Water Futures:
Assessing pathways, synergies & tradeoffs in alleviating poverty through sustainable ecosystem services in Sub-Saharan Africa

Situational Analysis 3
Ethiopia & the River Awash Basin

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Preamble

The *Water Futures* consortium[1] comprises leading social and physical scientists from East Africa (Ethiopia, Kenya, Tanzania, Uganda) and the United Kingdom and proposes to work with key stakeholders from small-scale farmers to national ministries in an effort to develop, test and institutionalise an integrated, interdisciplinary, and scientifically rigorous methodology to identify and assess pathways toward more sustainable and socially just water futures in Sub-Saharan Africa (SSA). This region is characterised by substantial intra- and inter-annual climate variability and influenced by multiple, dynamic drivers of biophysical and socio-economic change that collectively pose an immense challenge to the sustainable management of water for a range of ecosystem products and services to alleviate poverty.

The *Water Futures* consortium was developed under a Partnership and Project Development (PPD) grant (Ref. NE/IOO386X/1) from the Ecosystem Services and Poverty Alleviation (ESPA) programme of the UK's Natural Environment Research Council (NERC), Economic and Social Research Council (ESRC) and Department for International Development (DFID). Under this grant in 2010, the *Water Futures* consortium conducted national and basin-scale *Situational Analyses* in Ethiopia, Tanzania and Uganda (Fig. 1) to assess local conditions, capacities and priorities and engaged in in-depth consultations with a diverse set of stakeholders concerned with the future management and allocation of water in a context of multiple pressures and competing demands. The following *Situational Analyses* is consequently one in a series of three *Situational Analyses* that were used to design the Water Futures that seeks to:

(i) generate new data on biophysical and socio-economic drivers and their impact on water availability, allocation and use;

(ii) integrate this information into an innovative suite of models to downscale climate projections and simulate dynamic hydrological-ecological-crop interactions under different climate and development scenarios; and

(iii) link these models to a Decision Support System through a deliberative, multi-stakeholder engagement and multi-criteria mapping approach that will inform policy and practice in order to give priority to water allocation pathways that meet poverty alleviation and sustainability objectives, particularly the needs of poor people who rely on water-based ecosystem services for their well being.

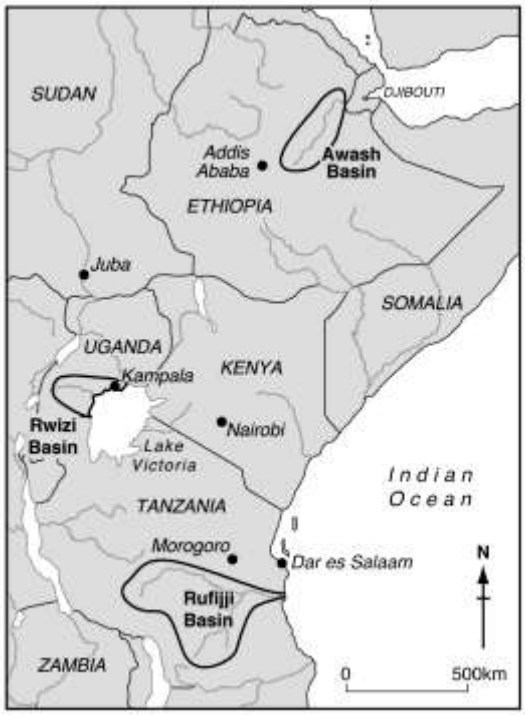

Figure 1. Water Futures study area including three focal basins

[1] http://www.steps-centre.org/ourresearch/waterforfood.html

Overview/Summary

Ethiopia, with an area of 1.127 million sq. km is the second most populous country in Africa with a population of 82.8 million in 2010 and an annual growth rate of 2.7 % that places enormous pressure on natural resources and infrastructure. The majority of the population of Ethiopia (84%) lives in rural areas. Ethiopia is endowed with tremendous diversity of climatic, biophysical and socio-economic settings. For example, annual rainfall varies from 3000 mm to 200 mm. The Ethiopian economy is based on agriculture of which the livelihoods of 85% of the population depend.

Ethiopia has 12 river basins with an annual runoff volume of 122 billion m^3. Water availability is 1743 m^3 of water per person per year. The complex interaction between the climate, biophysical and socio-economic characteristics of Ethiopia is associated with a high level of spatial and temporal variability in riverflow, turbid surface waters, and tremendous potential for hydropower in the highlands and irrigation in the lowlands. Ethiopia is also extremely vulnerable to drought and other natural disasters such as floods, heavy rains, frost and heat waves. These extreme weather events cause loss of lives, property and disrupt livelihoods. Global circulation models predict a 1.7-2.1°C rise in Ethiopia's mean temperature by 2050. Food insecurity is an enormous challenge as Ethiopia has become increasingly dependent on commercial food imports and food aid. However foreign assistance amounts to $13 per capita, significantly lower than the average for other countries in sub-Sahara Africa (i.e. $33 per capita).

International bodies all call for substantial increases in irrigated agriculture in Ethiopia to improve food production, livelihoods and resilience to climate variability/change. The maximum irrigation potential of the country range from 3.6 million hectares to 5.7 million ha. The current cited economical irrigation potential is estimated at 2.7 million ha. The actual irrigated land is about 0.29 million ha, ~11% of the potential (WB, 2009). Of the total irrigation potential area, ~27% is found in the Rift valley Rivers (Awash). Due to economic water scarcity which is described through lack of water storage capacity and large spatial and temporal variations in rainfall, there is not enough water for most farmers to produce more than one crop per year leading to frequent crop failures due to dry spells and droughts. The five year national development plan PASDEP (Plan of Action for Sustainable development to End Poverty) and the current growth and transformation plan (GTP) provide direction towards the achievement of the Millennium Development Goals (MDGs) which is at heart of the country's fight against poverty.

Water legislation (permit, priority of use)

In the 1995 Constitution of the Federal Democratic Republic of Ethiopia (FDRE) stated that the right to ownership of land, as well as natural resources, is exclusively vested in the people of Ethiopia. As stated in various proclamations water is the common property of all citizens of the country and recognize to access to water, and the basic minimum requirement, as the reserve (basic human and livestock needs, as well as environment reserve). The policy covers water supply and sanitation, irrigation, and hydropower, and aim to enhance and promote all national efforts towards efficient, equitable uses and wise utilization of the available water resources of Ethiopia for better development and environmental sustainability, promoting the principles of integrated water resources management.

The different basins of the country have a diverse and varied resource base. A planned approach to the utilization of these resources in a holistic and integrated manner can change the existing grim picture. These plans should take the specific socio-economic, ecological and resource bases into consideration. In this respect, the proper implementation of the existing Integrated Basins Development Master Plans can help reverse the prevalent watershed degradation on top of improving the socio-economic status of basins.

This is fundamentally as much an issue of politics, local governance and resource access as it is a problem of responding to increasing environmental uncertainty. Therefore, it requires a more sophisticated analysis of the problem framing and policy response, as we need to ensure that policies in agricultural development and water resources management take account of the many biophysical and socio-political challenges faced by small-scale farmers in diverse, risk-prone environments and the root causes of inefficiencies and low yields that characterize much of Ethiopia's food production systems.

Awash River Basin

This Situation Analysis is a collaborative effort of key stakeholders including government, research, private sector, knowledge institutes and relevant civil society organizations. This analysis report is based on direct input from these stakeholders combined with the outcomes of extensive desk research. The situation analysis actively involved the Ministry of Water and Energy (MoWE) which plays role of overall coordination, planning, conducting different studies and monitoring & evaluation. The Awash Basin Authority within the MoWE actively contributed in the analysis and have the main responsibility of day to day management and operation, maintenance of the structures and allocation & enforcement of permits for water allocation & discharge. From the public organizations, Ministry of Agriculture and Environmental Protection Authority also have mandate. At regional levels bureau of water resources, Irrigation Authority, Bureau Agriculture and several NGOs are involved. There are others group which includes State Farms, large and small private enterprises who got the land on lease basis from the community, small holder farmers and the clans who leased the land for 20 private investors and also requiring water for livestock watering.

Awash basin is intensively utilized river basin in Ethiopia due to its strategic location, access roads, available land and water resources. Currently 21,865 ha traditional and 4,932 ha modern small-scale irrigation schemes have been developed. Irrigation potential in River Awash Basin is estimated to be 206,000 ha. However, the basin suffers from severe environmental degradation, annual flooding improper utilization of land and water resources, socio-economic constraints, poor agricultural practices, low yielding and community health problems.

Part A. Ethiopia

1. The National Context

1.1 Basic statistics and characteristics

Ethiopia covers an area of 1,127,000 km^2 and is the second most populous country in Africa with a population of 82.8 million in 2010. The proportion of urban and rural dwellers nationally is 16.1% and 83.9% respectively; mean population density is 66 km^{-2}. Population growth is currently 2.7% per annum. Despite an agrarian economy, the agricultural sector in Ethiopia has been unable to produce sufficient quantities of food over the last three decades to feed the country's rapidly growing population. As a result, the country has become increasingly dependent on commercial food imports and food aid.

In 2004/05, poverty in terms of income (<USD$1.25 day^{-1}) and food (<2200kcal per adult per day) were 39% & 29.2%, respectively. By 2009-2010, these figures had marginally reduced to 38% & 28.2%. In parts of the country, the proportion of the population classified by income as poor can exceed 70%. Inequality in terms of family income, defined by the Gini index, reduced from 0.40 in 1995 to 0.30 in 2000. According to the Ministry of Finance and Economic Development (MoFED), the Ethiopian economy experienced GDP growth of 11% in 2009/10. Over the past five years, growth in GDP has ranged from 9.9% to 12.6%.

The Ethiopian economy is primarily based on agriculture accounts for 47.7% of GDP in 2004/05 and 41% of GDP in 2009/2010. The livelihoods of 85% of the population still depend upon agriculture of which most of this is small-scale, subsistence-oriented, and strongly reliant upon rainfall. Approximately 90 percent of the country's agricultural output is generated by subsistence farmers using traditional tools and farming practices. The country's main exports are: pulses, coffee, oilseed, cotton, sugar, cha, cut flowers; hides, gold, leather products, live animals, vegetables, fruits, incense, meat, and tea. Cereals like maize, sorghum, teff, barely, wheat, outs and various types of pulses (pea, bean) and oil seeds primarily serve the domestic market. The country imports food, petroleum and petroleum products, chemicals, machinery, motor vehicles, cereals, textiles, electronics, fertilizers, improved seeds, construction equipment, and sugar.

