Statues quo analysis, Characterization and Assessment of Performance of Irrigation in Ethiopia

Seleshi B. Awulachew and Aster Denekew Yilma
International Water Management Institute for Nile Basin and East Africa
s.bekele@cgiar.org

Abstract

This paper first looks in to the background on major challenges of Ethiopia with respect to poverty. It discuses the root cause of poverty and its vicious cycle nature, the interlink of population growth, the scarcity of land and natural resources, the extension of agriculture in to marginal land, the decreasing productivity, inability to invest and deepening of poverty and further aggravation as a result of various shocks such as drought, flood, war, etc. The paper also looks in to the importance of the broad agricultural water management in general and irrigation in particular with respect to increasing productivity and capability to break the vicious cycle and opportunity to reverse in to virtuous cycle that can help eradicate poverty and develop the poor economy. The paper also looks in to how poor management of water resources and impacts of variability of rainfall and related drought affecting the socio-economy and the overall wellbeing of the country to the extent that significant population became dependent on imported food. Results of broad assessment of water resources, database of irrigation development and potential, characterization by typology and major performance in Ethiopia are presented. Key water resources information related to each of the 12 river basins in Ethiopia is summarized. Details of existing irrigation and future potential are also captured in the paper. A geographic information system (GIS) database describing irrigation by typology, region and location, scheme size, type of structures, water source, number of beneficiaries, investment cost, etc, are some of the important attributes of the database. In addition, schemes that are operational and failed are identified in the database. Based on the broad database, performances of the schemes are highlighted. Furthermore, the various sites that are used in the detail study and the selection criteria for the impact of irrigation on poverty and environment project and the specific characteristics of these sites are described.

Key words: poverty, water scarcity, database, GIS, irrigation, water resources.

1. Introduction

Ethiopia is mainly agrarian nation and the rainfed system has always played a central role in Ethiopian society. Dependency on rainfed system has put more than 80% of the society at the mercy of meteorological variability.

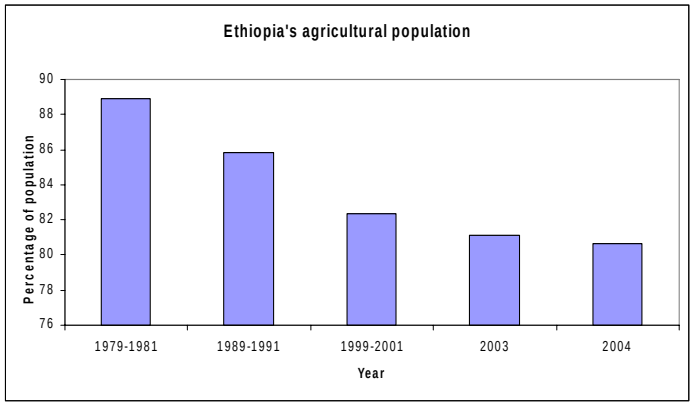

Figure 1: Ethiopia's agricultural population (data extracted from the World Bank Development Indicator WB 2006b)

Figure 1, shows the dependency of Ethiopian population on agriculture and in 25 years the agricultural population reduced only from 89% to 81%. Agriculture in Ethiopia is dominated by small holder production of cereals under rainfed condition, accounting a total area of approximately 10 million hectares. According to Central Statistics Authority [CSA, 1995-1999], within agriculture, some 60 percent of the output is from crops, with livestock and forestry producing 30 percent and 7 percent respectively. Crop production by area is predominantly cereals (84.55 percent) followed by pulses (11.13 percent) and others (4.32 percent). Five crops account for almost all cereal production: maize (15.75 percent), teff (*Eragrostis tef*) (25.78 percent), barley (12.29 percent), sorghum (12.39 percent) and wheat (10.76 percent). According to Mulat et al (Mulat et al 2004), agriculture remains the main activity in the Ethiopian economy. It is the most important contributor to the country's GDP: accounted, on the average, 65.5%, 52.7% and 47.1% of the GDP during 1960-1973, 1974-1991 and 1992-2002, respectively.

Despite the above mentioned facts, there are a number of factors that led to failure of achieving food security in Ethiopia. The major causes for food insecurity in Ethiopia can be associated to the following:

- Population growth and associated inadequate resource base to support
- Lack of growth of production and productivity
- Vulnerability to climatic variability
- Political instabilities and war
- and poverty

The main development objective of the Ethiopian Government is poverty eradication. Hence, the country's development policies and strategies are geared towards this end (MOFED: PASDEP 2006). As Ethiopia's economy and majority of people's livelihood is dependent on Agriculture, to develop the socio-economy of Ethiopia and eradicate poverty, the policy and interventions should focus on Agriculture as entry point. The current rural development policy and strategy of the government clearly stipulates this as priority.

Building further on the above factors, the poverty situation in Ethiopia is a vicious cycle in nature and requires key entry points for intervention. The following figure is a schematic example showing poverty is linked to and aggravated by various demographic, biophysical, production system, productivity and other socio-economic factors.

