 5,000

Source: *Compiled by the authors from various statistical reports*

Note: Figures in brackets are number of the facilities in the region

NA= not available

Generally, the health facility to population ratio is low; i.e. one health facility is to serve a very large population. The distribution of health facility to population ratios varies from zone to zone in each region. These results imply the need to give greater attention to increasing health facilities, taking the disparity among zones into consideration.

Drug retail outlets

Economic and physical access to drug stores is an important indicator of health services. The drug outlets include pharmacies, drug shops and rural drug vendors. Tigrai Region possessed more pharmacies (106) than Amhara (28) and Oromia (42) in 2007. More drug shops were found in Oromia (143) than in Amhara (69) and Tigrai (129). In terms of rural drug vendors, Oromia had the highest number (1117) compared to Amhara (221) and Tigrai (192). Immense effort is needed to raise the number of drug outlets in the country in general and in the study regions and zones in particular.

Level of major health services

Family planning and maternal health related services are very important and basic to the health development of adults. The level of the services in the

study regions is presented in Table 5.15. In measuring the level of services, the percentage of the service receivers to regional or zonal population, as the case may be, was computed in order to get estimates on the extent of health services. The health services considered in this study are:

(i) Antenatal care (ANC) provided to pregnant women who attended the service at least once during pregnancy;
(ii) Postnatal care (PNC),
(iii) Family planning (FP) service, and
(iv) Deliveries attended by skilled health personnel. As shown in Table 5.15, Tigrai leads in the level of the services rendered, followed by Amhara and Oromia in that order.

Table 5.15: Antenatal, postnatal and family planning services delivered, 2007

Service	Amhara	Oromia	Tigrai	National Level
Antenatal care (ANC)- care provided to pregnant women who attended at least once during pregnancy, % of total population	1.9	1.5 %	3.3	1.9
Deliveries attended by skilled health personnel, % of total population	0.4	0.4	1.2	0.6
Postnatal care (PNC), % of total population	0.8	0.4	1.5	0.7
Family planning service coverage, % of total population	9.1	5.2	16.0	6.6

Source*: Compiled by the authors from various statistical reports*

Intra-regional distribution of the major health services considered was also explored. In Amhara Region, North Shewa leads in FP service level (13.0%), East Gojam in ANC (2.5 %), Oromia zone in PNC (1.2 %), North Shewa and Wag-Hemera in deliveries attended by skilled personnel (0.7 %), excluding Bahir Dar that registered the highest level (1.1 %), for it is the capital city of the region (Annex III, Table 6). In Oromia Region, Kelem Wollega leads in FP service level **(**10.6%), East Shewa in ANC (2.4%), Bale in PNC (0.9%),

and East Shewa in deliveries attended by skilled personnel (0.9 %) (Annex III, Table 7). Similarly in Tigrai Region, Central zone in FP (21.6), ANC (4.0 %), PNC (1.8 %) and deliveries attended by skilled personnel (1.4 %), excluding Mekele which has registered the highest level (1.8 %) of deliveries attended by skilled personnel, for it is the capital city of the region with higher degree of access to health facilities (Annex III, Table 8).

The health services provided vary from region to region and from zone to zone, pointing out the disparity in the service level. This again calls for extra effort needed to expand the scope and level of health services provided in each region and zone. The inequality in the service level also requires more attention.

5.4.2 Kenya

Kenya's health service indicators place it among the comparatively higher levels of access and quality within the Nile Basin countries. It stands fourth in per capita expenditure and third in physicians per 100,000 people. More recent official figures released by the Kenyan Government indicate further improvements in the ratio of physicians to population ratio. It stands at 16 physicians per 100,000 population and 153 nurses per 100,000 population totaling a workforce density of 169 per 100,000 in 2008 against the World Health Organization (WHO) recommended health worker population standard of 228 per 100,000 population (Government of Kenya, 2008a). According to the report, the physicians to population ratios vary between 1:20,715 in Central Province to 1:120,823 in the North Eastern Province (Society for International Development, 2004).

The Kenyan health system is composed of community health institutions (level 1), primarily health care (levels 2 & 3), general hospitals (level 4) and referral and teaching hospitals (levels 5 & 6). The emphasis, at least at the policy level, is on the first and second levels. The actual number of facilities is provided in Table 5.16. The total number of health facilities in the country was 5170, of which major and sub-district hospitals accounted for 5%, health centers and

clinics for 47% and dispesnsaries for 44%. About 44% and 41% of the health facilities were owned by private and public institutions respectively. Similarly, NGOs and Missions had a share of 15% of the health facilities.

Table 5.16: Kenya's health facilities by type and responsible agencies (2005-2006)

	Hospi-tals	Sub-District Hospi-tals	Health centers	Disp.	Nursing Home	Clinics	VCT Centers	Total facilities	% total facilities
Gov-ernment	85	73	459	1503	0	0		2120	41%
NGO/ Mission	74	0	172	546	0	0		792	15%
Private	68	0	21	203	191	1734	41	2258	44%
Grand Total	227	73	652	2252	191	1734	41	5170	100%
% Total	4%	1%	13%	44%	4%	34%	1%	100%	

Source: *SAM, Kenya 2004 and HMIS 2005 and 2006*

The latest figures indicate that the Government of Kenya allocated 8 percent of the total government expenditures or 1.7 percent of the GDP amounting to US$ 10.9 per capita to the health sector. This does not compare favorably with the US$ 34 per capita expenditure recommended by the WHO for developing countries and the commitment of African governments in the Abuja Declaration to allocate 15 percent of their annual spending on health care.

Moreover, health services are still not accessible to the majority of Kenyans due to the prevalence of poverty. According to the Household Health Expenditure Report of 2003, 44 per cent of the Kenyans who fell sick did not seek care due to lack of money and 60 percent of births in Kenya take place outside health facilities (ibid). Regional disparities in coverage are also reported to be high with urban areas, where only 20% of the population lives, accounting for 70% of health care expenditure.

5.4.3 Sudan

Cumulatively considered, the National Health Service indicators for Sudan are the second highest within the Nile Basin Region next to Egypt and are reported to be favorable by sub-Saharan standards. In addition, existing sources indicate that there are about 11,000 physicians,[15] 18,000 nurses, 6,000 medical assistants, about 7,000 other paramedical staff, and 9,300 trained midwives working in Sudan in 2003 adding up to a total of 51,300 health personnel.[16] The physicians, dentists and nurses per 100,000 population in 2004 were 55, 8, 2 and 84 respectively (WHO, 2008).

The above-stated national picture masks wide disparities in the geographic distribution of human resources for the health sector within the country. For instance, compared to more than 48 physicians per 100,000 population in Khartoum, there are 1-6 physicians in Darfur and Kordofan.

The health care system operational in north Sudan is a three-tiered network composed of primary health care, secondary/rural hospitals, and tertiary hospitals. Primary services are provided by primary health care (PHC) units, dressing stations, dispensaries, and health centers. The first three primary health care institutions are staffed by Community Health Workers (CHWs), a nurse or "uncertified dresser," a medical assistant, a nurse, and a midwife respectively. The health center, which is the referral point for the lower-level facilities, is staffed by physicians, medical assistants, and nurses and equipped with a laboratory and x-ray facilities. Secondary or first-referral level hospitals are rural hospitals with inpatient capacities of 50 to 100. Tertiary hospitals, which include teaching, specialized, and general hospitals, form the highest tier in the health care system.

In southern Sudan, the 1998-99 SPLM health policy provides for a three-tiered system composed of fixed and mobile PHC units, health centers, and rural hospitals, and allows for the establishment of one tertiary hospital (World Bank, 2003). Though the SSGO has established health authorities, these

15 Although 16,000 physicians are registered with the Medical Council, about 5,000 are working in Sudan (with most of the remainder apparently working abroad).

16 Taking the estimated 33.61 million population for the same year, the health worker – population ratio would be around 1:655 or 153:100,000 against the World Health Organisation (WHO) recommended health worker population standard of 228 per 100,000.

facilities are administered and supported for the most part by UN agencies, international NGOs, and church groups.

According to the Sudanese Government Health report (2007), the number of health centers grew from 964 in 2003 to 1397 in 2007, while the number of primary health units increased from 2401 in 2003 to 2744 in 2007. However, the number of dispensaries declined 1612 in 2003 to 1224 in 2007 (refer to Table 5.17).

Table 5.17: Sudan-Health Units Development (2003-2007)

Health Units	2003	2004	2005	20006	2007
No. of Beds	23976	24785	2694	26577	27467
No. of Health Centers	964	1009	1043	1202	1397
No. of Dispensaries	1612	1423	1226	1385	1224
No. of Dispensary Stations	1129	771	762	935	207
No. of Primary Health Units	2401	2679	3044	2592	2744
No. of Blood Banks	58	69	93	122	137
No. of X. Ray Units	105	111	144	166	164

Source: *Federal Ministry of Health, 2007*

5.5 Relationships between health infrastructure and food security

The status of health facilities and services, especially primary health care, may impact on food security at various levels. On the one hand, access to health services is a crucial factor in enhancing and sustaining the capabilities of individuals and communities to produce, access, and utilize food by improving health status. In this sense health infrastructure services may be considered essential pre-requisites for food security. On the other hand, health services are key components of interventions in addressing the manifestations of food insecurity such as malnutrition, communicable diseases and restoring a food secure community. In fact, this is part of the reason most indicators of food insecurity such as stunting in children also serve as health indicators and vice-versa.

Taking into account the influence of other relevant determinants, there is a discernible correlation between indicators of health infrastructure and indicators of food security. The five comparatively more food secure countries in the Region are also the ones with the higher per capita expenditure on health. Four among the same group of countries also have the highest physician – population ratio. At the other end of the spectrum, CDR and Burundi, countries with the least per capita expenditure on health, are among the three most food insecure countries in terms of incidence of malnutrition. The following sub-sections will discuss the findings related to the relationships between health infrastructure and food security in Ethiopia, Kenya and the Sudan.

5.5.1 Ethiopia

As indicated earlier, the argument of this study is that health status and food security status of individuals/household members influence each other. Good health conditions of individuals enhance motivation, productivity and efficiency of productive labor. Adequate health service is instrumental to improve the health status of individuals and households. Thus, health services, improved health status of individuals, enhance food security. Relations of level of health services and food security of populations of a region or sub-region are examined in this section. The initial relation diagnosis is a bi-variate correlation analysis in order to assess the strength and direction of the correlations of health service indices and the food security level of a population. The correlation analysis is a partial measuring of the degree of association between two variables and does not have predicting value. The correlation analysis was therefore followed by linear regression analysis of food security (dependent variable) and health service indices (independent variables) in order to examine the predicting power of health service on the food security stsatus of a population, given that other conditions are the same. All zones in each region were considered for both bi-variate correlation and multivariate regression analysis. The regression analysis was conducted first by testing the collinearity of the independent variables, and then avoiding

the independent variables that are strongly and linearly correlated with other independent variables for each region.

The results of the bi-variate correlation analysis of health service indices and food security level measured in two indicators (percent of food insecure population and grain production per capita) for each study region are given in Annex III, Tables 9, 10 and 11). The results of the correlations analysis indicated some significant correlations among food security indicators and health service indices.

As shown in Annex III, Table 9, the two health service indices in Amhara Region, i.e. deliveries attended by professional personnel and health post coverage, significantly and strongly correlated with the percentage of food insecure population and per capita grain production. Deliveries attended showed positive relation with the percentage of food insecure population. This could prosbably be due to increased skilled attendance of deliveries that may enhance family size, in turn, increases food shortage. But the same variable is positively correlated with per capita grain production. On the other hand, health post coverage is negatively correlated with proportion of food insecure population, implying that the higher the health post service, the lower the proportion of food insecure population. However, the same variable is strongly and negatively correlated with per capita grain production. This could probably be related to better access to health posts that may have a positive effect on family size, thus reducing per capita grain production.

For Oromia Region, family planning is found to be negatively correlated with proportion of food insecure population. It implies that the higher the family planning service, the lower would be the proportion of food insecure population. Family planning is positively correlated with per capita grain production, albeit insignificantly. Family planning is an important measure that contributes to better productivity and sparing resources for use in productive activities. Family planning also helps in reducing subsistence pressure by limiting family size, contributing positively to food security. Antenatal care coverage is also found to be positively and significantly correlated with per

capita production, while it is negatively correlated with proportion of food insecure population, though insignificantly.

The result may imply that in areas or zones where better antenatal care services are available, the per capita grain availability is relatively high. These health care services may indirectly support higher per capita grain production in the region. Though some expected relations between some of the health service indices and food security indicators are observed, the relations are weak and statistically insignificant. These include health post coverage and deliveries attended by skilled health personnel (Annex III, Table 10).

In the case of Tigrai Region, postnatal care and health post coverage have shown strong and positive correlations with per capita grain production, showing the indirect positive effect of both health services on food security via their contribution to labor productivity and efficiency The other health service indicators have shown unexpectedly contrary relations to assumed ones (Annex III, Table 11).

The regression analyses conducted for each region showed that the regression equations have high R^2 and a few significant coefficients, probably as a consequence of multi-collinearity problems, although some of the strongly correlated independent variables were excluded from the regression models. The limited or censored nature of both the dependent and independent variables (all are percent points) and small sizes of samples (zones) in each region might have caused multi-collinearity problems in some of the health indices.

In Amhara region, deliveries attended by skilled health personnel are positively related with the percentage of food insecure population with a 10 % significance level. Contrary to expectations, the direction turned out to be positive as was also observed in the bi-variate analysis results. This could be probably associated with high family size that might have come as a result of improved access to skilled health personnel. In the same region, health post coverage has shown the expected negative relation with the percentage of food insecure population at a significance level of 11 % corroborating with the result of bi-variate analysis. Family planning,

ANC and PNC have the expected signs for the coefficients but at statistically insignificant levels. The same explanatory variables were also examined with grain production per capita, as a proxy indicator of food security. In this regression analysis, deliveries with skilled health personnel were found to be positively and significantly related to per capita grain production, again corresponding with the positive bi-variate relation reported earlier. The remaining health service indices considered were not found to be statistically significant, though the direction of relations was unexpectedly negative (refer to Annex III, Table 12).

The significant and positive effect of deliveries attended with skilled personnel on food security (per capita grain production) could be due to the important role the service (skilled attendance) plays in minimizing problems related to maternal health, thus sparing time and money for production activities.

The multivariate regression analysis conducted for Oromia Region showed that only family planning index was found to be negatively and significantly related to the percentage of food insecure population, matching with the result of the bi-variate correlation. The result implies that the higher the service level, the lower will be the percentage of food insecure population. This is probably because households with better access to the service take care of maternal health and bear less subsistence pressure. The other health service indices are not statistically significant. The regression analysis of the same health service indices with per capita grain production did not result in any significant coefficients, except antenatal care which was significant at less than 12 % level. This variable was also observed to have positive and strong correlation with per capita grain production (see Annex III, Table 13).