1.2 Renewable freshwater resources and water availability (FAO, 2005; WB, 2006)

Ethiopia's substantial rainfall has led to the country being called as Africa's 'water tower'. Total internal renewable (mean annual) freshwater resources are 110 km^3 (cubic meters). Per capita freshwater availability was 1,666 $m^3 \cdot year^{-1}$ in 2001; in 2015, per capita water availability is projected to be 1,006 $m^3 \cdot year^{-1}$. In 2000, per capita freshwater withdrawals were estimated to be a small fraction of this mean freshwater availability at just 81 $m^3 \cdot year^{-1}$. Critically, actual freshwater availability is highly seasonal with 70% of freshwater resources – defined by river discharge - occurring between June and August. Renewable (mean annual) groundwater resources are estimated to be 2.6 km^3.

Due to limited water storage capacity and the substantial spatial and temporal variations in rainfall, farmers commonly are only able to produce one crop per year. Crop failures frequently occur due to periods of low or absent rainfall. Highly seasonal rainfall exacerbates soil erosion, impairing the productivity of farmland.

1.3 Arable land under irrigation

The potential land area for irrigation has been estimated to range from 3.6 million ha to 5.7 million ha. The current, economically viable land area for irrigation has been estimated at 2.7 million ha. In

contrast, arable land under irrigation amounted to just 11% of this figure, 0.29 million ha (WB, 2009). The Nile Basin includes the majority of the potential arable land for irrigation (~49%); the River Awash and River Shiebele-Juba Basins represents 27% and 24% of the land nationally available for irrigation. Of the 0.29 million ha irrigated land in 2009, 62% of this was in the Nile Basin, 29% in River Awash and 9% in the River Shiebele-Juba Basin. In terms of regions, Oromia accounts for 39% of irrigated land, Amhara for 24%, Afar for 15% and SNNPR for 12%. In terms of technologies, traditional small-scale irrigation accounted for nearly half (~47.7%) of Ethiopia's irrigated land ~47.7%; modern small-scale irrigation was 16.6%, modern private small-scale irrigation was 2%, and modern medium-& large- scale irrigations was 33.7%. Overall, the development of irrigation in Ethiopia remain low (WB, 2009).

1.4 Major water users

The Ethiopian Water Resources Management Proclamation No. 197/2000, define: "*water uses as the use of water for drinking, irrigation, industry, power generation, transport, animal husbandry, fishing mining and uses of water for other purposes*". Total water withdrawals in 2002 were estimated to be ~ 5.6 km^3 of which 5.2 km^3 (93.6%) was used for agricultural (irrigation and livestock). Nevertheless, almost all food grown in Ethiopia derives from rain-fed agriculture; irrigated land accounts for ~3% of food production. Freshwater withdrawals for the water supply and sanitation (WSS) 'sub-sector' account for ~0.3 km^3 (6%) of annual freshwater withdrawals nationally. In rural areas, per capita domestic freshwater withdrawals are commonly between 5 and 10 litres per day (2 to 4 $m^3 \cdot year^{-1}$). Annual, freshwater withdrawals for industry are estimated to be ~0.02 km^3 (~0.4% of total freshwater withdrawals) in 2002 (FAO, 2005 and WB, 2006).

The livestock sector is the third highest consumer of water in the country and contributes ~20% of the country's GDP. Fisheries are comparatively under-exploited due largely to limited domestic demand and long distances between export markets for this perishable product. The annual sustainable fish yield from Ethiopia's rivers and lakes is an estimated to be 35,300 tonnes$\cdot year^{-1}$. Rivers in many areas are not navigable due to rapids and steep gradients. Ecological water uses are essential to the maintenance of biodiversity and tourism in Ethiopia. Key wetland areas include the inland delta of the River Awash River bordering Djibouti and the lower reaches of the Baro-Akobo Sobat River on the border with Sudan.

Ethiopia has a huge potential for hydro-electric power (HEP) generation that has been estimated at 45,000 MW. Current HEP generating capacity is ~2,000 MW (~4% of potential HEP generation). Access to electricity in Ethiopia is ~35%; 5,189 towns and villages out of 7,000 are currently electrified. As a result, most Ethiopians live with energy insecurity. Use of traditional fuels such as fire wood continues increasing deforestation and soil erosion (EFDR, ELPA, 2009). Substantial investment is planned with the construction of HEP generating facilities in the Abay, Gibe, Beles and Tekeze basins.

2. Policy / legal frameworks

2.1 Land Tenure

The Government's has recently confirmed state ownership of land (Proclamation No. 456/2005; Proclamation No. 89/1997) but grants access to land for all citizens engaging in agriculture. The Government also stated that all rural land will be measured and the holders be given a cadastral map. This proclamation (Proclamation No. 89/1997) provides for the registration and certification of individual rural land holdings, and provides tenure security and right of transfer in perpetuity. The revised proclamation holds that "*the right to land is exclusively vested in the state and in the peop*le" and grants only "holding rights" to users. Holding rights include leasing rights and inheritance rights. The proclamation is designed to increase tenure security of individual rights holders (peasants) and

emphasizes the importance of land measurement, registration, and certification of those holding rights. Rights remain, however, restricted. The regional states are now expected to revise their regional proclamations according to the revisions in the 2005 (Proclamation No. 456/2005; Proclamation No. 89/1997). The policy (Proclamation No. 89/1997) allows for land to be leased (but not sold) to others provided the holder is not displaced from the land and it also allows the lessee (but apparently not the lessor) to use the right as collateral. Most importantly it defines obligations of rural land users and land-use restrictions. Protection of land becomes an obligation and failure to protect can lead to loss of title.

2.2 National poverty reduction strategies

The main development objective of the Ethiopian Government is poverty eradication. In 2002, the Government of Ethiopia began developing its interim Poverty Reduction Strategy Paper (PRSP-I), namely as Sustainable Development and Poverty Reduction Programme (SDPRP). The guiding strategic framework for the five-year period 2005/06-2009/10 is named "Plan for Accelerated and Sustained Development to End Poverty" (PASDEP). The first phase of the Poverty Reduction Strategy Program (PRSP) process was begun under the Sustainable Development and Poverty Reduction Program (SDPRP) from 2002 to 2005. As part of the poverity reduction the government has designed a comprehensive food security strategy that targets the chronically food insecure especially in highly vulnerable areas: marginal and semi-arid areas that are largely moisture deficient, including pastoral areas, with high population pressure. If such measures can be effectively and sustainably implemented, they can make significant difference (Awulachew et al, 2005).

A growth and transformation plan is the next comprehensive and ambitious poverty reduction strategy of the government for the period 2010 to 2015. Programs under this plan carry forward important strategic directions related to infrastructure human development, rural development, food security, and capacity-building. As reported on the growth and transformation plan document, agricultural production increased from 11.9 million tonnes in 2004/05 to 18.08 million tonnes in 2009/10. The current plan seeks to more than double this figure to 39.5 million tonnes by 2014/15. Estimated GDP and the 2015 forecast showing the contribution of major sectors is summarised in Table 1.

Table 1: Ethiopian Economic Performance 2004/05-2009/10

Sector	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	mean	2014/15
GDP	12.6	11.5	11.8	11.2	9.9	10.1	11.0	14.9
Agriculture	13.5	10.9	9.4	7.5	6.4	6.0	8.0	14.9
Industry	9.4	10.2	9.5	10.0	9.9	10.2	10.0	21.4
Service	12.8	13.3	15.3	16.0	14.0	10.5	14.6	12.8

GDP forecasts were developed from experience and lessons in setting targets over the last five years and include the following strategies:

1. expansion of domestic and export markets in the pastoralist and farming community;
2. private-sector support in agriculture;
3. marketable agricultural commodities will generate foreign currency;
4. encouragement of commodity exchanges among stakeholders and actors;
5. irrigation coverage will increase from 5% to 16% of arable land;
6. improved number and skill of agricultural extension workers; and
7. increased contribution of research and demonstration projects to the growth in all sectors.

2.3 Water legislation

The Water Sector Strategy (2001) has been developed as an instrument to interpret the water policy into action. In order to realize the policy's goal, the objectives in the water sector strategy are: extending water supply and sanitation coverage to larger segments of the society; and enhancing the contribution of water resources in attaining national development priorities. In addition, the country water sector development programme (WSDP), formulated in 2002, includes water supply and sanitation, irrigation and drainage and hydropower development and was designed to be implemented over a 15-year period from 2002 to 2016 (MoWRD, 1999 and Tafesse, 2009). The following are the key policy documents:

(i) Water Resources Management Proclamation 197/2000;
(ii) Water Resource Management Regulations Proclamation 115/2005;
(iii) and (iii) Proclamation for establishment of Awash Basin Water Resources Administration Agency (ABWRAA).

A new River Basin Proclamation is likely to be enacted in the near future. The restructuring was announced when the authority submitted its report and five-year strategic plan to Parliament on April 16, 2010. The restructuring will split the departments into resource management and operating departments, according to Fekahmed Negash, department head of Livestock, Land, and Water Resources Management at the ministry, which oversees the authorities. In the 1995 Constitution of the Federal Democratic Republic of Ethiopia (FDRE) stated that "*the right to ownership of land, as well as natural resources, is exclusively vested in the people of Ethiopia*". In the Water Resources Management Policy which has been provided in 1999 (including in the 2005 Proclamation) also stated that, "*water as the common property of all citizens of the country and recognize to have access to water, and the basic minimum requirement, as the reserve (basic human and livestock needs, as well as environment reserve) has the highest priority in any water allocation plan*" (MoWRD, 1999 and GoE, 2005).

Domestic water supply policy

The overall objective of the water supply and sanitation policy is to enhance the well-being and productivity of the Ethiopian people through provision of adequate, reliable & clean water supply and sanitation services and to foster its tangible contribution to the economy by providing water supply services that meet the livestock, industry and other water users' demands (MoWR, 1999). In line with this, the WSDP intended to reach the national rural water supply coverage to 76% by 2015 (Tafesse, 2009).