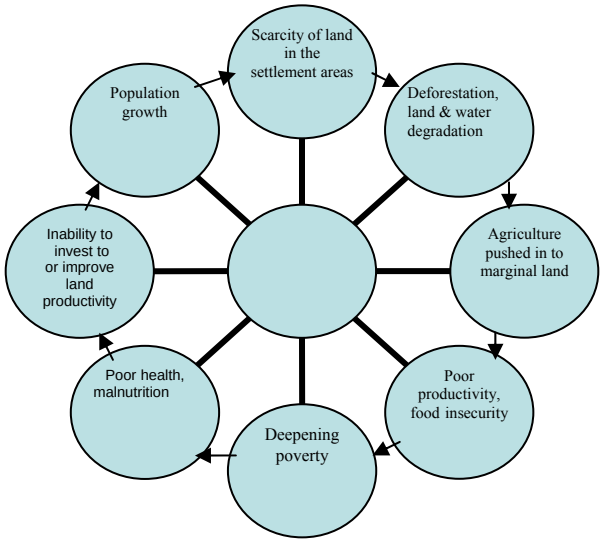

Figure 2: The vicious cycle of poverty and aggravating factors in Ethiopia

Socioeconomic development and civilization of human being is closely associated to ability to utilize and control water resources. Water serves as a positive input for many activities and play negative roles. Positively, it serves essential biological needs, as basic element of social and economic infrastructure, and as a natural amenity contributing psychological welfare. Water also serves in negative roles such as flooding and diseases transmission. In Ethiopia, as in all societies, there has always been a struggle to reduce the negative/destructive impacts of water and

enhance its positive/productive impacts, but with limited focus and capacity. These efforts have been increased since the past three to four decades and more so during the last few years. However, the ability to use and enhance the positive role of water and to reduce its negative impacts, in Ethiopia in general has been low.

2. The Importance of Agricultural Water Management and Irrigation in Ethiopia

It is essential to increase agricultural productivity in order to eradicate poverty, improve the economy, and reduce degradation. Irrigation and improved agricultural water management practice is important in Ethiopia for the following major reasons:

- Population in Ethiopia is rapidly increasing (over 80,000,000 currently), land holding size particularly in highland areas is decreasing substantially. Intensification and increasing productivity of land and labour is essential to produce enough food, particularly from the limited available land.
- Agriculture is primarily rain fed dependent. Unless the rain fed system is upgraded through improved water management, recurrent drought and dry spell continue to affect productivity and hamper agricultural production
- Ethiopia's economy is strongly dependent on rain fed based agriculture, and rainfall variability impact costs the economy significantly. Therefore, unless agriculture is de-linked from the strong linkage to rainfall variability, the economy of the country will continue to be severely affected. Particularly, this could be more severe under the strong impact of climate change and variability. WB (2006) and IWMI (2007) describe the impact of costs 1/3rd of growth potential of Ethiopian economy. The impact of this can be shown from the recent information. According to MOFED (MoFED 2006), GDP Growth of Ethiopia in 2002/3 was -3.3% during the drought year while the previous and latter years were positive. In 2004/5, GDP growth was 11.9% and 2005/6 was 10.6%, which brings the three year average down to 6.4%.
- Improved agricultural water management and irrigation can increase productivity of land, water and labor. The following figure based on Central Statistical Authority data and Mulat et al (2004) shows the crop productivity and productivity growth for the period of the last two decades for major crops in Ethiopia. However, recent data of 2004/5 onwards and predicted productivity data according to MOFED (2006) shows there has been increase in productivity of cereals. The increase is mainly attributed to increased input use (seed, fertilizers, and pesticides) and improved water management for agriculture in certain areas. The strategy to achieve the future targeted result focuses to use intensification (irrigation, vertisol management, seed, fertilizer, pest control) and expansion.

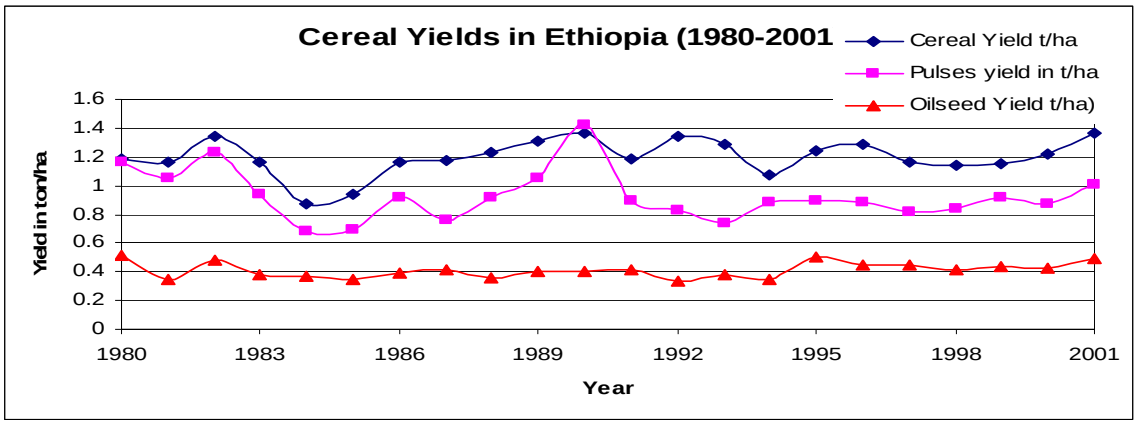

Figure 3: Crop yield in Ethiopia for the period of 1980-2001 (Data source: Mulat 2004)