In Tigrai Region, the regression analysis did not produce any significant and meaningful regression coefficients. The coefficient of determination for the regression equation (R^2) unusually showed 100% value. Further multi-colinearity diagnostics also pointed out the prevalence of multi-colinearity, leading us to have regression analysis with one independent variable, physician to population ratio, (R^2 being 44.3%) which is not significant, though the direction of the relation is positive (refer to Annex III, Table 14).

5.5.2 Kenya and Sudan

The status of health facilities and services, especially primary health care, may impact on food security at various levels. On the one hand, access to health services is a crucial factor in enhancing and sustaining the capabilities of individuals and communities to produce, access, and utilize food by improving health status. In this sense, health infrastructure services may be considered essential pre-requisites for food security. On the other hand, health services are key components of interventions in addressing the manifestations of food insecurity such as malnutrition, communicable diseases and restoring a food secure community. In fact, this is part of the reason most indicators of food insecurity such as stunting in children also serve as health indicators and vice-versa.

Taking into account the influence of other relevant determinants, there is a discernable correlation between indicators of health infrastructure and indicators of food security. The five comparatively more food secure countries in the Basin are also the ones with the higher per capita expenditure on health. Four among the same group of countries also have the highest physician – population ratio. At the other end of the spectrum, DRC and Burundi, countries with the least per capita expenditure on health are among the three most food insecure countries in terms of incidence of malnutrition. This however does not seem to be applicable with comparable consistency in every case. For instance, Eritrea ranks last within the Basin in terms of food security despite spending more on health per capita than DRC, Burundi and Ethiopia.

Health infrastructure services in the two countries selected share two major characteristics to varying extents: sub-national disparities and focus on higher-tier structures in coverage and expenditure. In Kenya, the location of health facilities and expenditure on the health sector disproportionately favor urban centers at the expense of rural areas. Health infrastructure expenditure also appears to favor the highest tier as could be implied from the existence of four times as many (specialized) hospitals as there are sub-district hospitals.

The health system in Sudan is similarly skewed towards the general geographic center of the country with the peripheral/boundary states receiving very low coverage. A pronounced shift of expenditure focus from primary health care towards general, referral and teaching hospitals is also evident.

The characteristics of the health systems in Kenya and Sudan have had direct correlations with the profiles of poverty and food insecurity within the countries. In Kenya, rural poverty stands at 49.1 percent compared to 38.8 percent in urban centers. The incidence of rural poverty also varies among the provinces. For instance, poverty in the North Eastern province (74.0 %) is much higher than in Central province (30.3 %). In Sudan, on the other hand, the same areas missing out on health infrastructure services including Darfur, the South, the three areas, and the East host the poorest communities in the world in contrast to the central and northern states with very high rates of development. While the role of other related factors should not be overlooked, the fact that these areas are chronically food insecure indicates a perceived correlation between health infrastructure services and food security.

5.6 Existing policy on water infrastructure

Although water sector policies vary from one country to another, there are some common denominators that are shared by all, most particularly in developing countries. In general, water policies possess or address:

(a) Cross-sectoral interests in water and watershed management,
(b) The issue of sustainable development in the management of water resources,
(c) The prioritization of water uses so as to ensure that socio-economic activities and the environment receive their adequate share,
(d) Sustainable water use, conservation and ground water resources development,
(e) The protection of the environment, ecological system and biodiversity,
(f) Water resources assessment, planning and development procedures,
(g) The correct and timely availability of data and information for design,

construction and operation of different projects,

(g) Research and technical development aimed at increasing knowledge, information and communication between community and resource users,

(h) Capacity building geared towards implementation of different water resources activities,

(i) Disaster management through flood and drought management plans,

(j) Transboundary water resource shares and usage,

(k) Institutional framework that can bring effective management of water resources,

(l) Legal and regulatory framework for water resources management, and

(m) The financing of water resources management.

Water policies should also include the following four main objectives:

(i) Ensure the availability of water to all elements of society, including the poor and the underprivileged, and to take into account the particular needs of women and children,

(ii) Develop a legal and regulatory environment that will help the process of decentralization and sound environmental management that will improve the investment climate for the private sector in water development and management,

(iii) Bring institutional changes that will help decentralize the management of water resources and enhance the role of women in water development, and

(iv) Develop a state of knowledge and capability that will enable the country to design future water resources management plans by itself with economic efficiency, gender equity, social justice and environmental awareness.

The Ethiopian Water Resources Management Policy (WRMP) was issued in 1999. It contains two sections addressing three sub-sectoral issues, namely, water supply and sanitation (WSS), irrigation and hydropower. The overall goal of the policy is to 'enhance and promote all national efforts towards the efficient, equitable and optimum utilization of the available water resources

of the country for significant socio-economic development on a sustainable basis. The policy is developed giving due attention to general, cross-cutting and sectoral issues. Inland water transportation, aquatic resources and tourism and recreation issues have been addressed under the general aspects of the policy. Issues related to water allocation and apportionment; environment; watershed management; water resources protection and conservation; technology and engineering; water resources management information systems; monitoring, assessment and auditing; water cost and pricing (economics of water); ground water resources; disasters, emergencies and public safety; transboundary waters; gender; research and development; water quality management, and enabling environment have been dealt with under the umbrella of cross-cutting issues. The sectoral part of the policy discusses specific issues in areas of WSS, irrigation and hydropower.

The policy has also recognized the disadvantaged groups of the population by stating that 'although all water resources development ought to be based on the economic value of water, the provision of water supply services to the underprivileged sectors of the population shall be ensured based on a special social strategy'. The most important role of water valuation relates to demand management and better allocation of water among the various uses. The value of water depends on its quantity, quality, location, access, reliability and time of availability. Valuing water is linking the concern that water uses must be able to meet different social, economic and environmental functions. Priority in water allocation is given to human and animal consumption, followed by irrigation.

The main actors in irrigation development are also identified as farmers, cooperatives and other relevant bodies who should have strong participation in plan setting, study, implementation, operation and maintenance. Besides, governmental and non-governmental organizations are also identified as important stakeholders who can be involved in bulk water storage and transfer schemes. With regard to financing the development of irrigation schemes, the policy suggests to establish norms and procedures for financing sustainability

and viability of the schemes by promoting credit facilities and bank loans. The hydropower development policy has also been put as an integral part of the WRMP. Its overall objective is to 'enhance efficient and sustainable development of the water resources and meet the national energy demands as well as cater for external markets to earn foreign exchange'.

The Ethiopian Water Sector Strategy is taken as an instrument to translate the Ethiopian WRMP into action. Put another way, the Strategy aims at providing a road map to attain the water policy objectives. The goals and guiding principles are more or less the same with the policy. The strategy has, however, set guidelines on how to make a meaningful contribution towards improving the living standards and the general socio-economic wellbeing of the Ethiopian people. The Strategy is elaborated in four sub-sectors, namely, water resources, hydropower development, water supply and sanitation, and irrigation.

Following the issuance of the WRMP and the development of the Strategy, the MoWR embarked upon the preparation of the Water Sector Development Programme (WSDP), which was published in 2002. The Ethiopian government has developed a 15 year WSDP spanning from 2002 to 2016. Having fully realized the inadequacy of supplying clean water to the population and its implications for the various dimensions of social and economic developments, the government is considering supplying adequate clean water in the plan period. The provision of clean water is expected to improve the health conditions of people and to release labor for productive engagement, especially the female population who spend a lot of their time on fetching water for domestic use. The 15-year WSDP (2002-2016) has three main sub-sectoral development programs, namely, water supply and sewerage, irrigation and drainage, and hydropower development.

In general terms, the Ethiopian WRMP addresses almost all pertinent issues related to water by calling for an integrated approach; the incorporation of cross-sectoral interests; the special treatment of women, the disadvantaged, the underprivileged and rural communities; the participation of the private sector; a decentralized approach (rural-centered); prioritization of water uses; and the adoption of a basin approach. Although the private sector has been

mentioned here and there in the Ethiopian water policy document, it failed to be robust enough to attract and involve the sector. Implicitly, it seems that the policy is inclined to sustain the status quo under which the state will serve as the sole investor, implementer and manager of water projects in the country. Any future water policy should, therefore, attempt to switch the government's role from service provider to that of coordination, guidance, formulation and regulation.

Given the vulnerability of Ethiopia to natural disasters (e.g., drought, flood), the policy document underlined the recognition and adoption of the management of disasters associated with water. However, the policy failed to mention social disasters, such as wars, inter-ethnic conflicts, epidemics and sudden changes in market conditions that can equally require water-related interventions, for example, by way of water tariff adjustment, provision of water and sanitation for war victims and the displaced.

Although the policy has in many instances raised the issue of harmonizing water and environment, the strategy on the contrary stated: 'reclaim existing wetlands and prevent the formation of new ones'. Since wetlands serve as sanctuaries to specific types of flora and fauna and since a sizeable number of people earn their livelihood from them, the measure suggested in the strategy could do social and environmental injustice to those who depend on it. This should be taken care of while revising the strategy or promulgating a new one.

Notwithstanding the plans, achievements and challenges of the water sector policy, strategy and programs, it is still possible to raise some points that could be accommodated while revising the policy or producing a new one.

(i) It is time to anchor a water policy in a sustainable livelihoods (SL) perspective, which provides a framework within which the needs and priorities of the poor, the rural population, women and the disadvantaged could be protected by a water resource-based policy. SL is geared to support livelihoods by addressing poverty. Put another way, the vision should be grounded on sustainable development, aiming to provide 'a better quality of life for everyone, now and for generations to come'.

The application of the SL approach can meet four objectives at the same time:

(a) Social progress which recognizes the needs of everyone,
(b) Effective protection of the environment,
(c) Prudent use of natural resources, including water, and
(d) Maintenance of high and stable levels of economic growth.

(ii) The development of water policies and institutional challenges needs to be seen within the wider social and political context of contemporary Ethiopia. Of critical importance are the moves towards decentralization and democratization as there has to be effective participation and a meaningful link between local communities and government agencies. In a way, the policy needs to treat access to a safe and adequate supply of water for all people, urban as well as rural, as a human rights issue.

(iii) Given the fact that there is recurrent drought and an emerging natural disaster in Ethiopia, namely, flood, future water policy should give room to and sufficiently address these events. These natural events should, at least in the context of Ethiopia, serve as policy drives. Such a focus is important in three ways: Firstly, the natural events set the priority: for example, the floods that were recently evidenced in Dire Dawa, the southern parts of Ethiopia, and in and around Lake Tana area signify that water management becomes equated with flood control as the first priority even where other issues become important. Secondly, they dictate the timing: policy changes can and do happen extremely rapidly in such circumstances, with the urgency of the situation perhaps being used to legitimize less than satisfactory consultation processes. Thirdly, the events can greatly raise the profile of issues that have not been widely considered or seen as a low priority.

(iv) In order to reduce overlaps of responsibilities between sectoral policies and strategies, an integrated water resources management (IWRM) should be put in place. Such a framework promotes the integration of all aspects of water resources in the country by reducing duplication of efforts and wastage of human and material resources. IWRM can also reinforce

joint planning and coordination, institutional harmony and efficient information and resource flows in the water sector.

(v) What has been achieved so far in the water sector is at variance with what has been envisaged by PASDEP, most particularly in the realm of water supply coverage. Given this state of affairs, efforts should be made to come up with plans that are realistic and less ambitious. Plans should take into account the available manpower, budget, infrastructure and the objective conditions in the country and the regional states.

Kenya's National Water Policy was issued in 1999 and the New Water Act in 2002. The latter was enacted to tackle the worsening water services experienced over the earlier decades. This step has given poverty reduction in Kenya a new possibility. The Water Act enabled the establishment of an autonomous Water Resources Management Authority, destined to manage and protect resources. It also shaped an institutional framework that gave responsibility for providing decentralized services to seven regional Water Boards (WSB). These Boards manage water service assets and ensure that they remain in the public realm. An essential aspect of the reform outlined in the Water Act is the separation of water and sanitation from the management of resources. Overall supervision of water services has consequently been transferred to the Water Services Regulatory Board (WSRD), an organ in charge of regulating the services supplied by the regional Boards and their providers. Simultaneously, representatives for the new Area Catchments Advisory Committees are being selected and the Water Users Associations are being encouraged to define their new roles.

The political determination for structural change of water management in Kenya has been manifested when the government developed national Integrated Water Resources Management and Water Efficiency strategies and plans – set off at the 2002 World Summit for Sustainable Development in Johannesburg. This links directly with the six priority issues in Kenya's efforts towards achieving the Millennium Development Goals (MDGs) – food security, unemployment, gender, water, sanitation and infrastructure.

5.7 Existing policies on health infrastructure

Provision of adequate health service to individuals, families and communities is one of the basic requirements of human development. The scope, level and quality of health services in the three case study countries of the Nile Basin, namely, Ethiopia, Kenya and Sudan, is very limited. The ratios of health professionals and health facilities to population and the level of health services in the countries are far below the standard recommended by the World Health Organization (WHO). Factors that aggravate poor health status in these countries include widespread poverty, low educational level (especially among women), poor environmental conditions, low access to safe water, and poor organization and management of health institutions. Moreover, the high population growth in the three countries aggravates the inadequacy of health services. The existing health policies of the aforementioned case study countries are briefly presented in this section.

(a) Contexts

The current health policy in Ethiopia was issued, taking the malfunctioning health system of the country into consideration. The health status of Ethiopian people is very poor compared to other low-income countries. The major causes of morbidity and mortality in Ethiopia are infectious diseases that are potentially preventable and nutritional deficiencies. Low socio-economic status, inadequate access to clean water and sanitation facilities and poor access to health services have contributed to high level of burden of ill health.

The national health policy in Sudan was formulated in 2005 in the context of a post- conflict comprehensive peace agreement and the growing revenue from oil that provided opportunities for alleviating sufferings. The existing health policy of Kenya was issued in 1994 by the Kenyan government in view of the increasing population and the growing demand for health care that outstripped the government's ability to provide effective services.

(b) Vision and mission

All the three case study Nile countries have common vision and mission for their health policies. The health policies envision the building up of a healthy nation thereby contributing to the achievement of the overall social and economic development of the countries and the Millennium Development Goals (MDGs). The mission of the policies in the three countries is envisaged to ensure the provision of healthcare to all citizens, with emphasis on the healthcare needs of the poor, the disadvantaged and vulnerable that can enable them to lead socially and economically productive lives.

(c) Principles and values

The national health policies of the three case-study countries are issued with the intent to achieve equity, reduce poverty, increase investments in health, attain the Millennium Development goals, maintain and secure human rights and dignity, preserve the rights of children and women and fight diseases and ignorance. Health is central to the human development and a social right of all citizens irrespective of regional, racial, cultural and ethnic origins and diversities.

The health system is planned in such a way that it will be built on the principles of comprehensive concept of health, attention to health promotion, quality improvement and client satisfaction, accountability, equity, accessibility, affordability, appropriateness, efficiency, effectiveness, transparency, inter-sectoral collaboration, community participation, innovation, work values and ethics, gender mainstreaming and teamwork.