Irrigation Water Supply Policy

The existing the water sector policy, strategy and programme, has policy priority and recognises the economic uses of water based on the Dublin Principles of 1992 (that include a concern to the conservation of the water resources, finite and vulnerable environmental resources (MoWR, 1999, and Tafesse, 2009). The current water policy categorises large, medium, and small-scale irrigation schemes (MoWR, 1999):

- Small traditional irrigation includes areas of <1 ha to 100 ha and accounts for ~ 138,000 ha of land involving over 572,331 farmers (mean of 0.24 ha·farmer^{-1}) and more than 89% of irrigated area in Amhara and Oromia;
- Modern small-scale irrigation (< 250 ha) accounting for ~48,300 ha involving over 174,000 farmers (mean of 0.3 ha·farmer^{-1}), 82% of this type of irrigation occurs in Oromia, SNNPR and Tigray;

- Modern private small-scale irrigation accounts for 5,500 ha of irrigated land of which 37% is in Afar, 48% in Oromia and 15% in SNNPR; and
- public irrigation schemes (modern medium-& large- scale irrigations) of between 200 and 300 ha though occasionally exceeding 3000 ha accounting for ~98,000 ha of irriated land of which 40% is in Afar, 37% is in Oromia, and 21% in SNNPR - concentrated in the River Awash Basin (FAO, 2005).

Livestock Water Supply Policy
This policy seeks: (1) to promote the availability of water nearer to pastoralists as much as possible by providing livestock water supplies in all the regions, particularly to the lowland areas; and (2) to harmonize and promote the "user pays" principle with the willingness and ability to pay for livestock water supply, (MoWR, 1999).

Water Supply for Industry
This policy recognises that industrial and other water uses are integral parts of the water sector and incorporate industrial and other users' water supply plans with comprehensive water resources management undertakings. The policy also promotes the "user Pays" principle in the supply of water for industrial and other users; and seeks to ensure that water bodies are protected from pollution by waste water and other wastes indiscriminately discharged by industries and other institutions (MoWR, 1999).

Other Components of the Water Policy
The Water Policy (MoWR 1999; Water Sector Strategy 2001; water sector development programme (WSDP) 2002; Tesfaye Tafesse 2009) also includes hydro electric power generation, inland water transport, aquatic resources policy (establishes and adopts water quality standards and proper assessment procedures that enhance preservation and enrichment of aquatic resources), tourism and recreation, environmental conservation and protection. The other relevant legislation includes Water Resources Management Proclamation 197/2000; Water Resource Management Regulations Proclamation 115/2005 and Proclamation for establishment of Awash Basin Water Resources Administration Agency (ABWRAA) also discussed the above sectors.

3. Literature review

3.1 Parallel initiatives & research projects

Several institutions in the water sector have been established at federal and regional levels under the regionalization and decentralization policy. At federal level, the public institutions involved in water resources development and their remit are listed below.

- Ministry of Water Resources (MoWR) is responsible for the overall planning, development, management, utilization and protection of the country's water resources as well as supervising all water development activities carried out by other institutions.
- Awash Basin Water Resource Management Agency (ABWRMA) is the only basin-level institution established for administering and managing the water resources of the River Awash Basin. At present, most of Ethiopia's medium- and large-scale irrigation projects, salinity and flooding problems are concentrated in this basin. This Agency is responsible for operation and maintenance of the headworks, primary canal, and main drain at Amibara.
- The Ministry of Agriculture (MoA) is in charge of water management (irrigation extension), including water harvesting for smallholder irrigated and rainfed agriculture.

- The Environmental Protection Authority (EPA) is responsible for the preparation of environmental protection policy, laws and directives. It is also in charge of evaluating the impact of social and economic development projects, particularly irrigation and hydropower projects, on the environment.

There are also different initiatives by research, academic, development organizations and private sector. The Mekasa Research Centre is the prominent national research institute involved in agricultural extension and water retention research as well as technology generation. The institute has released a number of improved varieties of cereals and beans. The centre works in partnership with other international and Africa regional research institutions like CIAT, FOODNET and ICRISSAT. Addis Ababa University, Mekelle University, Haromaya University also conduct research on dryland agriculture, rangeland, spate irrigation and markets. Universities and research centres have well established partnerships with the farmers and local development institutions. The Harmaya University research and extension program uses research-extension advisory council (REAC) in strengthening the research outreach program. IWMI also plays a key role in basin research which includes the ongoing CPWF in Nile basin with ODI and other partners. There is a plan to undertake detailed policy and institutional analysis which will be an input to the AWASH basin ESPA initiative.

There are several research initiatives in crop and livestock sector development. In the past, a number of projects have been implemented for the development of livestock in the country as a whole. National projects that had direct relevance to the River Awash Basin include the First Livestock Development Project, the Second Livestock Development Project, The Third Livestock Development Project, Fourth Livestock Development Project, Dairy Rehabilitation and Development Project, Southern Rangelands Development Project and Pan African Rinderpest Campaign. Currently, the major ongoing livestock development projects that affect part or whole of the respective regions in the Awash Basin are the:

- Pan African Control of Epizootics (PACE);
- Pastoral Community Development Project (PCDP);
- Support to Livestock Export from the Horn of Africa (EXCELEX).

The EPA has been given the mandate to lead the sector coordination the national and international initiatives on climate change adaptation and mitigation. The authority has developed its institutional arrangement and structures to effectively manage programmes in this sector. The responsibility was taken from National Meteorlogical Agency (NMA). Similarly there is national network working on climate change, chaired by the Prime Minister, involving various governmental and non-governmental organisations. The network plays key role at national and international level initiatives addressing climate change and its impacts in the country. The National Adaptation Plan of Action (NAPA) was developed and used as a framework for planning and implementation of the climate change mitigation and adaptation activities. A number of projects are under implementation like MERET (WB and government of Ethiopia), irrigation and integrated watershed management supported by UNDP, USAID and other international partners.

3.2 Food security and food production

For over 30 years, responses to food insecurity in Ethiopia were dominated by emergency food aid, costing on average $265 million per year from 1997 to 2002. Ethiopia imports about 15% of its food (Awulachew et al (2005). In the ten years from 1994 to 2003, an average of five million Ethiopians were declared “at risk” and in need of emergency assistance, and since 1998 the numbers of food aid beneficiaries in Ethiopia have fluctuated between 5 and 14 million every year (**Devereux, S. etal, 2006)**. Concerns arose regarding several operational shortcomings in the emergency appeal system’s ability to

maintain a reliable safety net and develop productive assets. While food aid saved lives, it often failed to protect livelihoods, resulting in millions of people sliding into poverty. Consequently, the National Food Security Strategy (NFSS) was developed and rests on three pillars, namely, to increase supply or availability of food; to improve access/entitlement to food, and to strengthen emergency response capabilities.

Realisation of the NFSS is planned through:

(a) increased domestic food crop production and productivity, transformation of subsistence farming into small-scale commercial agriculture and use of household based integrated and market oriented extension package in areas with sufficient moisture;
(b) comprehensive asset building mechanisms to augment production-based entitlement in chronically food insecure households;
(c) increased livestock production and productivity, improved livestock marketing, and promoting agro-pastoralism and sedentarisation on voluntary basis;
(d) promotion of micro and small-scale enterprises through industrial extension services, infrastructure development, encouragement of competitive marketing of inputs and outputs and use of tax incentives for selected commodities to shift the consumption pattern;
(e) enhanced food entitlement of the vulnerable groups through supplementary employment-income support schemes, targeted programs for the disadvantaged groups and nutrition interventions; and
(f) enhanced emergency response capability through better early warning system, surveillance and monitoring, food and relief distribution.

3.3 Parallel strategies to use water to increase food production

Rainfed agriculture dominates agricultural production in Ethiopia; the irrigation sub-sector accounts for only 3% of food production. Export crops such as coffee, oilseed and pulses are also mostly rainfed but other commercial crops such as sugar cane, cotton and fruit are irrigated. Other important irrigated crops include vegetables and fruit trees in medium and large- scale schemes and maize, wheat, vegetables, potatoes, sweet potatoes and bananas in small-scale schemes. The government is giving high attention to the use of groundwater and surface water for irrigation though how use of these resources will meet the target of increasing irrigated land from 5% to 15% is unclear.

3.4 Improving farmer access to markets

Market-Led Livelihoods for Vulnerable Populations (MLVP) is a USAID-funded project working on increasing the engagement of rural Ethiopian households in markets in chronic food deficit areas. MLVP is closely associated with the Productive Safety Nets Program (PSNP) implemented by the Government of Ethiopia (GOE) and its donor partners. Since the start of the PSNP and MLVP, there is a growing realisation that markets are central to poverty reduction efforts. The concept of markets for the poor (M4P) grew out of the realisation that the Sustainable Livelihoods Approach embraced by DFID and other donors was not enough to reduce poverty. The framework was perceived as not well linked to the markets and to overall economic growth.

The agricultural sector is the most important source of food and cash income in rural Ethiopia. Livelihood analyses show, however, that the poorest are not able to sustain themselves from agriculture alone. Lack of arable land, agricultural inputs, and capital mean that they are only able to produce on average 30-40% of their own food needs. The remainder of their food and cash needs must come from

other income generating activities. On-farm labour is still a very important income source but the reality is that the poor are forced to look outside of the agricultural sector in order to make ends meet. In this regard, labour markets and informal markets become very important for the poor.

Part A. River Awash Basin

4. Physical Characteristics

4.1 Location and drainage

Awash basin have a total area of 110, 000 km^2 with a total length of 1200 km. It is situated in east-central Ethiopia. It is surrounded to the north by the Danakil River Basin, to the west by the Abbay River Basin, to the south-west by the Omo-Gibe and Rift Valley Lakes River Basins, to the south-east by the Wabi Shebele River Basin and to the east by the Republic of Djibouti, the Somali Democratic Republic and the Aysha Dray Basin. The basin lies between longitude 7°52'12" N and 12°08'24" N, and latitude 37°56'24" E and 43°17'24" E.

The Awash River originates from Becho west of Addis Ababa at an elevation of about 3,000 m above mean sea level (mamsl) in the central Ethiopian Highlands. It then flows eastwards through the Becho Plains along the Rift Valley before entering the Koka Reservoir, a dual-purpose dam for flood control and hydro-power generation, and terminating in saline Lake Abe at elevation of 250 mamsl. The River Awash Basin has a total length of 1200 km and crosses three administrative regions, Oromiya, Afar and Amhara, and two administrative cities, Addis Ababa and Dire Dawa. The western catchment (64,000 km^2) drains to the main tributaries whereas the remaining area (46,000 km^2) drains to the eastern catchment.

4.2 Demography

The population of the basin in 2007, as forecasted from a population and housing census of 1994, was 14 million out of which about 37.5% of the basin are in Oromiya, 18.7% in Amhara, 9.9% in Afar ,7.5% in Somalia, 22.7% in Addis Ababa and 2.7% in Dire Dawa. There are substantial variations in population densities; highland densities range from 100 to 250 persons·km^{-2}.

4.3 Climate

The climate of the River Awash Basin is strongly influenced by the inter-Tropical Convergence Zone (ITCZ). This zone of low pressure marks the convergence of dry tropical easterlies and the moist equatorial westerlies. The seasonal distribution in rainfall results from the annual migration of the ITCZ. In March, the ITCZ advances across the basin from the south, bringing the small or spring rains. In June and July, it reaches its most northerly location beyond the basin which then experiences heavy or summer rains. It then returns southwards during the August to October, restoring the drier easterly airstream which prevails until the cycle repeats itself in March. Mean annual rainfall varies from ~1600 mm at Ankober in the highlands northeast of Addis Ababa to 160 mm at Asayita along the northern boundary of the basin. Addis Ababa receives 90%of its annual rainfall during the rainy period March to September. Mean annual rainfall over the entire western catchment is 850 mm. Over the headwaters of the River Awash, as gauged at Melka Hombole, mean annual rainfall is 1216 mm. Over the eastern catchment, mean annual rainfall is ~465 mm. The annual and monthly rainfalls are characterised by high variability. Mean annual temperatures vary substantially with elevation (Table 2) and range from 20.8°C

at Koka to 29°C at Dubti; highest mean monthly temperatures at these stations occurring in June, 23.8°C and 33.6°C respectively.

Table 2. Variations in mean air temperature with elevation in the River Awash River Basin.

Mean Temperature (°C)	Altitude (m)	Mean Temperature (°C)	Altitude (m)
> 27.5	< 450	15 - 17	2 250 – 2 550
25 – 27.5	450 – 900	12 - 15	2 550 - 3 100
22.5 - 25	900 – 1 400	10 - 12	3 100 – 3 400
20 – 22.5	1 400 – 1 750	7.5 - 10	3 400 – 3 850
17 - 20	1 750 – 2 250	< 7.5	> 3 850

Source: Land Use Planning and Regulatory Dept; Ministry of Agriculture (1984), updated by WBISPP

4.4 Water Resources

The River Awash River Basin is divided into 7 physiographic units. Each is briefly described below.

- **The Upland basin** features steep headwater streams that receive rainfall in excess of 800 mm per annum and drain into the structural basin of the Becho Plains. In much of the highland area at the western extreme of the basin, annual rainfall exceeds 1200 mm and can be as high as 1750 mm. From the outlet of the Becho Plains, the river drains towards the Koka Dam which marks the eastern limit of the Uplands Basin.
- **The Upper, Middle and Lower Valleys**. Below the escarpment, on which stands the Koka Dam, the Upper, Middle and Lower Valleys of the basin lie within the Ethiopian Rift Valley. The valley has been divided up based on a physiographic analysis but is convenient from a hydrological point of view as well. The Upper Valley is taken to end at the confluence with the Kesem River and thus is supplied by highly incised tributaries including Rivers Keleta and Arba. The Middle Valley which extends as far as Adaitu, is supplied by "wet" western highland tributaries whereas the Lower Valley is supplied by the two large but highly seasonal western highland tributaries, Rivers Mile and Logiya.
- **The Western Highlands** comprise tributaries of Rivers Kesem to Logiya. All of these tributaries originate in wet areas along the watershed with the Abbay River Basin though the proportion of their catchments that lie in the high rainfall zones generally decreases downstream. As a result, Rivers Mile and Logya, the most downstream of the western highland tributaries, are ephemeral in nature compared to the River Kesem despite their large catchment areas.
- **The Lower Plains** lie downstream of River Logiya where the Awash River meanders and terminates at Lake Abe. Very little runoff is generated in this area where rainfall is low.
- **The Eastern catchment** accounts for about 40% of the basin area. Areas of relatively high precipitation exceeding 800 mm·year^{-1} are remote from the main tributaries of the River Awash Basin so that generated runoff generally disappears in the lowland plains without contributing to the basin discharge.

4.5 Land Use

The land area slated for irrigation in the Upper, Middle, and Lower valleys is estimated to be 69,000 ha and is fairly well distributed among the three zones. Traditional irrigation schemes currently cover 21865 ha whereas modern, small-scale irrigation schemes cover 4932 ha. The potential land area for irrigation in the River Awash basin is estimated to be 206,000 ha. The basin suffers, however, from a range of problems that inhibit the realisation of this potential including severe environmental degradation, annual flooding, inefficient uses of land and water resources, socio-economic constraints, poor agricultural practices, low crop yields, and community health problems (Tadesse, 2008).

Major crops grown in the Upper Basin along the River Akaki include: lettuce, swiss charade, carrot, kale, cabbage, potato, cucumber, beans, tomato, pepper, and onions. These crops are produced mainly to supply to the Addis Ababa market. In the Middle and Lower Valleys, there are perennial crops grown dominated by sugarcane and cotton and these occupy the majority of the land produced by government owned enterprises and private investors.

4.6 Livestock Resources

The livestock population of the basin (2007) is estimated to include 6,871,000 cattle, 3,055,000 sheep, 3,640,000 goats, 1,188,000 equines, 411,000 camels, 6,221,000 poultry and 263,000 bee colonies. This is equivalent to over 6,725,000 tropical livestock units (TLU). Within the Upper Basin cattle predominate and small herds, normally limited to 3-5 TLU per family, are primarily used for tillage. Deficiencies in animal feed, fodder and grazing reserves are becoming chronic. Fuelwood shortages further aggravate this situation as it involves increasing use of straws and other crop residues for fuel. In the Upper and Middle Valleys, individual livestock herds and flocks are larger with less demand for **cultivation** as rainfed cropping is marginal. In the Lower Valley, where dessert and semi-dessert conditions prevail, only very low stocking rates can be obtained by transhumance (i.e. transfer of livestock from one grazing ground to another); here, goats and camels dominate livestock populations.

4.7 Aquatic Ecosystem Services

Tourism and agriculture are considered the major ecosystem services in the River Awash Basin. There is abundance of wild animals in the basin that are found mainly in two National Parks, three Wildlife Reserves and three Controlled Hunting Areas. The Awash Basin is the most intensively developed river basin in Ethiopia because of its strategic location that includes a good transportation network. Both facilitate investment and open up market opportunities to develop land and water resources for small, medium and large scale irrigation (MoWRD, 2007). Many of the large irrigation schemes in the Basin were established in the early 1960s by private entrepreneurs (foreign and local investors). Cropping patterns were dominated by commercial crops sugarcane, tobacco and cotton with smaller areas of fruits and vegetables (MoWR, 2007). On small-holder plots, main crops are cotton, maize, banana, sesame, onion, tomato and sweet potato. However, with changes in government, farms have gone through different ownership systems that include State Farms, community groups, cooperatives and private operators. The prevailing situation irrigation development of the Awash is given on annexed table.

5. Socio-political characteristics

5.1 Stakeholders

Since 1984 the number and variety of stakeholders have greatly increased and now comprise six distinct groups: (i) three state farms under the MAAE; (ii) two large private enterprises, Amibara Agriculture Development Enterprise and Africa Agriculture Development Enterprise; (iii) About 17 small private enterprises with land holdings from 4ha to 140ha; (iv) small holders with average landholdings of 1.6ha; (v) the Melka Werer Research Centre; and (vi) Afar clans who are owners of much of the land farmed under lease to the private enterprises, and who also require water for stock watering. With the exception of the MAAE state farms, many of these stakeholders rely on water from both the gravity irrigation system and from pumping stations along the Melka Werer Western dyke.

There are three State Farms (or farm units) managed by the Middle Awash Agricultural Enterprise MAAE: (i) Melka Sedi (2,222 ha); (ii) Sidha Fage (1,008 ha); and (iii) Melker Werer (3,242 ha). In terms of

private enterprises, Afar communities have leased to private enterprises most the 6,000 to 7,000 ha of land transferred to them in 1994. Because the land is owned communally, leasing is arranged through clan leaders and elders. The following farms were transferred:

- Part of Melka Sedi (630 ha),
- Amibara-Angelele (2,500 ha),
- Part of Melka Werer (530 ha),
- RRC settlement farm (2,000 ha), and
- Doffan Bolhamo (1,440 ha) on the bank of the River Awash.

There are currently about 20 private investors leasing these former state farms cultivating cotton. Areas farmed vary from as little as 4 ha but can be as large as 3,000 ha. The majority of the land is shared by two large enterprises: (i) Amibara Agricultural Development Enterprise (about 3,000ha) and (ii) African Agricultural Development PLC (about 500ha).

In terms of small land holders, irrigated agriculture, not leased to private investors, was mostly abandoned due to Afar community's lack of interest in irrigated agriculture, cultural restrictions, communal ownership status, and lack of technical and managerial skills. In recent years, recurrent drought ha resulted in a decline in grazing and browsing resources, and encouraged a significant number of Afars (particularly young men and women) to engage in crop cultivation. Crops grown include cotton, maize, banana, sesame, onion, tomato and sweet potato as part of an agro-pastoralist system. The primary occupation of the Afar is pastoral transhumance in which livestock play a central role. Afar pastoralists depend on livestock either directly (by consuming their products) or indirectly through trading livestock for other commodities such as grain or household goods.