(d) Policy directives and measures

In order to ameliorate the health problems of the countries, the governments have issued principal policy directives and implementation strategies. For instance, the Health Sector Strategy of Ethiopia emphasizes the expansion of primary health care (PHC). Within the framework of the twenty years' strategic framework, the initial five-year plan of the health development programme focused on meeting three principal objectives:

(i) Improving the coverage and quality of health service,

(ii) Empowering the regional, zonal and local level health institutions in the implementation and management of plans, and

(iii) Maintaining financial sustainability for the service deliveries. The pluralistic healthcare system of Ethiopia comprises different public, private and NGO healthcare providers and financing agencies. The major healthcare providers in Ethiopia are the Ministry of Health, Regional Health Bureaus and the Ministry of Defense. Parastatal health institutions are also categorized under public sector providers.

Currently, the health sector strategy and programs in Ethiopia in general focus primarily on preventive and preliminary (basic) curative health service packages. Lately, the health sector of the regions and the nation have launched health extension services and expanded primary health care units in order to give basic health services for all segments of the population.

Similarly, the Kenyan government has set out policy agenda for the health sector up to 2010. These agenda or directives include adoption of an explicit strategy to reduce the burden of diseases and a definition of essential cost effective care packages. The health policy objectives' implementation strategy emphasizes decentralization of healthcare delivery through redistribution of health services to rural areas. The strategic plan focuses on the essential key priority packages based on the burden of diseases and the support services required to deliver the health services. The major players in the health sector of Kenya include the government as represented by the Ministry of Health, local governments, private sectors and NGOs.

In Sudan, the Ministry of Health is the sole government body responsible for setting up National Health Policy in consultation with other relevant bodies. Public sector institutions involved in the provision of healthcare including universities, military and police health services and the National Health Insurance Corporation are obliged to comply with the provisions of the National Health Policy. An important health policy directive inferred from the 2005 Interim Constitution of the Republic of Sudan is that the state is obliged

to provide free primary health care and emergency services to all citizens, while the private sector plays its role under regulations and mechanisms instituted by the government.

The contents of PHC package in Sudan, also reiterated in the health policies of the other two case-study countries, include child health (immunization against vaccine-preventable diseases, nutrition, counseling and growth monitoring and integrated management of childhood illness, school health); reproductive health (safe motherhood, including safe pregnancy and family planning); control of endemic diseases (malaria, tuberculosis, HIV/AIDS etc.), environmental health and sanitation; treatment of simple diseases and injuries; and mental health.

6

Conclusions and Recommendations

Food insecurity in the Nile Basin Region is attributed to a number of factors including the unavailability of food, low purchasing power, unbalanced intra-household food distribution and disruptions caused by conflicts. In the context of low economic development levels, food production is the most important determinant of food security status in almost all the countries of the Basin. Thus, improving agricultural performance through different measures, including irrigation application, would significantly improve the food security status of the population in these countries, supplemented greatly by non-farm income activities. Important measures of agricultural performance that enhance food security status in the study regions in Ethiopia and other study basin countries are per capita grain production and per capita cultivated land. There are also other constraints such as recurrent drought, degradation of natural resources and political instability that need to be considered in improving agricultural performance.

The findings of the study have shown that populations of all countries in the Nile Basin Region, except Egypt, suffer from high levels of malnutrition and all but Uganda are net importers of cereals. Thus, food production is a determinant factor in food security status in most of the countries of the Basin. Food security status in the three regions of Ethiopia is low and varies considerably from zone to zone and region to region. This implies the need for food security strategies that can address the problem in each region so as to improve food security level and reduce food security disparities among the zones and regions. The food security situation in Kenya is characterized by seasonal food insecurity in rural areas before the start of the harvest and acute food insecurity in the semi-arid and arid regions. Population growth, land tenure, improper resource use, deregulation and commercialization play a significant role in determining food availability in Kenya. The food security situation in Sudan over the last two decades has often required food aid. Acute

malnutrition rates, rainfall fluctuations, declining agricultural sector growth and deterioration in the traditional rain-fed agriculture are evidently seen in the country.

With the exception of Egypt and Sudan, the agricultural sector provides the substantial bulk of employment for populations in the basin countries. The percentage of agricultural land developed through irrigation in the Basin is generally low except in Egypt and to some level in the Sudan. The existing water infrastructure in Ethiopia, Kenya and Sudan is not sufficient to meet domestic water-use demand. The case-study results in Ethiopia have indicated the pivotal role that irrigation agriculture can play in the attainment of food security in the country. Generally, there is direct relationship between water infrastructure and food security in all the case-study countries.

Although the relations between water and food security indices vary across regions in Ethiopia, the bi-variate correlation results have in general terms shown that the number of water schemes in a zone has a positive moderate impact on food security in Oromia and Tigrai; the density of water schemes has also some moderate effect on food security in Oromia and the degree of water accessibility to users also has some moderate effect on levels of food security. When irrigated land per capita becomes higher, the number of food insecure population decreases and vice versa. This shows, among other things, the pivotal role that irrigation agriculture can play in the attainment of food security in the region.

The multivariate regression analyses that was carried out to assess the degree of relationships between two independent variables (food security indices - percentage of food insecure population and per capita grain production) and a set of independent variables (water infrastructure indices – percentage of rural population accessed to potable water, number of water schemes per 10,000 population, irrigated land per capita) yielded varied results for the regions in Ethiopia. Two of the set of water indicators (percentage of rural population accessed to potable water and irrigated land per capita) explained the bulk of the variations (98%) in the percentage of food insecure population in Amhara

Region. The same explanatory variables have also explained 92% of the variations in the per capita grain production in the same region. In the second case study region in Ethiopia, viz. Oromia, the explanatory variables (four water infrastructure indices) explained about 47% of the variations in the percentage of food insecure population, leaving aside a residual value of 53%. The results have not been so different for the variations in per capita grain production in Oromia, with only 52% being explained by the water infrastructure indices. Lastly, in Tigrai Region, percentage of rural population accessed to potable water and irrigated land per capita explained 75% of the variations in the percentage of food insecure population, while the same two explanatory variables explained 92% of the variations in per capita grain production.

Health workers and health facility to population ratios are low and vary from zone to zone in the sample study countries. This situation requires strong interventions in terms of training medical manpower and the expansion of health facilities at various levels. Devising appropriate incentive systems to curb brain-drain is also important. Health services provided in the countries vary from region to region and from zone to zone, pointing out the disparity in the level of services. This again calls for extra effort to expand the scope and level of health services in all regions and sub-regions of Ethiopia, Kenya and Sudan. The inequality in the service levels also requires more attention.

The bi-variate correlation and regression analyses for Ethiopia have shown a few significant health service indices that are associated with food security indicators. The health services that need investment/intervention attention in all the study regions are deliveries attendance with skilled personnel, health post coverage and family planning. Antenatal care is also an important service that may deserve attention. To sum up, the health and water service statuses and food security level in the three case study countries in the Nile Basin Region are generally low, with considerable disparity among regions and sub-regions. This situation calls for more effort on improvement of access to safe water, health and food security, taking into account the inequality among sub-regions and regions in each country.

6.1 Recommendations

The following policy recommendations are drawn from the study findings.

(i) Prioritizing health services for expansion: On the basis of the findings of the study, deliveries attendance with skilled personnel, health post coverage, and family planning are priority services that deserve attention for investment/intervention.

(ii) Adopting an integrated approach for food security and health infrastructure development: In developing food security policies, strategies and programs, the countries need to consider and integrate health and water infrastructure development and service delivery.

(iii) Addressing geographic and demographic disparity in health and water infrastructure and service distribution: This is an essential policy direction that needs multiple policy measures targeting the disadvantaged and marginalized groups and areas in each basin country.

(iv) Upgrading and expanding irrigation infrastructures: The potential of the agriculture sector in most Nile countries including Kenya and Sudan has remained substantially unrealized, requiring increased expansion of irrigation infrastructure. Moreover, the capacity and efficiency of the existing domestic water infrastructures leaves much to be desired.

(v) Attention and expansion of community participatory primary healthcare and community-based preventive healthcare: This approach is also recommended to benefit from the community knowledge, practices and participation that would make the health system more relevant to the needs of the country. This can also ensure increased efficiency in utilization of health expenditures. Such an approach can be facilitated by promoting the support of grassroots health extension services. The health systems of some of the Nile countries, in particular Kenya and Sudan, have focused on higher/top-tier health institutions at the expense of primary health care. In this regard, it is recommended to focus on community-based preventive healthcare and primary healthcare

References

African Development Bank (AfDB). 2008. Gender, Poverty and EnvironmentalIndicators on African Countries.

_____. 2008. Selected Statistics on African Countries, Volume XXVII, Economic and

Statistics Division. 2008.

_____. 2008. Statistics Pocketbook, Volume X, Economic and Statistics Division. 2008.AfDB and OECD, 2008. African Economic Outlook Kenya, 2008.

African Union, n.d., The Comprehensive Africa Agriculture Development Programme (CAADP) Pillar II Framework for the Improvement of Rural Infrastructure and Trade-Related Capacities for Market Access (FIMA).

Agricultural Sector Coordination Unit, 2006. Draft Report, Nairobi, Kenya, 9 June 2006.

Amhara Finance and Economic Development Bureau. 2008. 2006/07 Budget Year Annual Statistical Bulletin. Bahir Dar: Tis Abbay Printing Press.

Block, Paul J., Kenneth Strzepek and Balaji Rajagopalan. 2007. International Food Policy Research Institute, Integrated Management of the Blue Nile Basin in Ethiopia: Hydropower and Irrigation Modeling, IFPRI Discussion Paper 00700, University of Colorado, May 2007.

Bryman, Alan and Duncan Cramer. 2001. Quantitative Data Analysis with SPSS Release 10 for Windows. Also suitable for SPSS Release 11. A guide for Social Scientists. Hove and New York: Routledge.

CSA, 2004, Welfare Monitoring Survey – 2004, Analytical Report. Addis Ababa: CSA.

_____.2005. Demographic and Health Survey. Addis Ababa: CSA.

_____.2008. Ethiopia. Annual Statistical Abstract 2008. Addis Ababa: CSA.

Degefa Tolossa. 2005. Rural Livelihoods, Poverty, and Food Security in Ethiopia: A Case Study at Erenssa and Garbi Communities in Oromia Zone, Amhara National Regional State. Doctoral Thesis, Norwegian University of Science and Technology, Faculty of Social Sciences and

Technology Management, Trondheim, Norway.

Degefa Tolossa and Tesfaye Tafesse. 2008. Linkages between Water Supply andSanitation (WSS) and Food Security in four case-study communities of East Hararghe Zone, Oromia Region, Unpublished Research Report, Addis Ababa, Ethiopia. College of Development Studies, Addis Ababa University.

Devereux, Stephen and Simon Maxwell (eds.), 2001, Food Security in Sub-Saharan Africa. Southampton Row, Lon.: ITDG Publishing.

DFID (Department for International Development). 2007. Fact sheet: Water & Sanitation, November 2007.

DPPC (Disaster Prevention and Preparedness Commission), 2004. Annual Reports for1997- 2003. Addis Ababa.

EC and FAO**,** 2007. Kenyan 2005/06 KIHBS, Food Security Statistics and Information for Targeting Poor and Hungry Populations at Sub-national Levels, EC-FAO Food Security Information for Action Programme, 25 October 2007, Friendship Hotel, Beijing, China.

Eggertson, Thrainn, 1990. Economic Behavior and Institutions. New York: Cambridge University Press.

FAO, 1997. Irrigation Potential in Africa: A Basin Approach, Natural Resource Management and Environment Department.

_____ 2002. The Role of Warehouse Receipt Systems in Enhanced Commodity Marketing and Rural Livelihoods in Africa. Cited in http:// www. Fao.. org.food-policy-paper final.htm.

_____ 2005. Water Resources of Ethiopia. Rome: FAO.

_____ 2005**.** Kenya Nutrition Profile, Rome: Food and Nutrition Division, FAO.

_____ 2006. Special Report: FAO/WFP Crop and Food Supply Assessment Mission to Sudan, 15 February 2006.

_____2007. Infrastructure. Cited in : http://www.fao.org/africa/e-agricultralfood.

Glossary Terms (Infrastructure).htm.

_____ 2008, Water Profile of Sudan, In: Encyclopedia of Earth. Eds. CuterJ.

Cleveland (Washington, DC.: Environmental Information Coalition, National Council for Science and the Environment). [First published in the Encyclopedia of Earth, 19 March 2007; Last revised August 24, 2008; Retrieved September 4, 2008]. Cited in: http://www.org/article/Water_profile_of_Sudan).

FAO and WFP. 2006. *Special Report on Crop and Food Assessment Mission,* Rome: FAO & WFP.

Federal Democratic Republic of Ethiopia (FDRE). 2002. Food Security Strategy, Addis Ababa.

_____, 2007**.** Federal Democratic Republic of Ethiopia (FDRE), 2007. Ethiopia. 2006 –2009 Country Strategy Paper. Plan for Accelerated Progress and Sustained Development to End Poverty. April 2007, Addis Ababa, Ministry of Finance and Economic Development (MoFED).

Government of Ethiopia and UNICEF, 2007.Country Programme Action Plan, 2007-2011. Addis Ababa, FDRE and UNICEF.

Government of Kenya, 2007. 2005/06 Annual Progress Report of the Investment Programme for the Economic Recovery Strategy, Draft, April 2007.

_____ 2007. Basic Report on Well-being in Kenya, Kenya National Bureau of Statistics, Ministry of Planning and National Development.

_____ 2007. Economic Survey 2007, Central Bureau of Statistics, Ministry of Planning and National Development.

_____ 2007. Medium-Term Budget Strategy Paper 2007-2009/10, June 2007._____ 2008. Strategy for National Transformation 2008 – 2012: Accelerating Equitable

Economic and Social Development for a Prosperous Kenya, Nairobi, Ministry of State for Planning, National Development and Vision 2030.

_____2008. Vision 2030, Medium Term Plan, Strategy for National Transformation, 2008 – 2012, 2008.

Guvele, Cesar, Luka Biong Deng, Anne Itto and Brian D'Silva. 2003. Sudan: Food Security Analysis. Paper presented at the Rumbek strategymeeting, February 12, 2003.

Haggard, Stephan and Mathew D. McCubbins, 1997. Political Institutions and theDeterminants of Public Policy: An Introduction'. In Haggard and McCubbins (eds.), Political Institutions and the Determinants of Public Policy: When do Institutions Matter? San Diego, CA: University of California, June, 1997.

Hamza, Waleed and Simon Mason, 2004. Water availability and food security challenges in Egypt, Paper presented at the "International Forum on Food Security under Water Scarcity in the Middle East: Problems and Solutions", Como, Italy, 24-27 Nov. 2004.

Henry J. Kaiser Family Foundation. 2008. Global Data on HIV/AIDS, TB, Malaria & More: Customized Data Sheet (Ethiopia, Kenya, Sudan and Uganda). Cited in: http://www.globalhealthfcts.org).

Huizingh, Eelko, 2007, Applied Statistics with SPSS. London, Thousand Oaks and New Delhi: SAGE Publications.