The majority of Afars perceive themselves as pastoralists but persistent drought and the invasion of *weed (unpalatable acacia species)* are major challenges to Afar livelihoods and food security. The capacity of Afar households to exchange livestock and livestock products for goods has been severely eroded. As a result, a limited but growing number of Afar has become involved in arable farming as smallholders, either individually or in co-operatives. Given this change, albeit very gradual, towards a more sedentary lifestyle, future work should seek to involve Afar communities in irrigation farming as well as supporting traditional livestock dependent livelihoods. Concerning irrigated agriculture there are a range of challenges to be addressed:

- shortage of water for small-holders who depend on water from the canal network;
- lack of training and skills in irrigated agriculture coupled with a weak extension system; and
- shortages of crop inputs and equipment.

At the federal level, there are several stakeholders who are involved in the basin. These include: the River Awash Basin Authority and Awash Basin Agency which have the main responsibilities of day to day management and operation, maintenance of the structures and allocation & enforcement of permits for water allocation & discharge. The MoWR is involved in overall coordination and planning as well as conducting research, monitoring and & evaluation. The Ministry of Agriculture and the EPA also have a mandate. At regional levels, the Bureau of Water Resources, Irrigation Authority, Bureau of Agriculture and several NGOs are involved in the system. Other stakeholders include State Farms, large and small private enterprises leasing land from the community, small holder farmers and the clans who lease the land to private investors requiring water for livestock.

5.2 Agricultural Support Organizations

The Ministry of Agriculture provides different services within the basin such as agricultural extension, credit for fertilizer, and improved seeds. In Middle and Lower Valleys, there are high livestock populations for the Ministry also provides support. There are also cooperative offices that facilitate credit applications in an organized form and create opportunities to get access to better markets. In addition to government offices providing different support to the local communities, there exist different NGOs working in the area.

5.3 Water Management Organizations

The MoWR has the responsibility for overall management of the basin and all the issues related to the catchment development. The River Awash Basin Authority located at Amibara is responsible for the day to day operation of development activities in the basin.

The Koka hydro power dam was constructed in 1960 and is managed by Ethiopian electric power authority (ELPA) and other medium to large scale irrigation schemes by the MoWR. As these irrigation developments are done by government owned enterprises and private investors, there is no specific water management body established at local levels. For small-holder irrigation schemes, there are Water User Associations (WUAs) set up by the communities themselves. Each irrigation scheme has a WUA that is responsible for water administration, management, coordinating, operation and maintenance of canals and resolution of disputes among beneficiaries. The membership of the WUA includes both men and women and consists of 1574 family heads and 7630 families. Out of these 28% are women farmers. Farmers manage the operation and maintenance of their schemes. WUAs have their own bank account and are legally registerd as irrigation user's cooperative by the cooperative office. Legalization has been based on the traditional management and water sharing arrangement. The users have close follow up and support from the regional government and sector offices. There are also similar water points in Arsi and Hararghe where the WUAs has been legalised and managing in excess of USD$100k with over 67 water points in 113 km water pipeline.

5.4 Land Tenure System

The land tenure mentioned in the national context (section 2.1) applies to basin level policies. Land certification in the Upper Valley is mainly for crop agriculture in contrast to the Middle and Lower Valleys that are mainly on dependant upon the livestock raising. These pastoralist communities require communal land for grazing which is not included in the certification of land. There are, however, different traditional land tenure systems existing in the community which are recognised by government. 'Customary land rights' are based on a combination of group and individual ownership. The term communal ownership is often used in this country to describe pastoral tenure; other terms that are also pertinent are common property regimes. The group on which rights of ownership is vested frequently is the clan. If a clan has a large population and access to extensive resources, it may be divided into sub-clans and the rights may be vested in the sub-clan. Each group lays claim to a territorial area the boundaries of which are identified by natural land forms such as hills, valleys, lakes/ponds, streams, etc' (Desalegn, 2009). The same paper further explains how the ownership of land by the clan members at birth refers to the right of use only. The clan authority regulates the use of the territory both by clan members and outsiders, and protects its "integrity" from encroachments by others, or enclosure by clan families which may exclude other members from access to the land.

5.5 Water Use Legislation

Water-use legislation includes Water Resources Management Proclamation 197/2000; Water Resource Management Regulations Proclamation 115/2005 and Proclamation for establishment of Awash Basin Water Resources Administration Agency (ABWRAA).

The River Awash Basin Agency is responsible for distributing water diverted at the headwork to all entitled stakeholders as far as the Primary canal Offtake . Distribution along secondary and tertiary canals and in fields is the stakeholders' responsibility. There are only six legal agreements in place between the River Awash Basin Agency and its clients, despite there being many more clients, either small enterprise renting land from Afar, or small holder farmers (MoWR, 2007). These license holders are responsible for the payment of water charges and they re-sell water to small holder farmers taking water from shared canals. Water is transferred from field watercourses into field furrows using plastic hose siphons.

6. Monitoring infrastructure & reporting

6.1 Poverty

The Ministry of Agriculture annually record and report the amount of land under cultivation, types of crops grown, amount improved seeds and fertilizers used which finally used to estimate amount of crop production in the country. At federal, regional and woreda levels, there is an early warning team who regularly monitor the performance of food security indicators. Annually there are two comprehensive assessment coordinated by the Disaster Risk Reduction and Food Security Sector (DRRFSS) of the federal Ministry of Agriculture which involves UN agencies. Chronically food insecure households are targeted in the PSNP program as they are not covering their annual food requirement even in the normal year. There is also a weekly and monthly reporting mechanism from the kebele to the woreda then to the region. The information compiled at the federal level and help in identifying hotspot areas.

6.2 Food production (crops, livestock, fisheries)

The ministry of agriculture assign development agents at the kebele level who closely monitor the amount of land cultivated, type of crop planned, and the performance at various stage of the crop. The volume of production is then reported to respective woreda and regional sector offices. There is also a pre and post crop assessment following the information which has been submitted to the development agent and the woreda.

6.3 Meteorological stations

There are 115 meteorological stations in the River Awash Basin (Figure 2) recording rainfall and temperature. The National Meteorological Agency (NMA) is responsible to storing and sharing these data to the user on a regular basis. The NMA has a good working relationship with agriculture offices and DRMFSS for exchange of data (Source: MoWRD).

The NMA has the mandate to monitor and inform stakeholders on the following:

- Weather monitoring
- Weather forecasting and climate prediction
- Early warnings on unusual, extreme weather related events
- Agro-meteorology
- Hydro-meteorology

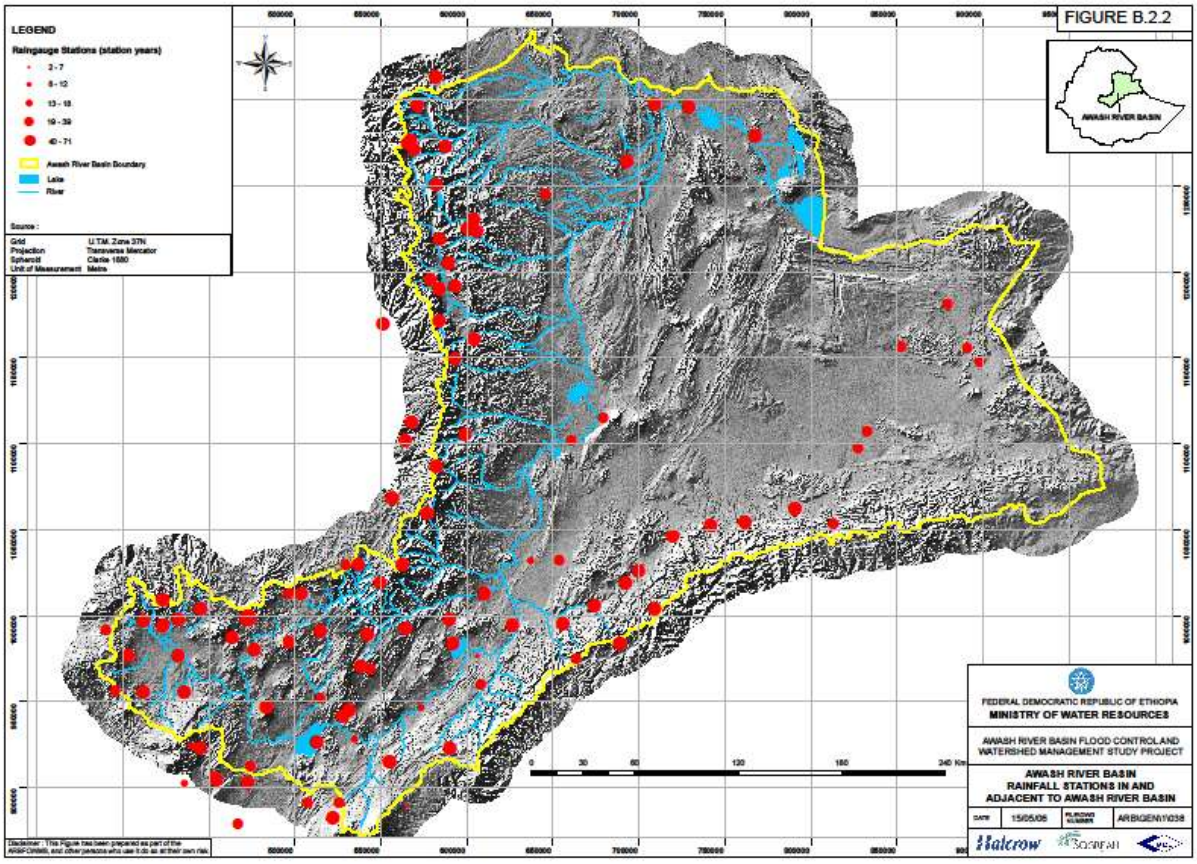

Figure 2. Map showing the location of meteorological stations in the River Awash Basin.