International Federation of Red Cross and Red Crescent Societies, Sudan: Appeal 2008-2009, Appeal No. MAASD001, 3 January 2007.

International Food Policy Research Institute (IFPRI), 2007. Global Action for Food Security-IFPRI Brief. Cited in http://www.ifpri.org/Global Action for Food Security-IFPRI Brief.htm .

Jorgensen, Peter, 2005. Poverty Targeting in Kenya Water and Sanitation Programme,Presentation to Danida Water Sector Workshop, Accra, Ghana 1st February. 2005.

Kenya Central Bureau of Statistics. 2006. Kenya Integrated Household Budget Survey, 2005/06. Nairobi: Kenya National Bureau of Statistics.

Kenya National Water Development. 2006. Kenya National Water Development Report, UN-WATER/WWAP/2006/12, Prepared for the 2nd UN World Water Development Report, 'Water: A shared responsibility', 2006.

_____ 2008. Kenya: Annual Water Sector Review, Draft Inception Report, August 2008.Kenyan Ministry of Planning and SIDA (Swedish International Development Agency). n.d, "Pulling Apart – Facts and Figures on Inequality in Kenya," Kenya, Ministry of Planning of Kenya, and SIDA.

Levy, Brian and Pablo Spiller, eds. 1996. Regulations, institutions and Commitment:Comparative Studies in Telecommunications. New York: Cambridge University Press.

Maxwell, S. 1991. Introduction. Simon Maxwell (ed.). To Cure All Hunger: Food Policyand Food Security in Sudan, 1- 14. London: Intermediate Technology Publications.

_____ 2001. 'The Evolution of Thinking about Food Security.' In: Stephen Devereux and Simon Maxwell (eds.). *Food Security in Sub-Saharan Africa.* Southampton Row, Lon.: ITDG Publishing.Microsoft Encarta Corporation, 2006, *Microsoft Encarta Encyclopedia*, *Standard Edition of* 2006.

Ministry for Planning and National Development. 2007. Kenya Economic Survey.

Ministry of Health. 2007. *Health and Health Indicators.* Addis Ababa: Planning and Programming Department, Federal Ministry of Health.

Ministry of Planning of Kenya, n.d. "Pulling Apart – Facts and Figures on Inequality in

Kenya," Kenya, Ministry of Planning of Kenya, and SIDA.

MoFED (Ministry of Finance and Economic Development). 2005. Annual Progress Report (2003/04), Addis Ababa, Development Planning and Research Department DPRD), March 2005.

MoI (Ministry of Information). 2005. *Investment Opportunities in Ethiopia,* Addis Ababa: Press and Audio-Visual Department, MOI.

National Bank of Ethiopia, 2007. *Quarterly Bulletin of the Second Quarter of 2006/07. F*iscal Year Series, vol. 22, No. 2. Addis Ababa: Master Printing Press PLC.

New Partnership for African 's Development (NEPAD). 2006, African Fertilizer Summit. Cited in http://www.ifdc-org/africa/african fertilizer summit/ifdc/nepad).

_____**.** 2006. Country Review Report of the Republic of Kenya, African Peer Review Mechanism.

NeWater, n.d., New Approaches to Adaptive Water Management Under

Uncertainty, Case Study Nile. Cited in: http://www.newater.info/everyone/2038

Oromia Regional State, 2007. Oromiya's Almanac. Publication of Information & Website Department of Oromia National Regional Government President's

Office. Addis Ababa: Rehobot Printers.

Paul, Sam. 1998. 'Making Voice Work: What Happened to the Report on Bangalore?'

PREM Seminar Series, Public Sector Group, Washington DC.: World Bank, March 4, 1998.

Pinstrup-Anderson, P. and R , Pandya-Lorch, eds., 2001, Unfinished Agenda. The Unfinished Agenda: Perspectives on Overcoming Hunger, Poverty, and Environmental Degradation, New York: International Food Policy Research Institute.

PricewaterhouseCoopers and Ministry of Water and Irrigation. 2008. Value for Money Study –Final Report, March 2008.

Republic of Sudan Government of National Unity. 2006. Sudan National Health Policy, Federal Ministry of Health.

Roman, J. 1996. Food Security in Sub-Saharan Africa. Cited in http://www.sarpn.org.za/
documents/ht d0000216/P205_Clover.pdf.

Sharif, Abusalech, 2004, A Status Report on Macroeconomics and Health Sector in Sudan, Study Commissioned by the World Health Organization, March 2004.

Sisay Asefa and Adugna Lemi. 2001. Eradicating Rural Poverty and Food Security in Ethiopia, the Quest for Sustainable Institutions and Technologies. Paper presented at the Ethio-Forum 2002 Conference, Ethiopian Social Rehabilitation and Development Fund (ESRDF).

Society for International Development, 2004. Facts and Figures on Inequality in Kenya, 2004.

Tigrai Bureau of Finance and Economic Development, 2008, Statistical Bulletin of the2006-07 Fiscal Year, Unpublished Statistical Bulletin

(Amharic and Tigrigna Version). Mekelle, BOFED.

Tigrai Health Bureau. 2007. 2006/07 Fiscal Year Annual Health Profile. VCT Service by Zones, Tigrai Region. Mekelle: Desta Printing Press.

UK-FCO. 2008. Sudan, Country Information.

UN World Food Programme. 2005. WFP, War and Famine: Food security in Sudan, UN World Food Programme Interagency Rapid Assessment, November 2005. Cited in: http://www.unsudanig.org/publications/assessments/data/Inter-Agency-Rapid-Food-Security-Assessment-of-Northern-Sector.pdf

UNDESA. 2006. The Millennium Development Goals Report, June 2006. DevelopmentInformation & MDGs. Cited in http://www.fao.org/Dev Info/ data on Internet access.htm.

UNDP 2006. Human Security and Human Development: A Deliberate Choice, Kenya National Human Development Report, 2006.

_____ 2008. Human Development Index, 2007-2008. Geneva: UNDP.

UNECOSOC, 2007. The 2007 Annual Ministerial Level Substantive Review of the Economic and Social Council (ECOSOC) Voluntary National Report Emerging Ethiopia: Strengthening Efforts to Eradicate Poverty and Hunger, Including Through the Global Partnership for Development, June 2007, Unpublished Annual Report, Addis Ababa.

UNICEF. 1997. World Development Report 1997: The State in a Changing World.New York: Oxford University Press. _____2003. Sudan Health Status Report, Draft version 1,AFTH3,August 2003._____2005. World Development Report. Oxford: Oxford University Press._____2006. Meeting the MDGs Drinking Water and Sanitation Target: The Urban and Rural Challenge of the Decade. Cited in http://www.who.org.

_____2007. Monthly Report, April 2007.

_____2007, The State of the World's Children. Cited in http://www.who.org.

WHO. 2008. World Health Statistics 2008. Cited in: http://www.who.int/whosis/en/index.html

_____n.d. Country Profiles: Sudan. Regional Office for the Eastern

Mediterranean. Cited in: http://www.emro.who.int/emrinfo/index.asp?Ctry=sud

World Bank, 2003. Sudan Health Status Report, Draft version 1, AFTH3, August 2003._____2008. Kenya: Country Brief, 2008.___2008. Sudan: Country Brief, 2008.

Section B

Policy Briefs and Implementation Strategies

7

Policy Brief on Water Infrastructure and Food Security in Ethiopia, Kenya and Sudan

7.1 Executive Summary

The Nile Basin has been cited among the most food insecure regions in Sub-Saharan Africa. The Basin states have experienced food insecurity over several decades. Based on the severity of the problems in the Basin, an attempt is made to see the relationships between water infrastructure (domestic water supply and irrigation) and food security in three of the Nile riparian states, namely, Ethiopia, Kenya and Sudan. The analytical framework of the study has been based on the assumption about the two-way relationships between infrastructure and food security at household level. Data and information pertaining to food security situations and the status of domestic water supply and irrigation in Ethiopia, Kenya and Sudan have been collected from various secondary sources. In addition, checklists were prepared to gather quantitative and qualitative data in all the three study regions in Ethiopia. The study employed descriptive and inferential statistical techniques to analyze the data.

The findings of the study have shown that the populations of all countries in the Basin, except Egypt, suffer from high levels of malnutrition and all but Uganda are net importers of cereals. Thus, the production of food items is a determinant factor in food security status in most of the countries of the Nile Basin. The food security status in the three regions of Ethiopia is low and varies considerably from zone to zone and region to region. This implies the need for food security strategies that can address the problem in each region so as to improve food security level and reduce food security disparities among the zones and regions. Similarly, the food security situation

in Kenya is characterized by seasonal food insecurity in rural areas before the start of the harvest and acute food insecurity in the semi-arid and arid regions. Population growth, land holding, improper resource use and deregulation and commercialization play a significant role in determining food availability in Kenya. Another case in point is the increased incidence of communicable diseases such as, STDs, TB, Typhoid, Malaria and HIV/AIDS attributed to low per capita spending on health.

7.2 Background

The Nile Basin has been cited among the most food insecure regions in Sub-Saharan Africa. The Basin states have experienced food insecurity over several decades. Although the degree varies from one riparian state to another, the problem has persisted for a long time. Food insecurity is explained by multiple factors, including poor and inadequate physical and social infrastructures, rapid population growth, diminishing land holdings, lack of on-farm technological innovations, lack of off-farm income sources, climatic shocks, resource degradation, bad governance and inefficient policies, widespread epidemics (e.g. malaria, TB, HIV), poor market integration and conflicts.

The roles of infrastructural services (e.g. water schemes, irrigation facilities, health services) in the food security of households, communities and regions have not been adequately studied. The hitherto existing food security studies have so far focused on the role of household socioeconomic and resource characteristics on household food security. Similarly, most past works have focused on the impacts of climatic shocks (drought and flood), land degradation and regional instability on food security. In this policy brief, water supply schemes and irrigation, which affect food security in Ethiopia, Kenya and Sudan, are selected. The selection of these services is based on the severity of the problems affecting the region, e.g. lack of access to potable water and underutilized/undeveloped irrigation.

There are very close linkages between water infrastructure and food security in the Nile Basin. Water infrastructure, both domestic water supply and irrigation

schemes, affect the level of food security in the Basin. The importance of irrigation infrastructure to food security is more direct especially in the context of the agriculture-dominated economies of the Nile Basin countries. Better irrigation infrastructure enables the cultivation of more land and production cycles free from seasonal rains. These, in turn, could help the ground to have more food production, more income to buy food, more food security and more resilience to withstand seasonal shocks.

The aim of this policy brief is to highlight the methodology employed in the report, the major findings of the study, the policy issues to be adopted in view of the need to improve water infrastructure that can enhance the food security situations in the Basin, and to identify activities, outputs and outcomes that can be used to implement plans and policies..

7.3 Methodology

The analytical framework of the study has been based on the assumption about the two-way relationships between infrastructure and food security at household level. On the one hand, access to sufficient infrastructure on a sustainable basis will help in the various dimensions of food security, while, on the other, people with better standard of living and secured livelihoods will demand more development in infrastructure. Data and information pertaining to food security situations and status of domestic water supply and irrigation in Ethiopia, Kenya and Sudan have been collected from various secondary sources. Within Ethiopia, three regions that fall within the Ethiopian portion of the Nile Basin, namely, Amhara, Oromia and Tigrai, have purposely been selected. Checklists were prepared to gather quantitative and qualitative data in all the three study regions in Ethiopia. The study employed descriptive and inferential statistical techniques to analyze the data.

7.4 Findings

The populations of all countries in the Basin, except Egypt, suffer from high levels of malnutrition and all but Uganda are net importers of cereals. Thus,

the production of food items is a determinant factor in food security status in most of the countries of the Nile Basin Region.

The Ethiopian population is highly dependent on subsistence agriculture for its food and income. It is estimated that 45% of the rural population in Ethiopia lives below the poverty line, of which about fifteen million people face food insecurity that is either chronic or transitory in nature. The causes for food insecurity are related to underdeveloped infrastructure, sub-optimal levels of agricultural technology and high population growth rates. The estimated food insecure population in the three study regions in 2007 was 22.0% in Amhara, 4.8% in Oromia and 11.7% in Tigrai. The cultivated land per capita in the same year was 0.21 ha each for Amhara and Oromia regions and 0.40 ha for Tigrai. These data indicate that the food security status in the three regions of Ethiopia is low and varies considerably from zone to zone and region to region. This implies the need for food security strategies that can address the problem in each region so as to improve food security level and reduce food security disparities among the zones and regions.

Kenya is a low income food deficit country that does not grow enough food to meet the needs of its growing population and lacks sufficient foreign exchange to address the shortfall through imports. The agricultural sector in Kenya is characterized by rain-fed subsistence farming and pastoralist livestock production that are vulnerable to unstable rainfall patterns. As a result, the food security situation is characterized by seasonal food insecurity in rural areas before the start of the harvest and acute food insecurity in the semi-arid and arid regions. Population growth, disparities in landholding and improper resource use aggravate food unavailability in Kenya. Another case in point is the increased incidence of communicable diseases such as STDs, TB, typhoid, malaria and HIV/AIDS attributed to low per capita spending on health. The resulting disease burden has reportedly impacted upon the productivity of the agricultural sector which employs over 74% of the country's labor force. The number of people considered food insecure, i.e. persons unable to get the bare minimum in nutritional requirements, was around 40% of the total population in 2007.

In Sudan, acute malnutrition rate varying between 19.5%-26% was recorded for the north and 32.4% for the south during the 1997-2001 periods. Agricultural sector growth rate has declined from 7.3% in 2002 to 5.2% in 2003 mainly due to the deterioration in the traditional rain-fed agriculture. An additional decline of 4.5% in 2004 was attributed to the poor performance of the mechanized rain-fed agriculture. Moreover, high levels of annual fluctuations mainly due to high rainfall variations characterize the production of cereals in Sudan. This has resulted in high levels of dependence on food aid. Food availability is enhanced by increasing imports, especially wheat and wheat-based foodstuffs. In southern Sudan, cereal deficit in the urban and rural areas was projected to reach 84,293 tones in mid-2006, despite increased agricultural production in 2005. Based on food security and nutrition assessments undertaken in 2005, the FAO/WFP Mission estimated that food deficits affected around 6.7 million people, who required emergency food assistance amounting to 800,000 tones of assorted food items.

With the exception of Egypt and Sudan, the agricultural sector provides the substantial bulk of employment for the population in the Basin countries. Even in these two countries, the figures are still high with Egypt and Sudan having 42% and 57% of their population engaged in agriculture. The percentage of agricultural land developed through irrigation in the Basin is generally low except in Egypt (100%) and the Sudan (10.7%). Indicators of access to improved water sources are comparatively high across countries with the exception of the Democratic Republic of Congo and Ethiopia. The highest levels of rural water coverage are reported in Egypt with almost comprehensive coverage followed by Sudan, Uganda, Tanzania and Burundi that have above 50% coverage. The remaining countries have reported levels below the 50% mark.

People with access to clean and safe water in Ethiopia was 52.5% in 2007; sanitation services were negligible except in the capital, Addis Ababa, and a handful of urban centers. About 5% of the potentially irrigable land of 3.7 million hectares was utilized and 2% of the hydropower potential of the

country that is estimated at 30,000 megawatt or 162 GWH has so far been exploited. In Ethiopia, where less than 5% of the potentially irrigable land has been developed, the per capita irrigated land is minuscule. In Amhara Region, the per capita irrigated land in 2007 was 0.31 m^2 while in Oromia the figure stood at 0.42 m^2. Such a size indicates, among other things, the limited use of irrigation in the regions. The figure for Tigrai (61.8m^2) was relatively better than the other study regions.

The most critical challenge for the water sector in Kenya is water scarcity. Kenya is chronically water scarce with a limited natural endowment of fresh water. In addition to the scarcity, Kenya is highly vulnerable to rainfall variability, recurrent droughts and frequent floods. Irrigation infrastructure in Kenya is generally confined to small scale rural schemes using furrow and basin irrigation that are not water efficient, require a lot of energy to spread the water and also result in high water losses. Domestic use constitutes the second largest demand on water resources in Kenya next to agriculture. However, the existing water infrastructure has not been sufficient to meet this demand, especially in rural areas where around 70% of the population has not yet been covered.

Irrigation infrastructure in Sudan is dominated by large-scale schemes, which provide water for a sizable proportion of the agricultural land. In fact, in terms of irrigated agricultural land, Sudan has the second most extensive infrastructure coverage in the Nile Basin Region next to Egypt. The total irrigated land in Sudan is estimated at 1,863,000 hectares. About half of the irrigated land is occupied by the Gezira and Managil schemes followed by the White Nile pump schemes (10%). The second largest user of water was the domestic sector (2.6%) followed by industrial use (0.7%).

Ease of access to potable water has a twofold implication for productivity as an essential component of food availability and access. A community using unsafe water sources is likely to have poor health and therefore low productivity. Time spent seeking distant water sources would similarly result in productivity loss.

The case study results in Ethiopia have shown the following results:

(a) Inverse relations between the degree of availability of water schemes, scheme density and the proportion of population having access to potable water with the level of food insecure population; the amount of irrigated land per capita and the proportion of food insecure population in one of the case-study regions in Ethiopia, namely Tigrai,

(b) Positive relations between the amount of water schemes in the zones and the per capita grain production in all the three case-study regions and the density of water schemes and the proportion of people accessed to potable water in Amhara Region. The bi-variate correlation results have in general terms shown that the number of water schemes in a zone has a moderately positive impact on food security in Oromia and Tigrai; the density of water schemes has also some moderate effect on food security in Oromia, while the degree of water accessibility to users also has some moderate effect on levels of food security. On the other hand, when irrigated land per capita becomes higher, the number of food insecure population decreases and vice versa. This shows, among other things, the pivotal role that irrigation agriculture can play in the attainment of food security in the region.

The multivariate regression analyses by which the proportion of food insecure population and per capita grain production have been considered as dependent variables and a set of water indices as independent variables yielded the following varied results across regions:

(i) A set of four water indices (percent of rural population accessed to potable water, number of water schemes per 10,000 population, irrigated land per capita for all and for beneficiaries only) may explain about 47% of the variations in the percentage of food insecure population in Oromia Region,

(ii) 98% of the variations in the percentage of food insecure population in Amhara Region might explained by the variations in the percentage of rural population accessed to potable water and irrigated land per capita,

(iii) 92% of the variations in per capita grain production might be explained by percentage of rural population accessed to potable water and irrigated land per capita in Amhara Region,

(iv) In Tigrai Region, three independent variables, namely, percentage of rural population accessed to potable water, irrigated land per capita (for all) and for beneficiaries only, may probably explain about 75% of the variations in the percentage of food insecure population in the zones and

(v) 92% of the variations in per capita grain production may possibly be explained by the variations in the percentage of rural population accessed to potable water and irrigated land per capita.

The correlation between the low level of water infrastructure and low status of food security is also apparent in Kenya and Sudan. The low level of irrigation infrastructure in Kenya has resulted in lower production and availability of food, in particular during drought seasons. It also resulted in low earnings from agricultural activities for the majority of the rural population, which in turn hampered their ability to access adequate food. In the case of the Sudan, the diverse agricultural sector and agro-ecological zones are potentially capable of producing outputs in excess of the country's food needs. However, rural environments in Sudan, especially in the north, are plagued by drought while the bulk of the agricultural resources in the south remain unexploited. Thus, there is significant correlation between the food security status and water infrastructure in Sudan. By the same token, access to improved water sources for domestic use in Kenya is in favor of urban areas and, biased against high poverty and low food security provinces. The gap between them is as high as 56 percent. Though the gap is narrower in Sudan compared to Kenya, the same bias against the peripheries, especially the south and northwest, is clearly observed in access to potable water for domestic use, with the gap standing at 14%. Generally, it is believed that intensified irrigation can increase agricultural productivity four-fold and depending on the crops, incomes can be multiplied ten-times in all the three countries.

7.5 Policy Recommendations

Some of the policy recommendations with regard to the relationship between water infrastructure and food security that can have implications on the water and food sector policies for the three case study countries, viz. Ethiopia, Kenya and Sudan, include:.

1. **Upgrading and expanding irrigation infrastructures**: in a region where rain-fed agriculture is unreliable due to the fluctuations and unpredictability of rainfall, the importance of irrigation agriculture becomes imperative. As the case studies have clearly shown, per capita grain production is directly related to irrigated land per capita, implying, among other things, the significant role irrigation agriculture can play in the attainment of food security. The irrigation potentials of Ethiopia, Kenya and Sudan have remained unrealized. Given this state of affair, it is incumbent upon the respective governments and the private sector to invest in the harnessing of the irrigation potentials of the countries. Moreover, the capacity and efficiency of existing water infrastructures leaves much to be desired. Therefore, it is recommended for the Nile Basin countries to take policy measures to upgrade and expand their irrigation infrastructures.
2. **Adopting an integrated food security and infrastructure development approach**: one of the major lessons drawn from the study is the significance of the relations that exist between the food security situation and water infrastructure development. This calls for adopting holistic and integrated food security and infrastructure policies, strategies and programs, which address issues related to the development of infrastructure, population growth, land tenure and health spending.
3. **Addressing geographic and demographic disparities in the distribution of water infrastructures**: As the study has shown, water sector investment and with it water supply infrastructure (schemes) are disparate demographically and geographically. These skewed and biased distributions in water infrastructure, which favor urban areas to the

detriment of rural and peripheral regions, have resulted in food security disparities among regions and societies. This calls for policy measures and interventions in the Nile countries to address geographic and demographic disparities in the distribution of water infrastructure.

4. **Maintenance of the existing water schemes**: building and distributing water schemes in an area or a region without paying due attention to the maintenance aspect puts the users in a quagmire situation. As the case studies from Ethiopia have demonstrated, the average proportion of dysfunctional water schemes in 2007 was 13.6%. Mechanisms should be found by which the national governments set aside a reasonable maintenance budget. In conjunction with this, it is also possible to train people from among the users, who will be equipped with skills to maintain the water schemes.
5. **Increasing water coverage:** since the domestic water supply coverage in the Nile Basin countries is far from being universal and comprehensive, governments and private investors need to inject money with the intent to improve access to potable water for all.

8

Policy brief on health infrastructure and food security in Ethiopia, Kenya and Sudan

8.1 Executive Summary

The health service indicators for the countries of the Nile Basin Region indicate that the infrastructure is at a low level of state for most countries, in terms of health professionals and facilities and the scope and level of services. Health workers and facilities to population ratios are low and vary across countries and sub-regions. In order to ameliorate such a dire situation, strong interventions are needed in terms of human resource training at various levels and expansion of different types of health facilities. The intervention, in turn, requires the involvement of the private sector and Nile Basin governments in terms of health training, health infrastructure development and health service delivery.

The study findings pointed out the existence of various health service gaps that need close policy and investment attentions to expand delivery attendance by skilled health personnel, family planning and expansion at the grassroots level. Such measures can have a considerable effect on food security of people in the Nile Basin Region.

8.2 Background

Evidence indicates that a wide range of diseases, such as malaria, HIV/AIDS and TB, adversely affect food security. Poverty increases the vulnerability to infections and the transmission of diseases. HIV/AIDS and other epidemic diseases debilitate the capacity of people to produce and/or to purchase food. Put another way, good health of individuals contributes to sufficient and efficient utilization of adequate food, improves food availability via its positive effect on labor productivity. On the other hand, consumption of

sufficient and nutritionally balanced food contributes to improvement of health status and productivity of individuals and families.

This policy brief is based on a research report titled 'Infrastructure and Food Security in the Nile Basin Region: A Case Study from Ethiopia, Kenya and Sudan' that was conducted by IDR-SDBS Research Team. The central purpose of the study was to assess the status of water and health infrastructures and food security and the relations thereof in the Nile Basin, with particular focus on Ethiopia, Kenya and Sudan.

8.3 Methodology

The study upon which this brief is based was carried out using secondary quantitative data and information gathered for three case study Basin countries, namely Ethiopia, Kenya and Sudan and by also collecting and analyzing primary and secondary data for Ethiopia. The research team reviewed pertinent literature in light of the issues under investigation. Data and information pertaining to food security situations, and the status of health infrastructure in Ethiopia, Kenya and Sudan have been collected from various secondary sources. Within Ethiopia, three regions, namely, Amhara, Oromia and Tigrai, were selected purposely, for all of them fall within the Ethiopian portion of the Nile Basin. Checklists were prepared to gather data (both quantitative and qualitative) in all the three study regions in Ethiopia. The study employed descriptive and inferential statistical techniques to analyze the data. The intention of the analysis was to explore the direction and strength of the bi-variate correlation between major health service indices and food security indicators, and to determine the key health service indices that affect food security level in a multivariate context.

8.4 Findings

The findings of the study indicate that the populations of all countries in the Nile Basin Region, except Egypt, suffer from malnutrition. For instance, the level of undernourishment reaches up to and beyond two-thirds of the

population in Burundi, DRC and Eritrea. The levels of stunting among children also indicate high levels of food insecurity in all Nile Basin countries, with the exception of Egypt.

The overall picture emerging from examination of health service indicators in the countries of the Nile Basin Region indicates that the infrastructure is not a low level for most countries. With the exception of Egypt, Uganda and Rwanda, per capita health expenditure in the countries is less than thirty dollars. The overall assessment is that the levels of infrastructure, access and quality of health services in almost all countries in the Basin are very low. For example, the average life expectancy in the study regions in Ethiopia ranges between 52 and 56, which is lower than most of the sub-Saharan African countries. In the study regions, under-five child mortality ranges from 106 in Tigrai to 154 in Amhara region, the national average being 123. Factors that aggravate poor health status in Ethiopia, Kenya and Sudan include widespread poverty; low educational level, especially among women; poor environmental conditions; poor access to safe water; and poor organization and management of health institutions. Moreover, the high population growth aggravates the inadequacy of health services.

The study regions in Ethiopia have a limited number of health facilities and personnel relative to their population size. The ratios of health professionals and health facilities to the population for the regions are far below the standard recommended by World Health Organization (WHO). The ratio of physician to population in Oromia region of Ethiopia in 2007 was 1:290,020, which is significantly lower than the national average of 1:35,493, whereas the WHO standard is 1:10,000. Tigrai region showed the highest physician to population and health extension worker to population ratios. With regard to health facilities, for instance, health center to population ratio in Oromia in 2007 was 1:140,625, while it was 1:25,000 at national (Ethiopia) level. For Amhara and Tigrai regions, health center to population ratio was 1:116,119 and 1:104,355, respectively.

Family planning and maternal health related services are very important and basic to health development of adults. The health services considered in this study were:

(i) Antenatal care (ANC) provided to pregnant women who attended the service at least once during pregnancy;
(ii) Postnatal care (PNC),
(iii) Family planning (FP) service, and
(iv) Deliveries attended by skilled health personnel. As observed in the study, Tigrai Region leads in the level of the services rendered, followed by Amhara and Oromia in that order.

Kenya's health service indicators place it among the comparatively higher levels of access and quality among the Nile Basin countries. It stands third in physician per 100,000 people. Within Kenya, the ratio varies from 1:20,715 in Central Province to 1:120,823 in North Eastern Province. Moreover, health services are still not accessible to the majority of Kenyans due to poverty and regional disparities in coverage are also high in favor of urban areas.

Cumulatively considered, the National Health Service indicators for Sudan are the second highest within the Nile Basin Region next to Egypt and are reported to be favorable by sub-Saharan standard. However, the national picture masks the wider geographical disparities prevailing in the country in terms of the distribution of human resources for the health sector within the country. For instance, compared to more than 48 physicians per 100,000 population in Khartoum, there are only 1-6 physicians in Darfur and Kordofan.

The relations of health services and food security were examined on the assumption that there is a discernible correlation between indicators of health infrastructure and indicators of food security. The results of the correlation and regression analyses of food security upon health service indices indicated the existence of some significant relations among food security indicators and health service indices. In Amhara region, deliveries attended by skilled health personnel were found to be positively related with the percentage of

food insecure population at 10 % significance level in a multivariate regression context. Contrary to expectations, the direction turned out to be positive as was also observed in the bi-variate analysis results. This could probably be associated with high family size that comes as a result of improved access to skilled health personnel. In the same region, health post coverage has shown the expected negative relation with the percentage of food insecure population at a significance level of 11 % corroborating with the result of the bi-variate analysis. Family planning, ANC and PNC have the expected signs for the coefficients but at statistically insignificant levels. The same explanatory variables were also examined in relation to per capita grain production (a proxy indicator of food security). The results have shown that deliveries with skilled health personnel were found to be positively and significantly related to per capita grain production, which is in conformity with the corresponding positive bi-variate relation. The significant and positive effect of deliveries attended with skilled personnel on food security (per capita grain production) could be due to the important role the service (skilled attendance) plays in minimizing problems related to maternal health, thus sparing time and money for production activities.

In the multivariate regression analysis conducted for Oromia Region, only the family planning index was found to be negatively and significantly related to the percentage of food insecure population, matching with the result of the bi-variate correlation. The result implies that the higher the service level, the lower will be the percentage of food insecure population. This may probably be so because households with better access to the service take care of maternal health and bear less subsistence pressure. The regression analysis of the same health service indices with per capita grain production did not result in any significant coefficients, except antenatal care which was significant at less than 12 % level. This variable was also observed to have positive and strong bi-variate correlation with per capita grain production.

The characteristics of the health systems in Kenya and Sudan have had direct correlations with the profiles of poverty and food insecurity within the countries. In Kenya, rural poverty stands at 49.1 percent compared to 38.8

percent in urban centers. The incidence of rural poverty also varies among the provinces. For instance, poverty in the North Eastern province (74.0 %) is much higher than in Central province (30.3 %). In Sudan, on the other hand, the same areas missing out on health infrastructure services including Darfur, the South, and the East host the poorest communities in the world in contrast to the central and northern states that have relatively higher rates of development.