7. Trends

7.1 Food production (crops, livestock, fisheries)

Fishing and aquaculture are of limited commercial importance in the Awash Basin. There is a small fishing industry associated with Koka reservoir and subsistence fishing along the River Awash but no reported fish farming activities. The main fish species found in Koka reservoir are tilapia, carp and catfish and the annual catch is in the order of 500 to 600 tonnes. Primary constraints to fisheries development in the reservoir is the fluctuating water level, which can vary in surface area from 177 km² to 27 km². This considerable, climate-driven variation in the water level and reservoir area limit fish populations. The River Awash Basin is the most developed in Ethiopia. There is an urgent need to establish and police a water allocation system that ensures minimum flow is maintained in all reaches for primary uses and to sustain fish populations.

7.2 Population and population density

The overall population of the River Awash Basin is currently estimated at 12.05 million including the capital city of Addis Ababa. Main population centres reside in the Upper Basin and in upland areas above 1,500 mamsl, the lower limit of rainfed agriculture, and include Dire Dawa, Debre Zeit and Nazareth. Several small towns and villages (e.g. Metahara, Awash Station and Gewane) have developed along the

road network near irrigation projects but, below Nazareth, there are no significant population centres. The rapidly expanding population in the basin is placing increasing pressure on agricultural land and forests which is resulting in overgrazing, deforestation and land degradation. Before the development of the River Awash Valley in 1980s and 1990s the population was broadly divided into two groups, sedentary cultivators (i.e. Amhara and Oromo) in the highlands and pastoralists (i.e. Afar and Issa) in the lowlands. Between the highlands and lowlands, there is a buffer zone which is mainly inhabited by Kereyu. Historically, there has been deep-seated rivalries between the Afar and Issa. Conflicts and disputes have also arisen as a result of irrigation development in the Middle and Lower Valleys that have displaced the Afar grazing lands.

7.3 Land-use change

Free grazing in areas of Soil and Water Conservation (SWC) is prohibited and appropriate SWC measures are required for all lands of <30% slope. Cultivation on slopes of 31 - 60% slope requires bench terraces. Slopes of >60% cannot be used for either cultivation or free grazing. Closure of degraded lands, and compensation for prior users is provided. A minimum holding size is referred to, but this is to be determined by the Regions. In principle, the Rural Land Administration and Land Use Proclamation ensures the land tenure rights of the vast majority of subsistence farmers enabling their desire and ability to invest in their land for fuelwood provision and soil and water conservation. The capacity to enforce the policy in practice remains to be seen as does the emergence of a market to drive agricultural investment.

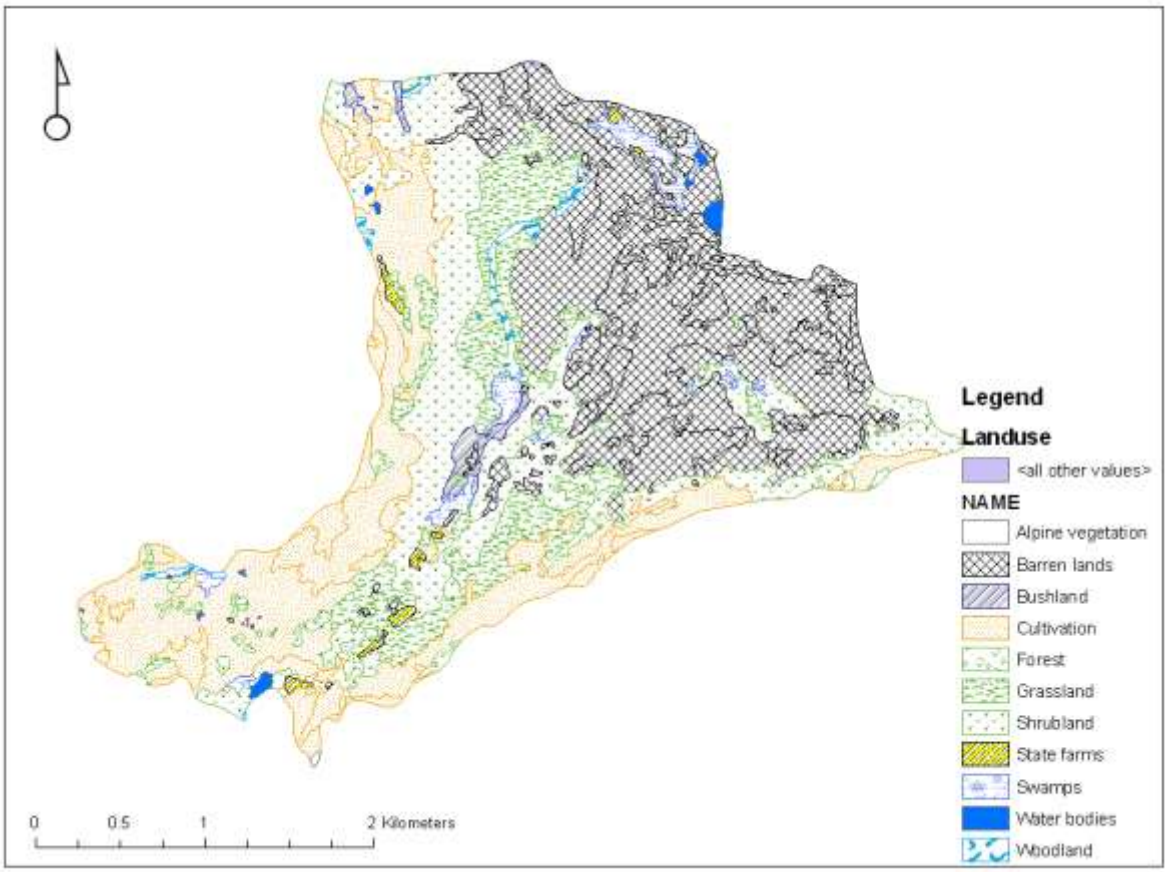

Figure 3. Land use in the River Awash Basin.

The major causes for land use (and climate) changes in the River Awash Basin are:

- agricultural land fragmentation in the upland area due to high population pressures making it very difficult to replenish soil fertility and maintain agricultural productivity in the basin;
- deforestation (forest cover is diminishing annually and has resulted in very high soil erosion, flooding and greater fluctuations in riverflow;
- drought (occurring every year in the lower part of the pastoral area where livestock feed is decreasing and desertification is increasing);
- high population growth and urbanization;
- high livestock populations which has resulted in overgrazing and severe land degradation.

7.4 Rainfall (annual, seasonal, extreme events)

The rainfall regime in the Awash River Basin shows four different rainfall regimes/trends:

- 7 rainy months between March and September, with peaks in April and August;
- 7 rainy months between March and September, generally increasing with a high in August
- 6 rainy months from February to April and June to September.
- 6 rainy months being March and April and the June to September.

In the first part the peak month has a rainfall coefficient inferior to 1.0, while in the second part it is in excess of 3.0. It is important to understand the concept of "rainy" in this context. A "rainy" month is defined as one in with a rainfall coefficient exceeding 0.6. The rainfall coefficient is defined as the mean monthly rainfall total divided by 1/12 of the mean annual precipitation.

7.5 River discharge

Unlike most other river basins in Ethiopia, the water resources of the River Awash Basin have been highly developed and used over the last five decades. Development, particularly of irrigation, continues today. As a result, the availability of water during the dry season can no longer be taken for granted as it was in the past. A number of major irrigation projects are currently being built, designed or planned and it is becoming increasingly urgent to properly evaluate the availability of the water resources and to take measures to best manage these resources.

Despite rapidly increasing use of surface water resources in the River Awash Basin, flooding remains a major risk at certain times of the year. The management of existing and the design (and management) of planned developments needs to ensure adequate flood protection. Storage of the Koka Reservoir is estimated to be declining at a rate of 17 Mm3 per year and the possibility of high sedimentation rates is a major concern for both the Kesem and Tendaho Dams, which are currently under construction. Sediment data, collected by the Hydrology Department, have been analysed carefully and used in the water resources model.

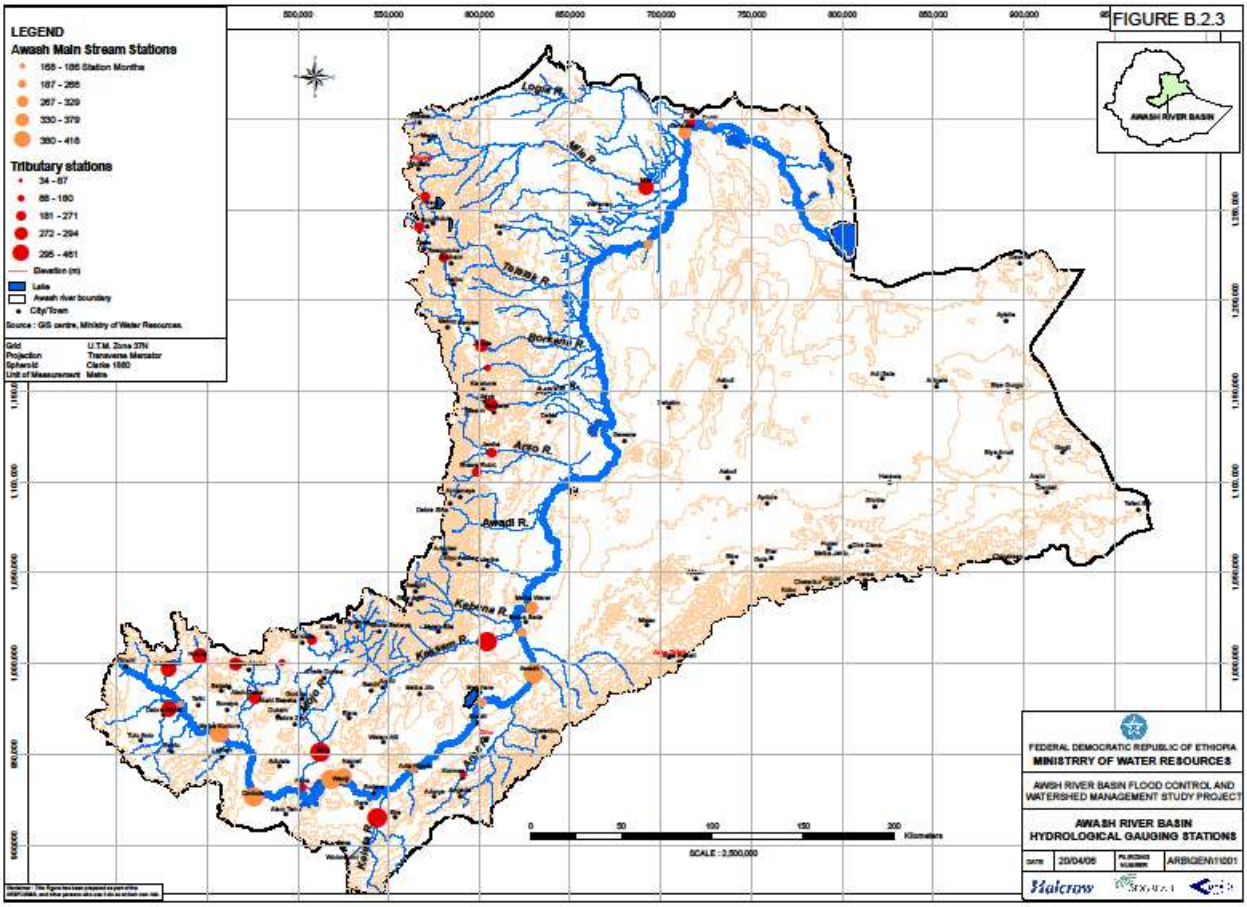

Figure 4. Map showing the location of hydrological stations in the River Awash Basin.

A delicate hydrological balance characterises the lower Awash Basin where, in a normal year, inflows equal losses in lakes and wetlands. Below Dupti in Ethiopia, no appreciable runoff from local rainfall reaches the river. The level of Lake Abe thus rises and falls according to the balance between inflow and evaporation losses. The available water from rainfall in the basin is 39,845 ($Mm^3 \cdot year^{-1}$), 72% of the rainfall (28,383 $Mm^3 \cdot year^{-1}$) is lost through evapotranspiration, 18% (7,386 $Mm^3 \cdot year^{-1}$) contributes to runoff and 10% (4,074 $Mm^3 \cdot year^{-1}$) contributes to groundwater recharge (EDSA 1989) .

8. Adaptation strategies (to development & climate variability and change)

8.1 Traditional knowledge' for adapting to rainfall variability

The climate information is solely maintained by the NMA. Data are reported daily and weekly and are used by the agriculture sector to inform farmers through development agents working at village level. Climate information guides farmers in cropping and harvest times. Linkages between the NMA and the agriculture are increasing. In the River Awash Basin, different studies have identified several traditional knowledge and practices (largely in the pastoralist communities), eco- friendly and adapting to rainfall variability. In the pastoral livelihoods zones, adaptation strategies to variable rainfall include seasonal mobility, herd diversification (camel goat, sheep…), rotational grazing, and seasonal rangeland differentiation into wet and dry season grazing reserves (e.g. using riparian belts during dry seasons only), resources sharing, and reduction in consumption (Amsalu & Adem , 2009, Kaur, et al, 2010, and

ECSNCC, 2010). In the agricultural livelihood zones, adaptation strategies include mixed farming systems (crop and livestock), crop diversification, which includes the plantation of climate resilient crops, crop rotation, fallow, contour bunding to mitigate the impact, and grain storage. There are also different traditional institutions such as: debo, jigi, local water management norms; etc.

However, due to complex and diverse set of exogenous and endogenous pressures & factors the traditional knowledge, customary farm practices and institutions through time they are badly depleted (Rahmato, 2009).

8.2 Crop rotation, changes (minimal risk vs. maximum return)

The RiPPLE case study which has been undertaken around West and East Harargh areas; reveal that over time irrigated chat production showed a continuous increasing trends, through increasing farm size, replacing cereals & abandoning crop rotation, fallow and increasing irrigation water use. They usually use motorized pumps to get water from distant places. This is an excellent example of market driven production system and adaptation strategy (Kaur, et al, 2010), to minimize risks of rainfall variability.

8.3 Use of agricultural advisors / extension / support workers

Despite the country extension system has longer history than many sub-Saharan Africa countries; in the Awash Basin agricultural extension service to farmers has not been adequate in terms of coverage and providing quality services. In most cases, many of the district offices are understaffed; frontline staff is overburdened, together with insufficient budget and logistic supports, lack of incentives for DAs, etc, limiting the effectiveness and sustainability of the extension services (Fant, & Ali 2003 and MoWR, 2007).

8.4 Use of climate and water information

Empirical evidences show that there have been for long reliability issue in relation to weather forecasts in Ethiopia, including lack public trust. As per the RiPPLE case study that conducted in Awash Basin, meteorological records which have been taken from three stations were scanty and incomplete and lack of longer records (Kaur et al, 2010).

8.5 Drought mitigation

Traditionally activities such as rainwater harvesting, constructing dams, ponds to retain water during the dry season) and runoff irrigation (spate irrigation) is widely practiced in Chercher plain around Mehoni (). However, through the government initiated soil and water conservation programme, some efforts have been made for construction of farm ponds and micro-dams as alternative intervention to respond the 1971-74 droughts in Hararge, including in Wollo and Tigray. Since then however the intervention have been extended to other part of the country with very limited coverage. While, in the area of small-scale household water harvesting programme, has received due attention and made considerable progress nearly over the last ten years (Nega, 2003).

Currently, there are different ongoing interventions and initiatives with drought mitigation features, such as expanding use of water harvesting, construction of reservoirs, water conservation, improving irrigation efficiency; construction of dykes; promoting use of ground water; construction of sand dams; etc, in the basin.

However some of these interventions have failed due to myopic project planning, inadequate engineering studies, unsound designs, too short a time for implementation and lack of full farmers' involvement at different levels of project planning and implementation (CSNCC, 2010), and also,

according to the recent Public Works under PSNP impact assessment, in some case some communities have developed negative feeling and reduced sense of ownership for the micro-dam due to poor consultation process (WB, 2009).

9. Literature review (basin level)

9.1 Complementary initiatives & research projects (past & present)

The regional/sub-national institutions involved in the water sector include:

- The Bureau of Water, Mines and Energy (BoWME) and/or Bureaux of Water Resources Development (BoWRD) which exist in some regions and are responsible for small-scale irrigation and rural water supply as well as small-scale hydro power development.
- The Commissions for Sustainable Agriculture and Environmental Rehabilitation (Co-SAER) and the Irrigation Development Authorities which undertake operational activities in line with their mandates (study, design and construction of small-scale irrigation schemes).
- The Bureaus of Agriculture (BoA) have similar functions at the regional scale as the MoA.
- Several NGOs are involved in the water sector, particularly in small-scale irrigation and rural water supply projects.

As reported by the MoWRD basin directorate, there is no well structure information on various initiatives in the basin. However there are different research projects initiatives by research organizations, academic institutions, development organizations, private sector investors, basin institution and students. There is Amibara Research Station in the middle of the basin that undertakes research in agriculture, crop and livestock, water resources management mainly irrigation and also do some trial on salinity. Mekasa research center is also the prominent national research institute involved in agricultural research and water retention technology. The institute release a number of improved varieties of cereals and beans. The centre have a very good partnership with other international and Africa regional research institutions like CIAT, FOODNET, ICRISSAT and others. Addis Ababa University, Mekelle University, Haromaya University are also conducting different researches related to dry land agriculture. Harmaya University has been involved in rangeland development and spate irrigation.

Irrigation development is continuing in the basin both by Regional and Federal Government and the private sector. Most of the irrigation farms that were abandoned following the downfall of the formers regime are now taken up by the private sector and are producing different products for export and local consumption. The Oromia Regional Government is also developing large scale irrigation near Metehara about 7000 ha for food production. The Ministry of Water Resources is constructing two large dams in the middle of the basin at Kessem Kebena and Tendaho to irrigate about 70,000 ha of sugar cane plantation that will feed into sugar factories under construction. The schemes have out grower arrangement and irrigated pasture for livestock. There are also new irrigation scheme in different parts of the basin either for food production or other commodities that will contribute to the agenda of food security. There are private investors concentrated in the basin which are involved in floriculture, and vegetable production and marketing. They link their production with research institution for technical support and variety verification.

There are also watershed management projects aimed at protecting the dams from siltation. The Mille Dirma Watershed management project is under-implementation the Ministry of Water and Energy in collaboration of the Bureau of Agriculture of respective regions. However the basin master plan has not been updated and lacks coordinated intervention. There are also large number of NGO's, cooperative and cooperative union involved on various socio-economic activities.

9.2 Parallel strategies to improve food security (production)

The New Coalition for Food Security Programme suggested that Integrated Participatory Watershed Management Planning should form the basis for planning and implementation of food security programmes just as the Community Based Participatory Watershed Development Approach (CBPWD) is now the national policy approach to rural development.

9.3 Parallel strategies to use water (irrigation) to increase food production

In the early 1990s, following the government's new economic policy, ownership of irrigation schemes was transferred to local communities as compensation for lost cropping and grazing lands. In most cases however, the communities did not use the land themselves for irrigation and either abandon the land or leased it to investors who are currently operating the farms growing cotton, broomcorn and other crops. A total of 24,397ha, in eleven schemes, has been transferred to local communities as a strategy to increase food production and enhancing income to the community. A number of the schemes are currently abandoned or left fallow with small parts being operated either by private firms or used for intermittent cropping by the local communities. Many of these lands have now been covered with bushes and trees and will require significant rehabilitation work.

9.4 Reports on improving farmer access to markets

The accessibility of River Awash Basin for irrigation has attracted investors on commercial farm investment. Small-holder framers are also producing for market. In addition the market outlets in Djibouti, Somaliland and Addis Ababa have improved market access to farmers in the basin.