8.5 Policy recommendations

The health status and food security level in the study regions of Ethiopia and most countries of the Nile Basin are generally low, with considerable disparity among regions and sub-regions. This situation calls for more effort on improvement of health and food security status of the people in the countries, taking into account the inequality among zones and regions in each country. The following measures are suggested for consideration by relevant policy makers.

(i) Prioritizing health services for expansion: on the basis of the findings of the study, delivery attendances with skilled personnel, health post coverage, and family planning are priority services that deserve attention for investment/intervention.

(ii) Adopting an integrated approach for food security and health infrastructure development: in developing food security policies, strategies and programs, the countries need to consider and integrate health infrastructure development and service delivery.

iii) Addressing geographic and demographic disparity in health infrastructure and service distribution: this is an essential policy direction that needs multiple policy measures targeting the disadvantaged and marginalized groups and areas in each basin country.

(iv) Expansion of community participatory primary healthcare and community-based preventive healthcare: this approach is also recommended in order to gain the contribution of community knowledge, practices and

participation that would make the health system more relevant to the needs of the country, and ensure increased efficiency in utilization of health expenditures. This can be facilitated by promoting the support of grassroots health extension services by health extension workers.

The health systems of some of the Nile countries, in particular in Kenya and Sudan, have focused on higher or top-tier health institutions at the expense of primary health care. In addition to the expenses involved in building referral and teaching hospitals, emphasis should be made in the strengthening of the change in policy towards community-based preventive and primary healthcares.

9

Implementation Strategies

The major and important conclusions and recommendations stated earlier are drawn from the study findings. As shown in the findings of the study, the major food security and infrastructure problems include: (health, domestic water supply and irrigation) food insecurity and poverty; intra-state disparities in food security; low purchasing power to import food; water scarcity; poor access to potable water; undeveloped infrastructure (e.g. health and water facilities and services); high population growth; low agricultural productivity; sub-optimal levels of agricultural technology; erratic and unpredictable rainfall pattern; recurrent drought; undeveloped irrigation; flood hazards; high incidence of communicable diseases; child malnutrition; poor access and low quality of health services; low educational level; weak governance and management of health institutions; low ratios of health expenditure, facilities and personnel to population; intra-state health service disparities; and rural-urban and gender-based disparities in health services.

The study has also found strong relationships between food security and infrastructural services (health and water). All the above-stated problems related to food security and infrastructure in the Basin point out the need for designing appropriate measures and strategies. The latter require an integrated approach involving food security, potable water supply, irrigation, health and education. In the context of the Nile Basin region, the designing and planning of an integrated food security and infrastructure development strategy is imperative. In this regard, initiating partnership involving two or more riparian states can yield sustainable and effective outcomes in the context of improving the status of food security and infrastructural services. The envisaged integrated programme can be designed and implemented at the SAP's level. For instance, Egypt, Ethiopia and Sudan can come up with an integrated programme at ENSAP level. Such an opportunity of cooperation can open up windows to exchange information, knowledge, technology, experience and institutional capacity building, which are essential for the success of an integrated food security and infrastructure development approach.

The following table (Table 9.1) outlines the major strategic measures/activities and their expected outcomes that the Nile Basin states are expected to jointly undertake under the integrated food security and infrastructure development programme stated above:

Table 9.1: Activities and outcomes of integrated food security and infrastructure development programme

Strategic measures/activities	Expected outcomes
1. Develop and harness irrigation potentials	Increases agricultural production and productivity, enhancing food security
2. Enhance agricultural technology development and its dissemination	Increases agricultural productivity, enhancing food security
3. Improve access to potable water supply	Improves health status and increases productive labor time, improving food security
4. Improve flood mitigation measures	Enhances water availability, reduces erosion and sedimentation and minimizes human casualties
5. Enhance environmental health and sanitation	Improves environmental sustainability and people's health conditions, improving food security
6. Enhance maternal and child health care	Increases the health status of mothers and children, contributing to the availability of productive labor
7. Expand health extension services at the local level	Improves the health status of households and communities, contributing to the growth of labor productivity
8. Promote community-based primary health care services	Enhances community participation in health care and utilization of indigenous health knowledge and practices, increasing the coverage of health services
9. Increase access to education	Improves knowledge on the utilization of water and health services and technology, increasing the labor productivity and health status of household members and communities
10. Promote the equitable distribution of water and health services	Creates opportunities for all to have access to water and health services, impacting on the food security status of households and communities
11. Develop gender mainstreaming strategy in water and health services	Enhances women's and children's access to potable water and health services, improving their food security status
12. Enhance institutional capacity building	Increases trained manpower and facilities and expands effective, efficient and equitable delivery of water and health infrastructural services, accelerating the growth of productivity and the attainment of food security

References

Eggertson, Thrainn, 1990. Economic Behavior and Institutions. New York: Cambridge University Press

FAO, Kenya Nutrition Profile – Food and Nutrition Division, 2005

Ministry of Health. 2007. Health and Health Indicator. Addis Ababa: Planning and Programing Department, Federal Ministry of Health.

Roman, J. 1996. Food Security in Sub-Saharan Africa. Cited in http://www.sarpn.org.za/
documents/ht d0000216/P205_Clover.pdf.

UNICEF. 2006. Meeting the MDGs Drinking Water and Sanitation Target: The Urban and Rural Challenge of the Decade. Cited in http://www.who.org

World Bank, 2005. World Development Report. Oxford: Oxford University Press

World Bank, August 2003, Sudan Health Status Report, Draft version 1, AFTH3

Annexes

Annex I. Checklists

1. **Data and information on domestic water supply and irrigation facilities**
    - Sources of drinking water in rural and urban areas of the region
    - Number of tapped schemes, deep wells, shallow wells, hand-dug wells, ponds, cisterns, springs, etc. in the region
    - Number of people with access to clean water
    - Water schemes per specified number of population
    - Time series data on the development of water schemes in rural and urban areas
    - Operation and maintenance of rural water supply schemes
    - Financial viability of urban water supply schemes
    - Data on sanitation and hygiene coverage in rural and urban areas
    - Impacts of water supply coverage on (a) the frequency of water-borne diseases; (b) fetching time (kms)
    - Number of water users associations in the region
    - Number of livestock water points in the region
    - The number of small-scale irrigation schemes river diversification, micro-dam construction, ground water abstraction) and impacts on agricultural production and productivity
    - The number of medium and large-scale irrigation schemes and their impact on agricultural production and productivity
    - Traditional irrigation and impact on agricultural production and productivity
    - The number of watershed projects in the region and their impact
    - The number of hydro-meteorological stations in the regions

2. Indicators of regional health service

- Population per health facility (health post, health center [clinic], hospital)
- Population per medical personnel (physician, nurse, etc.)
- Family planning coverage
- Antenatal care coverage (ANC)
- Number of births attended by TBA
- Proportion of deliveries attended by skilled health professionals
- Number of general practitioners, specialists, health officers, nurses, para medical professionals, and health extension workers
- Safe water coverage
- Latrine coverage
- Availability of malaria prevention facilities
- Drug availability measures
- Health and health related training institutes in the region
- Regional public expenditure on health in the last five years

3. Data and information on food security

- Percentage of population who are chronically food insecure
- Percentage of population below poverty line
- Percentage of population on food aid in the last five years
- Food production per capita in the region
- Fertilizer use per unit of farmland
- Improved seeds use per unit of farmland
- Milk production per capita
- Improved dairy cows per capita
- Status and trends of food security level in the region
- Intra-regional variations in food security
- Causes of food insecurity in the region
- Food production status and trend in the region
- Major constraints to food production in the region
- Status and growth of agricultural productivity in the region
- Non-farm employment in the region

4. Interview guide checklist

- Changes in water supply coverage in the region
- Status of water sources (tapped schemes, deep wells, shallow wells, hand-dug wells, ponds, cisterns, springs, etc.)
- Status of sanitation and hygiene in the region
- Relations between water supply and food security
- Irrigation developments in the region (small, medium, and large as well as traditional) and their impact on food security (agricultural production and productivity)
- Plans on water supply coverage for humans and livestock as well as for irrigation
- Plans on improving food security status in the region
- The status (quantity, quality, and distribution) of health facilities (health post, clinic, health center and hospital) and health services in the region, and associated issues and challenges (e.g., costs, service prices, access, proximity, transport service, rural-urban distribution, access of marginalized areas and communities to health infrastructural services)
- The status (quantity, quality, and distribution) of different health equipment and laboratories and associated issues and challenges
- The status (quantity, quality, and distribution) of drugs in the region and associated issues and challenges (e.g., drug prices, access, proximity, transport service, rural-urban distribution, access of marginalized areas and communities to health infrastructural services)
- Status (quantity, quality, and distribution) of physicians, nurses, health extension workers, etc., and associated issues and challenges (e.g., manpower turn-over, incentives, on job-training, rural-urban distribution, access of marginalized areas and communities)
- Status and trends of food security level, variation among rural-urban areas, major causes of food insecurity in the region
- Food production status and trend,
- Major constraints to food production in the region

- Status and growth trend of agricultural productivity (labor and land productivity)
- The major non-farm employment opportunities for the rural population
- The status and trend of income contribution of non-farm sources to non-farm employment and income opportunities in the region
- Intensity and physical distribution of market places in the region
- Access opportunities to the market places available
- Contributions of health services to food security in terms of labor productivity, income, food utilization and social relations/capital

Annex II. Water supply and food security indices for the study regions in Ethiopia

(i) Amhara Region

(a) Water supply data for Amhara Region, 2007

Zone	Rural population	No. of water schemes*	No. of functional water schemes	No. of non-functional water schemes	No. of rural population accessed to potable water
Awi	956,584	818	736	82	222,702
East Gojjam	2,182,854	2274	2099	175	891,032
North Gondar	2,747,662	2082	1618	464	391,078
North Shewa	1,929,823	1952	1641	311	750,706
North Wollo	1,450,530	1460	1262	198	740,725
Oromia	507,104	671	536	135	225,059
South Gondar	2,070,230	2219	1860	359	640,578
South Wollo	2,506,010	2900	2541	359	983,635
Wag Hemira	384,440	449	379	70	96,378
West Gojjam	2,429,965	1731	1587	144	467,852
Total/ Average	17,165,202	16,556	14,259	2,297	5,409,745

(b) Water supply indices for Amhara Region, 2007

Zone	% of functional water schemes to total schemes	No. of water schemes/ 10,000 population	% of rural population accessed to potable water	Irrigated land per capita (for all) [m^2]	Irrigated land per capita (for beneficiaries only) [hectares]
Awi	90.0	9	23.3	30.4	0.23
East Gojjam	92.3	10	40.8	7.2	0.46
North Gondar	77.7	8	14.2	2.9	0.33
North Shewa	84.1	10	38.9	15.1	0.32
North Wollo	86.4	10	51.1	20.9	0.21
Oromia	79.9	13	44.4	29.9	0.34
South Gondar	83.8	11	30.9	4.0	0.28
South Wollo	87.6	12	39.3	5.8	0.20
Wag Hemira	84.4	12	25.1	6.6	0.21
West Gojam	91.7	7	19.3	5.6	0.47
Total/Average	85.8	10	32.7	12.8	0.31

(c) Food security indices, Amhara Region, 2007

Zone	No. of food insecure population	% of food insecure population	No. of PSNP beneficiaries	% of PSNP beneficiaries	% of cultivated area	Cultivated land per capita (ha.)	Agricultural produce (quintals)	Per capita grain production(kgs)
Awi	-----	0.0	-----	0.0	6.5	0.25	3,012,888	315.0
East Gojjam	88,053	4.0	88,053	4.0	14.1	0.24	6,749,044	309.2
North Gondar	374,556	13.6	374,556	13.6	16.8	0.22	8,342,159	303.6
North Shewa	167,398	8.7	167,398	8.7	12.6	0.24	8,087,975	419.1
North Wollo	426,805	29.4	435,667	30.0	6.9	0.17	3,074,448	212.0
Oromia	174,166	34.4	180,768	35.7	1.6	0.11	787,559	155.3
South Gondar	347,592	16.8	347,592	16.8	13.4	0.24	4,977,946	240.5
South Wollo	794,303	31.7	787,701	31.4	11.3	0.17	5,292,141	211.2
Wag Hemira	146,956	38.2	138,094	35.9	2.7	0.26	1,189,853	309.5
West Gojjam	-----	0.0	-----	0.0	14.0	0.21	7,706,803	317.2
Total/Average	2,519,829	22.1	2,519,829	22.0	99.9	0.21	49,220,816	279.3

(ii) Oromia Region

(a) Water supply data for Oromia Region, 2007

Zone	Rural population	No. of water schemes	No. of functional water schemes	No. of non-functional water schemes	No. of rural population accessed to potable water
Arssi	2,247,328	317	268	49	573,444
Bale	1,122,121	206	145	61	380,740
Borena	727,259	303	221	82	221,952
East Hararghe	2,400,882	919	634	285	747,474
East Shewa	1,036,196	413	344	69	520,350
East Wollega	1,097,651	624	471	153	357,992
Guji	991,232	459	340	119	204,030
Horo Guduru	530,092	220	158	62	182,409
Illubabor	1,212,251	1194	912	282	338,333
Jimma	2,504,577	1184	919	265	548,337
Kelem Wollega	753,293	653	531	122	211,338
North Shewa	1,678,636	1523	1380	143	644,496
Southwest Shewa	1,042,558	575	545	30	351,314
West Arssi	1,529,136	379	240	139	381,778
West Hararghe	1,076,437	460	312	148	402,813
West Shewa	1,912,394	1008	863	145	448,706
West Wollega	1,263,032	782	639	143	341,847
Total/average	23,125,075	11,219	8,922	2,297	6,857,353

(b) Water supply indices for Oromia Region, 2007

Zone	% of functional water schemes to total schemes	No. of water schemes/ 10,000 population	% of rural population accessed to potable water	Irrigated land per capita (for all) [m^2]	Irrigated land per capita (for beneficiaries only) [hectares]
Arssi	84.5	1	25.5	11.1	0.36
Bale	70.4	2	33.9	32.8	0.46
Borena	72.9	4	30.5	3.9	0.63
East Hararghe	69.0	4	31.1	11.5	0.29
East Shewa	83.3	4	50.2	23.0	0.41
East Wollega	75.5	6	32.6	15.8	0.36
Guji	74.1	5	20.6	2.7	0.91
Horo Guduru	71.8	4	34.4	---	---
Illubabor	76.4	10	27.9	1.9	0.37
Jimma	77.6	5	21.9	3.5	0.33
Kelem Wollega	81.3	9	28.1	---	---
North Shewa	90.6	9	38.4	2.9	0.23
Southwest Shewa	94.8	6	33.7	---	---
West Arssi	63.3	3	25.0	---	---
West Hararghe	67.8	4	37.4	10.6	0.33
West Shewa	85.6	5	23.5	6.4	0.37
West Wollega	81.7	6	27.1	5.3	0.35
Total/average	77.7	5	30.7	10.1	0.42

(c) Food security indices, Oromia Region, 2007

Zone	No. of food insecure population	% of food insecure population	No. of PSNP beneficiaries	% of PSNP beneficiaries	% of Cultivated area	Cultivated land per capita (ha.)	Agricultural produce (quintals)	Per capita grain production(kgs)
Arssi	152,700	6.8	110,889	4.9	11.1	0.23	7,281,889.00	324.0
Bale	116,400	10.4	155,892	13.9	6.9	0.29	4,998,481.04	445.5
Borena	110,676	15.2	124,185	17.1	0.9	0.06	433,319.00	59.6
East Hararghe	151,830	6.3	478,540	19.9	5.2	0.10	3,814,785.00	158.9
East Shewa	8,500	0.8	73,104	7.1	9.0	0.41	7,918,711.48	764.2
East Wellega	2,520	0.2	-----	---	6.3	0.27	4,219,945.98	384.5
Guji	69,000	7.0	-----	---	2.0	0.10	1,235,684.00	124.7
Horo Guduru	-----	---	-----	---	4.3	0.38	2,866,602.38	540.8
Illubabor	35,370	2.9	-----	---	0.6	0.02	3,612,027.00	298.0
Jimma	-----	---	-----	---	10.0	0.19	6,332,613.00	252.8
Kelem Wellega	-----	---	-----	---	2.8	0.17	2,506,034.37	332.7
North Shewa	6,337	0.4	31,221	1.9	7.7	0.21	3,963,920.00	236.1
Southwest Shewa	-----	---	-----	---	6.1	0.27	4,012,526.00	384.9
West Arssi	40,889	2.7	23,198	1.5	6.7	0.20	5,448,072.00	356.3
West Hararghe	23,300	2.2	367,222	34.1	4.4	0.19	3,010,415.00	279.7
West Shewa	39,875	2.1	-----	---	11.6	0.28	9,274,511.00	485.0
West Wellega	-----	---	-----	---	4.3	0.16	2,909,747.00	230.4
Total/Average	757,397	4.8	1,364,251	12.6	5.8	0.21	73,839,283.25	332.8

(iii) Tigrai Region

(a) Water supply data for Tigrai Region, 2007

Zone	Rural population	No. of water schemes	No. of functional water schemes	No. of non-functional water schemes	No. of rural population accessed to potable water
Central	1,232,075	2,442	2,111	331	747,993
Eastern	726,658	2,065	1,763	302	478,504
Northwestern	693,075	1,244	1,073	171	418,895
Southern	1,010,167	1,776	1,545	231	617,414
Western	265,160	307	266	41	131,228
Total/Average	3,927,135	7,834	6,758	1,076	2,394,034

(b) Water supply indices for Tigrai Region, 2007s

Zone	% of functional water schemes to total schemes	No. of water schemes/ 10,000 population	% of rural population accessed to potable water	Irrigated land per capita (for all) [m^2]	Irrigated land per capita (for beneficiaries only) [hectares]
Central	86.5	19	60.7	50.2	3.24
Eastern	85.4	28	65.9	71.6	4.22
Northwestern	86.3	18	60.4	27.4	4.30
Southern	87.0	18	61.1	111.9	2.15
Western	86.7	12	49.5	48.1	2.45
Total/Average	86.4	19	59.5	61.8	3.27

(c) Food security indices for Tigrai Region, 2007s

Zone	No. of food Insecure population	% of food Insecure population	No. of PSNP beneficiaries	% of PSNP beneficiaries	% of cultivated area	Cultivated land per capita (ha.)	Agricultural produce (quintals)	Per capita Grain Production (kgs)
Central	157,162	12.8	506,921	41.1	19.7	0.17	2,445,132.86	198.5
Eastern	84,760	11.7	433,824	59.7	8.7	0.13	992,079.76	136.5
Northwestern	82,248	11.9	121,201	17.5	19.3	0.29	2,849,956.45	411.2
Southern	100,189	9.9	391,752	38.8	22.7	0.24	4,045,935.44	400.5
Western	31,901	12.0	0	0.0	29.7	1.18	3,395,791.75	1,280.7
Total/Average	456,260	11.7	1,453,698	39.3	100.1	0.40	13,728,896.3	485.5

(iv) Multivariate regression analyses of food security and water service indices, Ethiopia

AMHARA REGION				
Food security indices (dependent variables)	**Water infrastructure indices (independent variables)**	**Regression coefficient values**	**Multiple correlation values (R)**	**Multiple coefficient of determination values (R^2)**
% of food insecure population	% of rural population accessed to potable water	0.17	0.99	0.98
	Irrigated land per capita	0.83		
Per capita grain production	% of rural population accessed to potable water	3.44	0.96	0.92
	Irrigated land per capita	4.39		
OROMIA REGION				
Food security indices (dependent variables)	Water infrastructure indices (independent variables)	Regression coefficient values	Multiple correlation value (R)	Multiple coefficient of determination values (R^2)

% of food insecure population	% of rural population accessed to potable water	-0.13	0.69	0.47
	No. of water schemes/ 10,000 population	-0.46		
	Irrigated land per capita	-0.07		
	Irrigated land per capita (for beneficiaries only)	0.38		
Per capita grain production	% of rural population accessed to potable water	0.21	0.72	0.52
	No. of water schemes/ 10,000 population	0.12		
	Irrigated land per capita	0.60		
	Irrigated land per capita (for beneficiaries only)	-0.13		

Continued

TIGRAI REGION				
Food security indices (dependent variables)	**Water infrastructure indices (independent variables)**	**Regression coefficient values**	**Multiple correlation value (R)**	**Multiple coefficient of determination values (R^2)**
% of food insecure population	% of rural population accessed to potable water	0.67	0.87	0.75
	Irrigated land per capita	-1.43		
	Irrigated land per capita (for beneficiaries only)	-0.71		
Per capita grain production	% of rural population accessed to potable water	-0.99	0.96	0.92
	Irrigated land per capita	0.09		

Source: prepared by the authors

Annex III: Health infrastructure indices for the three study regions in Ethiopia

Table 1: Professional health workers to population ratios by zones of Oromia Region, 2007

Zone	Physicians to population ratio	Nurses to population of ratio	Health extension workers to population ratio	Health posts to population ratio
Arssi	1:132,187	1:9,740	1:13,811	1:19,971
Bale	1:187,527	1:7,956	1:5,683	1:13,127
Borena	1:469,833	1:12,204	1:7,578	1:12,872
East Hararghe	1:564,162	1:11,803	1:8,060	1:28,493
East Shewa	1:217,397	1:28,511	1:6,794	1:16,104
East Wellega	1:116,230	1:1,278,532	1:8,698	1:10,311
Guji	------	------	1:7,683	1:17,494
Horo Guduru	------	------	1:6,756	1:8,813
Illubabor	1:272,316	1:8,841	1:6,484	1:12,607
Jimma	1:715,041	1:14,301	1:7,730	1:29,185
Kelem Wellega	------	------	1:8,797	1:14,408
North Shewa	------	1:14,042	1:8,212	1:21,641
Southwest Shewa	1:591,662	1:10,957	1:7,634	1:20,760
West Arssi	------	------	1:7,973	1:25,536
West Hararghe	1:135,871	1:5,572	1:8,832	1:16,984
West Shewa	1:182,774	1:14,622	1:7,696	1:14,335
West Wellega	1:238,022	1:16,606	1:6,768	1:17,631
Aggregate for Oromia	1:290,020	1:14,104	1:7,914	1:17,511

Source: *Compiled by the authors from statistical reports*

Table 2: Professional health workers to population ratios by zones of Tigrai Region,2007

Zone	Physicians to population ratio	Nurses to population of ratio	Health extension workers to population ratio	Health post to population ratio
Central zone	1:135,333	1:6,801	1:10,656	------
Eastern zone	1:103,622	1:3,498	1:3,454	1:7,402
Mekelle zone	1:13,622	1:1,514	--------	1:88,545
Northwestern zone	1:250,367	1:4,196	1:3,912	1:5,734
Southern zone	1:13,734	1:3,270	1:4,430	1:10,268
Western zone	-----	1:2,190	1:2,897	1:4,278
Aggregate for Tigrai	1:106,840	**1:3,755**	**1:4,969**	**1:10,761**

Source: *Compiled by the authors from statistical reports*

Table 3: Health facilities to population ratios by zones of Amhara Region, 2007

Zone	Hospital	Health center	Health post	Clinics
Awi	---------	1:155,960	1:7,089	1:32,109
Bahir Dar	1:280,070	1:93,357	1:18,671	1:15,559
East Gojjam	1:1,225,755	1:136,195	1:7,497	1:90,797
North Gondar	1:1,082,699	1:112,003	1:8,161	1:22,556
North Shewa	1:729,970	1:59,369	1:7,349	1:60,831
North Wollo	1:801,479	1:160,296	1:7,526	1:114,497
Oromia	----------	1:81,551	1:9,514	1:47,572
South Gondar	1:2,257,494	1:141,093	1:7,525	1:132,794
South Wollo	1:960,348	1:84,737	1:9,733	1:68,597
Wag Hemira	1:570,859	1:136,842	1:5,782	----------
West Gojjam	1:2,639,946	1:175,996	1:10,000	1:73,332
Aggregate for Amhara	1:1,154,361	1:116,119	1:8,190	1:51,643

Source: *Compiled by the authors from statistical reports*

Table 4: Health facilities to population ratios by zones of Oromia region, 2005/06

Zone	Hospital	Health center	Health post	Clinics
Arssi	1:2,775,923	1:146,101	1:23,930	1:37,012
Bale	1:656,343	1:82,043	1:14,115	1:17,739
Borena	1:939,666	1:156,611	1:15,927	1:46,983
E. Hararghe	1:141,041	1:141,041	1:33,986	1:44,775
E. Shewa	1:579,726	1:158,107	1:27,606	1:64,414
E. Wellega	1:639,266	1:85,236	1:10,147	1:17,278
Guji	1:1,137,106	----------	----------	----------
Illubabor	1:608,063	1:104,737	1:23,887	1:25,690
Jimma	1:1,361,582	1:168,245	1:25,537	1:46,132
N.Shewa	1:2,860,164	1:153,289	1:18,770	1:55,741
South .W. Shewa	----------	1:118,332	1:28,174	1:73,958
W. Hararghe	1:883,163	1:196,258	1:33,968	1:44,158
W.Shewa	1:1,096,646	1:182,774	1:19,939	1:68,540
W. Wellega	1:714,066	1:84,008	1:13,865	1:20,115
Aggregate for Oromia	1:1, 325,807	1:157,299	1:24,993	1:43,503

Source: *Compiled by the authors from statistical reports*

Table 5: Health facilities to population ratios by zones of Tigrai Region, 2007

Zone	Hospital	Health center	Nucleus health center (Clinic)	Health post
Central zone	1:270,665	1:123,030	1:37,592	-----
Eastern zone	1:414,489	1:92,109	1:39,475	1:7,402
Mekelle zone	1:177,090	1:59,030	1:88,545	1:88,545
Northwestern zone	1:751,100	1:125,183	1:50,073	1:5,734
Southern zone	1:549,351	1:122,078	1:42,258	1:10,268
Western zone	1:139,033	1:55,613	1:34,758	1:4,278
Aggregate for Tigrai	1:407,933	1:104355	1:41,549	1:10,761

Source: *Compiled by the authors from statistical reports*

Table 6: Health service indices by zones of Amhara Region, 2007

Zone	FP beneficiaries, %	ANC beneficiaries, %	PNC beneficiaries, %	Deliveries attended by skilled health personnel, %
Awi	6.4	2.4	1.0	0.4
Bahir Dar	7.1	1.8	1.0	1.1
East Gojjam	8.4	2.5	0.9	0.3
North Gondar	6.1	1.9	0.6	0.4
North Shewa	13.0	2.0	1.2	0.7
North Wollo	11.9	0.2	0.4	0.2
Oromia	2.3	2.4	1.2	0.4
South Gondar	6.8	1.4	0.8	0.4
South Wollo	12.5	1.9	0.8	0.6
Wag Hemira	8.2	1.5	0.6	0.7
West Gojam	9.5	2.1	0.6	0.3
Average	9.2	1.8	0.8	0.5
Aggregate for Amhara	9.1	1.9	0.8	0.4

Source*: Compiled by the authors from statistical reports*

Table 7: Health service indices by zones of Oromia Region, 2007

Zone	FP beneficiaries, %	ANC beneficiaries, %	PNC beneficiaries, %	Deliveries attended by skilled health personnel, %
Arssi	5.9	1.5	0.5	0.5
Bale	2.9	1.5	0.9	0.5
Borena	1.8	0.9	0.2	0.2
East Hararghe	2.4	1.0	0.3	0.6
East Shewa	8.3	2.4	0.2	0.9
East Wellega	8.0	1.7	0.7	0.5
Guji	2.5	1.3	0.1	0.4
Horo Guduru	3.2	1.5	0.2	0.3
Illubabor	5.6	1.1	0.4	0.4

Jimma	7.0	1.0	0.3	0.2
Kelem Wellega	10.6	2.2	0.2	0.5
North Shewa	5.2	1.0	0.3	0.3
Southwest Shewa	7.0	1.7	0.5	0.4
West Arssi	2.9	2.3	0.5	0.3
West Hararghe	4.2	1.2	0.4	0.8
West Shewa	5.9	1.4	0.3	0.4
West Wellega	3.8	1.5	0.2	0.4
Average	5.1	1.5	0.4	0.5
Aggregate for Oromiya	5.2	1.5	0.4	0.4

Source: *Compiled by the authors from statistical reports*

Table 8: Health service indices by zones of Tigrai Region, 2007

Zone	FP beneficiaries, %	ANC beneficiaries, %	PNC beneficiaries, %	Deliveries attended by skilled health personnel, %
Central zone	21.6	4.0	1.8	1.4
Eastern zone	14.9	3.0	1.5	1.0
Mekelle zone	3.0	2.5	1.4	1.8
Northwestern zone	11.3	3.5	1.4	1.2
Southern zone	15.6	2.8	1.4	1.2
Western zone	14.4	2.7	1.0	1.1
Average	13.5	3.1	1.4	1.3
Aggregate for Tigray	**16.0**	**3.3**	**1.5**	**1.2**

Source: *Compiled by the authors from statistical reports*

Table 9: Bivariate correlation analysis of food security and health service indices, Amhara Region

Health service index	Food insecure population, %	Per-capita grain Production (kg)
Family planning service coverage, %	-0.153	-0.009
Antenatal care service coverage, %	0.024	0.066
Postnatal care service coverage, %	0.219	0.250
Deliveries attended by health personnel, %	0.780*	0.811**
Health post coverage, %	-0.779*	-0.612*

* Correlation is significant at the 0.05 level of significance
** Correlation is significant at the 0.01 level of significance
Note: Health service percentages are of service receivers to zone population

Table 10: Bi-variate correlation analysis of food security and health service indices, Oromiya Region