References

Aboma, Girma (2008) Effective financing of local governments to provide water and sanitation services in Ethiopia, Water Aid Ethiopia Publication. Addis Ababa, WAE

Admassie, Yeraswork (1995) Twenty Years to Nowhere: Property Rights, Land Management and Conservation in Ethiopia. Uppsala: Uppsala University

African Development Bank (AfDB) (2003) Ethiopia Agricultural Support Project. Appraisal Report, Agricultural and Rural Development Department, 217 North, East and South. Tunis: AfDB

Alemu, Getnet (2009) *Proceedings of the sixth international conference on the Ethiopian Economy*, Addis Ababa, EEA

Amsalu, Aklilu and Adem, Alebchew (2009) *Community perspective on climate change impacts and the responses in southern lowlands of Ethiopia*. Addis Ababa: FSS

Awulachew, S. B., D. J. Merrey, A. B. Kamara, B. Van Koppen, F. Penning de Vries and E. Boelee with editorial assistance from G. Makombe (2005) Experiences and Opportunities for Promoting Small-Scale/Micro Irrigation and Rainwater Harvesting for Food Security in Ethiopia. IWMI Working Paper 98. Colombo: IWMI

Awulachew, S. B., D. J. Merrey (2006) *Assessment of Small irrigation and Water Harvesting in Ethiopian Agricultural Development;* International Water Management Institute (IWMI): Ethiopia

B. Tadesse, T. Girma, P. Don (2002) Community Based Traditional Irrigation Schemes Performance: A Case Study of Upper Awash River Basin of Addis Ababa Sub-Catchments; Ministry of Ariculture (MoA) and ILRI; Addis Ababa

Belay K. and W. Manig (2004) Access to Rural Land in Eastern Ethiopia: Mismatch between Policy and Reality. *Journal of Agriculture and Rural Development in the Tropics and Subtropics,* 105 (2): 123-138

Central Statistical Authority (CSA) (2007) Projection from National Population and Housing Census of Ethiopia (2007), Addis Ababa, Ethiopia

CSA (2007) Census Report Final http: www.csa.gov.et

Degefe, Befekadu and Niga, Berhanu (2000) Annual *Report on Ethiopian Economy*. Addis Ababa: EEA.

Food Security Coordination Bureau (2004) The Federal Democratic Republic of Ethiopia Food Security Coordination Bureau, the New Coalition for Food Security in Ethiopia Food Security Program Monitoring and Evaluation Plan October 2004 – September 2009: November 2004, FSCB M&E Task Force

ECSNCC (2010) Climate Change Researches in Ethiopia: A Collection of Selected Abstracts. Addis Ababa, ECSNCC

EEA (2005/2006) Ethiopian Economy over view, Addis Ababa

Eshetu, S., Belete, B., Goshu, D., Kassa, B., Tamiru, D., Worku, E., Lema, Z., Delelegn, A., Tucker, J. and Abebe, Z. (2010) *Income diversification through improved irrigation in Ethiopia: impacts, constraints and prospects for poverty reduction*. RiPPLE Working Paper. Addis Ababa, RiPPLE

Fant, Tesfahune and Ali, Osman(Ed) (2003) Proceedings of the Food Security Conference 2003: Challenges and Prospects of Food Security in Ethiopia, UNCC, Addis Ababa

FAO (2005) *Irrigation in Africa in figures. AQUASTAT Survey – 2005. Water Report 29*. Rome: FAO

Gebremedhin, Berhanu & Peden , Don (2003) Policy and Institutions to Enhance the Impact of Irrigation Development in Crop-Livestock Mixed Systems in the Highlands of Ethiopia. In Fant, Tesfahune and Ali, Osman(Ed) Proceedings of the Food Security Conference 2003: Challenges and Prospects of Food Security in Ethiopia, UNCC, Addis Ababa

GoE (2005) *Federal Negarit Gazeta*, Proclamation No. 197/2000, Berehanena Selame Printing Enterprise, Addis Ababa/Ethiopia

GoE (Government of Ethiopia) (2007) *Climate Change National Adaptation Programme of Action (NAPA) of Ethiopia*. Ministry of Water Resources and National Meteorological Agency, Addis Ababa

GoE (2005) Proclamation No. 456/2005, Federal Democratic Republic of Ethiopia Rural Land Administration and Land Use Proclamation

GoE (2007) Council of Ministers Regulations No. 135./200 7 COUNCIL OF MINISTERS REGULATIONS ON THE PAYMENT OF COMPENSATION FOR PROPERTY SITUATED ON LANDHOLDINGS EXPROPRIATED FOR PUBLIC PURPOSES

GoE(1997) the Federal Gorvernment of Ethiopia Rural Land Administration Proclamation No. 89/1997

GoE (2004) The Ethiopian Productive Safety Net Program, Addis Ababa

IWMI (2006) Resources on Micro-Agricultural Water Management in Southern Africa. A CD based report, May 2006, South Africa, IWMI

IWMI (2006) Resources on Micro-Agricultural Water Management in Southern Africa. A CD based report, South Africa, IWMI

Julie Van Domelen and Sarah Coll-Black (2010) DESIGNING AND IMPLEMENTING A RURAL SAFETY NET IN A LOW INCOME SETTING: Lessons Learned from Ethiopia's Productive Safety Net Program from 2005–2009, April 2010

Kassa, Habtemariam (2009) *Agricultural Extension in Ethiopia: Historical Evolution, Relevant Policies, and Challenges. In Assefa, Taye (Ed) Digest of Ethiopian's National Policies, Strategies and Programs*, Addis Ababa: FSS.

Kassahun, Daniel (2007) Rainwater Harvesting in Ethiopia. FSS Publication, Addis Ababa: FSS.

Kaur, N., Getnet, M., Shimelis, B., Tesfaye, Z., Syoum, G. and Atnafu, E. (2010) *Adapting to climate change in the water sector. Assessing the effectiveness of planned adaptation interventions in reducing local level vulnerability.* RiPPLE Working Paper. Addis Ababa, RiPPLE.

MoARD (2010) *National Food Security Strategy of Ethiopia*, Ministry of Agriculture & Rural Development, Addis Ababa

MoFED (2002*) Sustainable development and Poverty Reduction Program*, Ministry of Finance & Economic Development, Addis Ababa

MoFED (2006) *Program for Accelerated and Sustainable Development to End Poverty (PASDEP)*, 2006-2010, Addis Ababa

MoFED (2010) *Growth and Transformation Plan of Ethiopia, 2010/11-2015/16*, Ministry of Finance & Economic Development, Addis Ababa

MoFED (2008) Ethiopian Economy overview, Addis Ababa

Moriarty, Patrik et al (2009) Reaching Universal Access: Ethiopia's UAP in SNNPR, RiPPLE Working Paper, Addis Ababa

MoWR (1998) *Water Resources Management Policy*, Ministry of Water Resources, Addis Ababa

MoWR (2001) *Ethiopian Water Sector Strategy*, Ministry of Water Resources, Addis Ababa

MoWR (2002) *Water Sector Development Program: Water Supply and Sanitation Sub-Sector Development Program, 2002-2016,* Ministry of Water Resources, Addis Ababa

MoWR (2005) *Universal Access Program for Water Supply and Sanitation (UAP), 2006-2012*, Ministry of Water Resources, Addis Ababa

MoWR (2009) *Review of Rural Water Supply UAP Implementation & Reformulation of Plans and Strategies for Accelerated Implementation (Summarized Version), 2009-2012,* Ministry of Water Resources, Addis Ababa

Nega, Hune (2003) Rainwater Harvesting Technologies and The Contribution to Household Food Security in Dry Land Areas of Ethiopia. In Fant, Tesfahune and Ali, Osman(Ed) Proceedings of the Food Security Conference 2003: Challenges and Prospects of Food Security in Ethiopia, UNCC, Addis Ababa

OSSREA (2009) Assessment on Poverty Reduction Strategies in Sub-Sahara Africa: The Case of Ethiopia, Kenya, Malawi, Rwanda, Uganda, and Zambia, OSSREA Synthesis Report. Addis Ababa: Eclipse Printing & Graphics.

Rahmato, Dessalegn (2004) *Searching for Tenure Security thee Land System and New Policy Initiatives in Ethiopia*, FSS, Addis Ababa

Rahmato, Dessalegn (2009) *the Peasant and the State: Studies in Agrarian Change in Ethiopia 1950s-2000s*.Addis Ababa: AAU Press

Rahmato, Dessalege (2009) the Crises of Livelihood in Pastoral Societies in Ethiopia, FSS, Addis Ababa

S. Devereux, R. Sabates-Wheeler, M. Tefera, H. Taye, (2006) Ethiopia's Productive Safety Net Program (PSNP) Trends in PSNP Transfers Within Targeted Households Final Report 10 August 2006; Institute of Development Studies, Sussex, UK and Indak International Pvt. L. C., Addis Ababa, Ethiopia

Teshome Atnafie (2006) Irrigation Policies, Strategies and Institutional Support Conditions in Ethiopia Proceedings of Symposium on Best Practices and Technologies for Agricultural Water Management in Ethiopia, March 7-9, 2006, Addis Ababa, Ethiopia

T. Tesfaye (2008) Forum for Social Studies (FSS), Digest of Ethiopian Policies, Strategies and Programs, Review of Ethiopian's Water Sector Policies, Strategies and Programs, Taye Assefa (ed), part II Economics Sector, Addis Ababa/Ethiopia.

WB (2006) Ethiopia: Managing Water Resources to Maximize Sustainable Growth: A World Bank Water Resources Assistance Strategy for Ethiopia. Washington DC

WB (2009) *Impact Assessment of the PSNP Public Works Programme*, Volume II: Main Report, M.A. Consulting Group, Nairobi in association with Prospect Development Consult, Addis Ababa.

WB (2006) Ethiopia: Managing Water Resources to Maximize Sustainable Growth: A World Bank Water Resources Assistance Strategy for Ethiopia. Washington DC: World Bank.

WB (2009) *Impact Assessment of the PSNP Public Works Programme*, Volume II: Main Report, M.A. Consulting Group, Nairobi in association with Prospect Development Consult, Addis Ababa

UNDP (2007) Human development index 2007

UNEP (2008) Freshwater under Threat: Vulnerability Assessment of Freshwater Resources to Environmental Change-Africa, UNEP, Nairobi, Kenya

UNICEF (2007) Retrieved from the www on 2nd of June 2010
http://www.unicef.org/infobycountry/ethiopia_statistics.html#69

https://beta.worldbank.org/content/ethiopia-economics-adaptation-climate-change-study

Annexes

- Meteorological station List Awash RB
- Irrigation Development in Awash River Basin
- Awash River Basin population by region, zone and woreda
- Existing and potential net irrigation areas in the Awash valley (Halcrow 1989)
- Land use and land cover