Health service index	Food insecure Population, %	Per-capita grain Production, (kg)
Family planning service coverage, %	-0.706*	0.445
Antenatal care service coverage, %	-0.395	0.663**
Postnatal care service coverage, %	0.003	0.196
Deliveries attended by health personnel, %	-0.373	0.462
Health extension coverage, %	0.039	0.107
Health post coverage, %	-0.057	0.273

* Correlation is significant at the 0.05 level of significance
** Correlation is significant at the 0.01 level of significance

Note: Health service percentages are of service receivers to zone population

Table 11: Bi-variate correlation analysis of food security and health service indices, Tigray Region

Health service index	Food insecure population, %	Per-capita grain production, kg.
Family planning service coverage, %	0.335	-0.305
Antenatal care service coverage, %	0.650	-0.545
Postnatal care service coverage, %	0.265	-0.886*
Deliveries attended by health personnel, %	0.293	-0.246
Health post coverage, %	-0.119	0.728

* Correlation is significant at the 0.05 level of significance (2-tailed)
** Correlation is significant at the 0.01 level of significance (2-tailed)
Note: Health service percents are of service receivers to zone population

Table 12: Regression analysis of food security on health service indices, Amhara Region

Health service indices	Food insecure population, % (Y1)			Per capita grain production (Y2)		
	Reg. coeff. (Beta)	t-ratio	Sig.	Reg. Coef. (Beta)	t-ratio	Sig. level
Family planning service coverage	-0.193	-0.915	0.428	-0.041	-0.171	0.871
Antenatal care service coverage	-0.217	-0.740	0.513	-0.004	-0.014	0.990
Postnatal care service coverage	-0.114	-0.382	0.728	-0.123	-0.379	0.720
% of deliveries attended by health professionals by zone	0.624	2.779	0.069	0.721	2.732	0.041
Health posts coverage	-.528	-2.321	0.103	-.340	-1.399	0.221
	R^2 =0 .897			R^2 =0 .762		
	F- ratio= 5.233 (.102)			F- ratio= 3.208 (.113)		

Figures in parentheses show significance levels of the F-ratios

Table 13: Regression analysis of food security on health service indices, Oromiya Region

	Food insecure population, % (Y1)			Per capita grain production (Y2)		
	Reg. Coef. (Beta)	t-ratio	Sig.	Reg. coef	t-ratio	Sig.
Family planning service coverage, %	-1.292	-2.948	0.098	0.259	0.995	0.365
Antenatal care service coverage, %	0.776	1.832	0.208	0.614	1.930	0.111
Postnatal care service coverage, %	-0.116	-0.414	0.719	0.058	0.286	0.786
Deliveries attended by health personnel, %	-0.569	-1.866	0.203	0.142	0.546	0.609
Ratio of physicians to zonal population	-0.099	-0.273	0.810	-0.088	-0338	0.749
Health posts coverage, %	0.099	0.391	0.734	-0.106	-0.484	0.649
	R^2 =0 .914			R^2 = 0.822		
	F- ratio= 3.542 (.236)			F- ratio= 3.841 (.081)		

Note: Figures in parentheses show significance levels of the F-ratios.

Table 14: Regression analysis of food security on health service indices, Tigray Region

Health service index	Food insecure population, % (Y1)			Per capita grain production, (Y2)		
	Reg. Coef. (Beta)	t-ratio	Sig.	Reg. Coef. (Beta)	t-ratio	Sig.
Ratio of physicians to zonal population	0.666	1.261	0.334	0.128	0.182	0.872
	R^2 =0 .443			R^2 = 0.016		
	F- ratio = 1.591 (.334)			F- ratio = .033 (.872)		

Note: Figures in parentheses show significance levels of the F-ratios.

Annex IV. Maps of the three study regions in Ethiopia

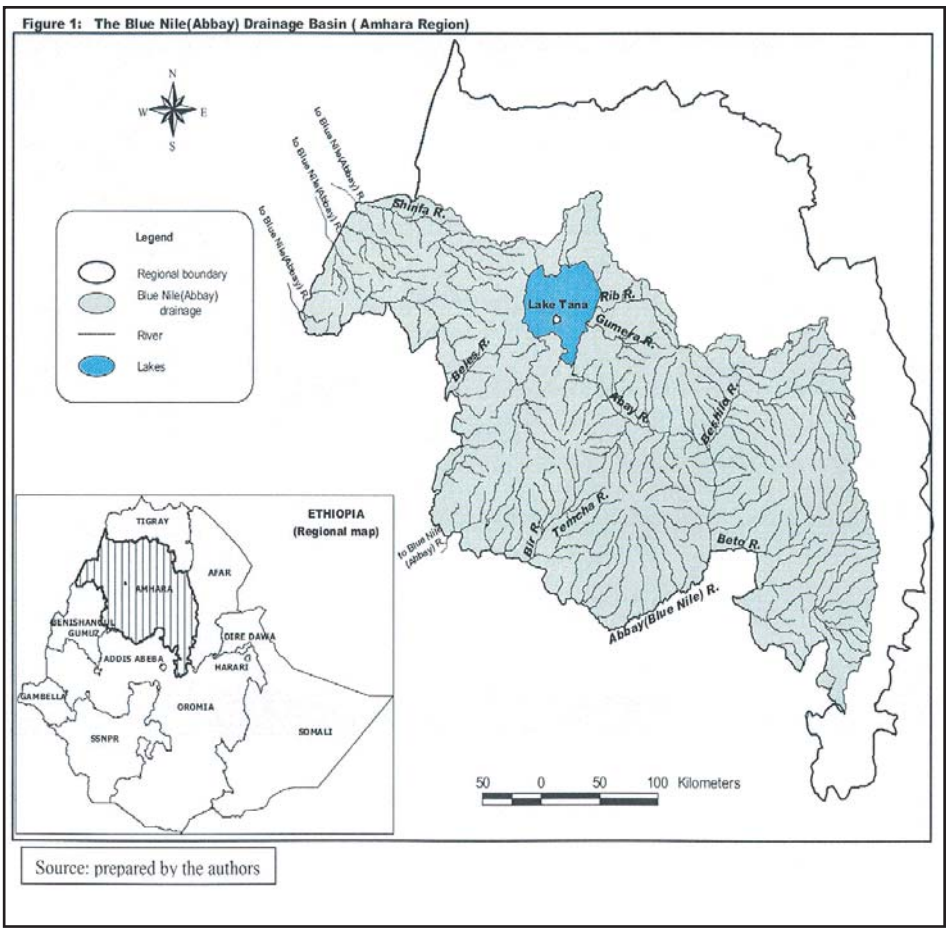
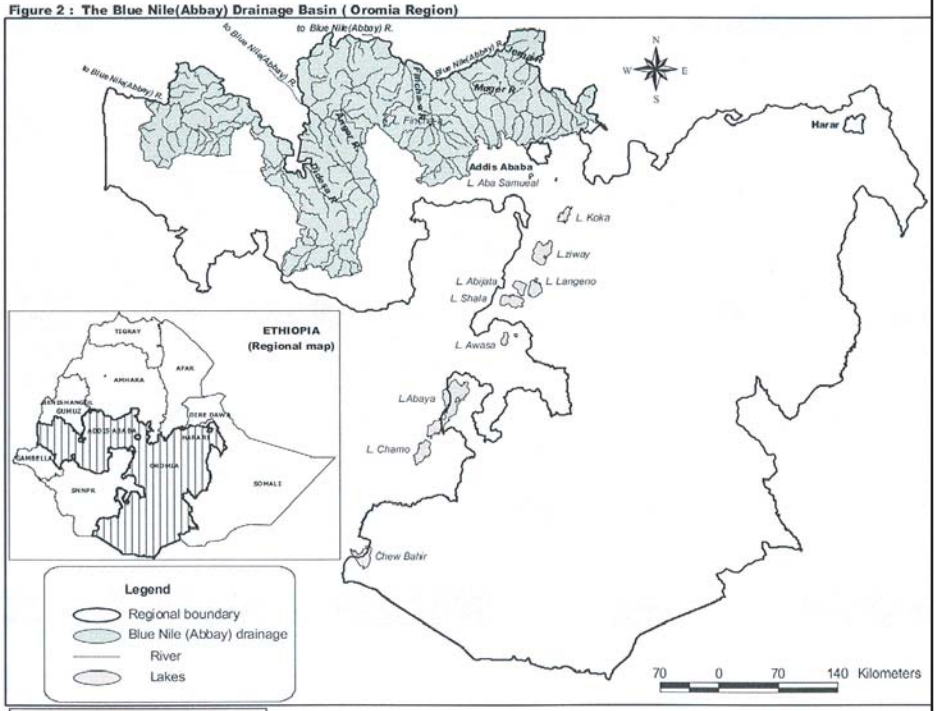
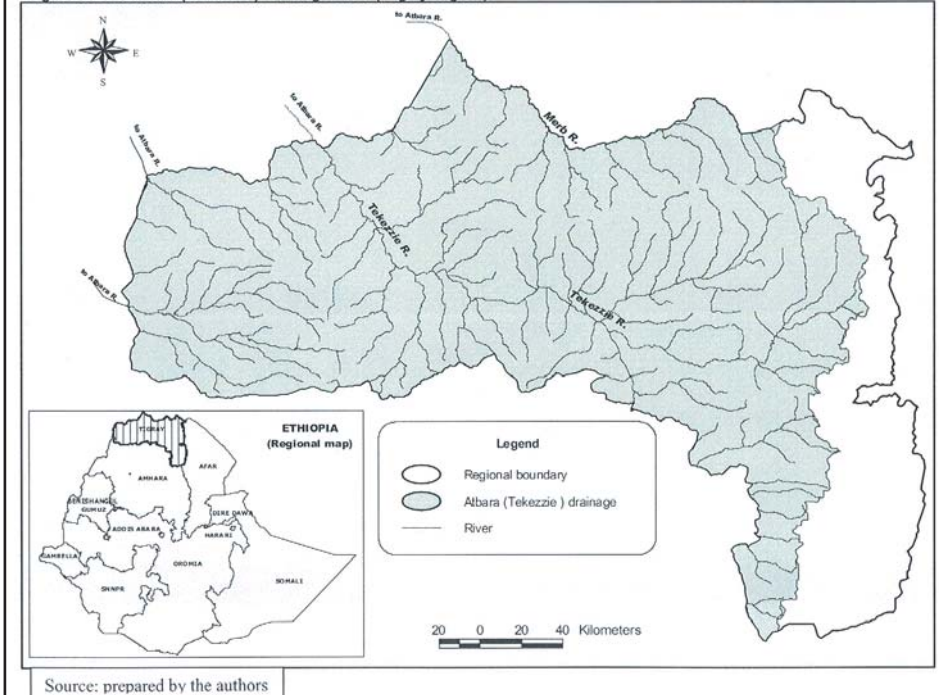


Figure 2 : The Blue Nile(Abbay) Drainage Basin (Oromia Region)



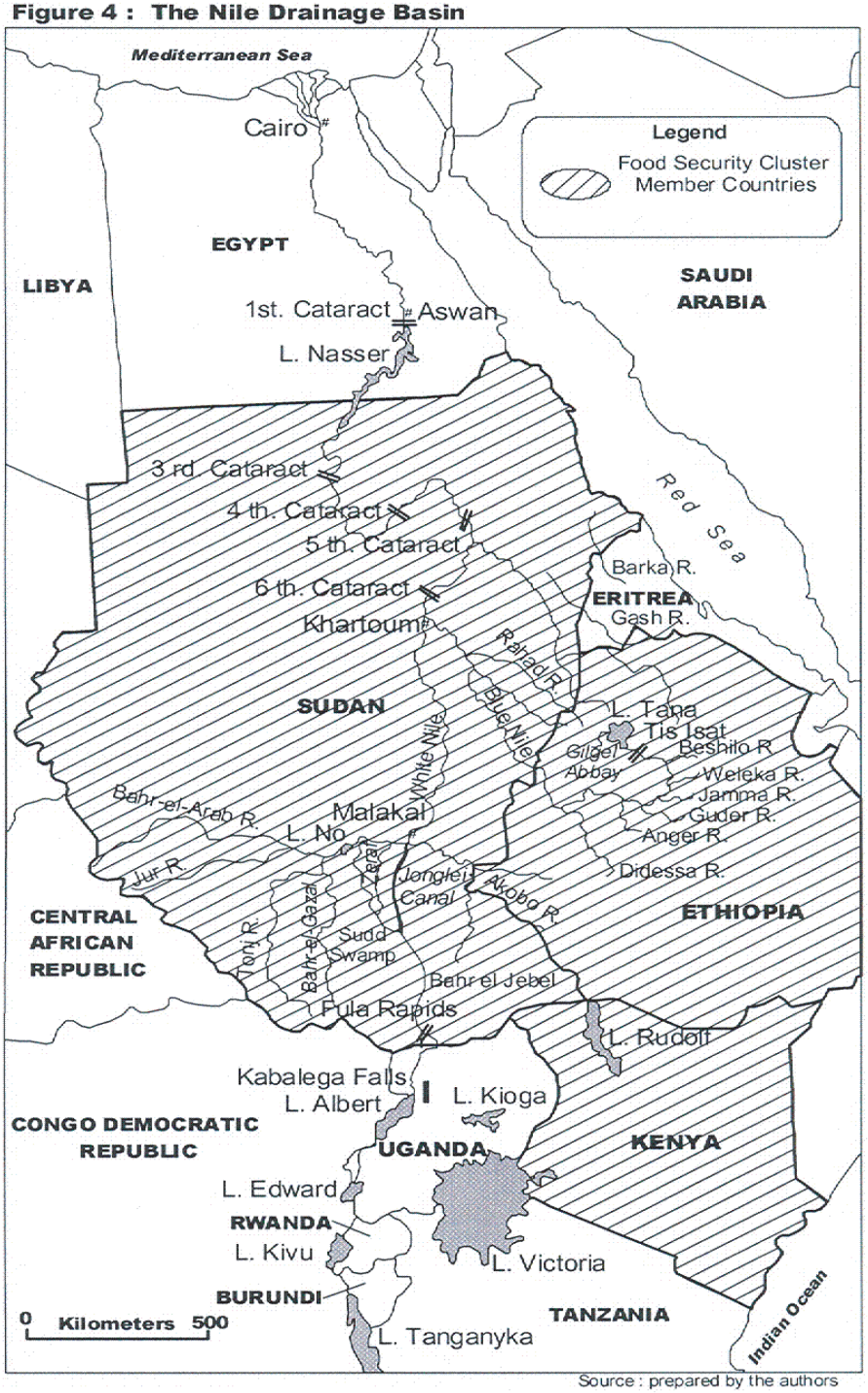
Source: prepared by the authors

Figure 3 : The Atbara (Tekezzie) Drainage Basin (Tigray Region)



Source: prepared by the authors

Figure 4 : The Nile Drainage Basin



Source : prepared by the authors

Annex V. List of stakeholders who participated in the SDBS Project Briefing/Debriefing Workshop in Addis Ababa, Ethiopia, July 18, 2008

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1. Data refers to fiscal year to June 30th (for example, 2003 refers to 2003/04)