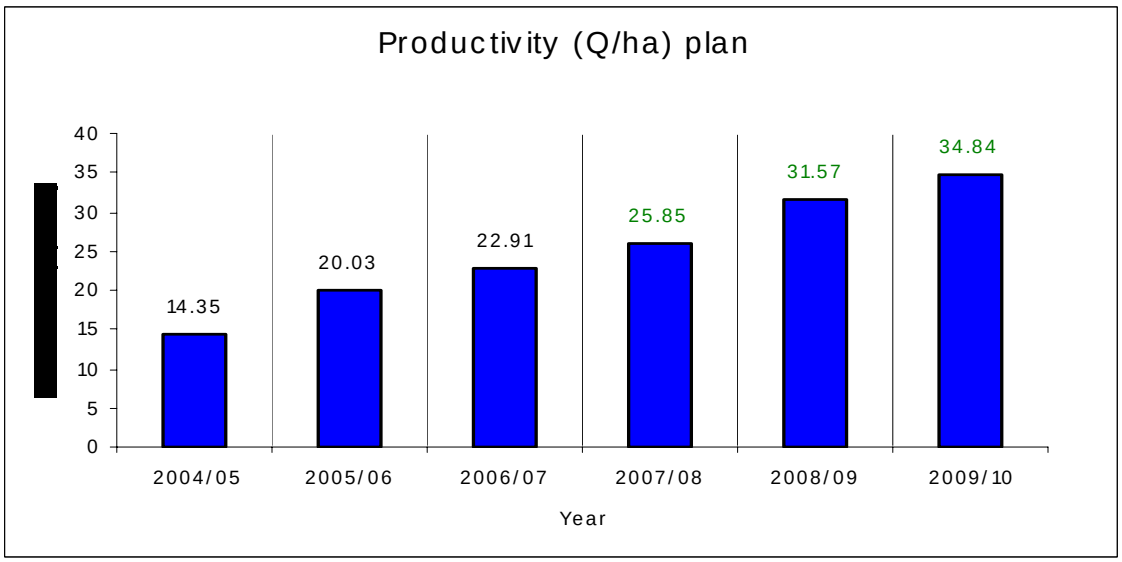

Figure 4: Cereal productivity and productivity Plan of Ethiopia (Data source: MOFED, PASDEP 2006)

- Contrary to the first bullet above, there are considerable land and water resources in various relatively remote parts of the country. The constraining factors for development however are low infrastructure that includes accessibility such as roads, and communication; unregulated water resources; no settled people to develop the resources; lack of capital; and lack of knowledge and capacity. Improving on these can enhance development of these resources. Particularly, the irrigation development through improved infrastructure is an important measure that may be pursued in Ethiopia to cope with complex problems

leading to poverty and insufficient food production

The major sources of growth for Ethiopia is still conceived to be the agriculture sector, as it is expected to be insulated from drought shocks through enhanced utilization of the water resource potential of the country (through development of small scale irrigation, water harvesting, and on-farm diversification), coupled with strengthened linkages between agriculture and industry

(agro-industry), thereby creating demand for agricultural output (MOFED 2006).

Irrigation development, including large and medium scale irrigation development, as public schemes, commercial farming and for small holders are getting importance under the current government, particularly since 2004.

3. Irrigation Status in Ethiopia

3.1 History

There is no documented history of water management for agriculture. Remnants of millennium old water storage structures for non-agricultural use around Axum in Tigray show the oldest usage of water in a controlled manner. Certain, non-irrigation related technologies to conserve water and soil have been practiced by Konso people in the South, at least for the last four hundred years. However, there is no well-documented resource material on water use for irrigation in Ethiopia. Modern irrigation development in Ethiopia is not having centuries old history. There is no written history on how Ethiopia has used irrigation technologies to secure agricultural production, as the vast country with small population had adequate natural resources base and rainfall to produce the food requirements without the need to develop irrigation.

Private concessionaires who operated farms for growing commercial crops such as cotton, sugarcane and horticultural crops started the first formal irrigation schemes in the 1950s in the upper and lower Awash Valley. In the 1960s irrigated agriculture was expanded in all parts of the Awash Valley and in the Lower Rift Valley. The Awash valley saw the biggest expansion in view of the water regulation afforded by the construction of the Koka dam and reservoir that regulated flows with benefits of flood control, hydropower and assured irrigation water supply. In addition, the construction of the tarmac Addis-Assab road opened the Awash Valley to ready markets in the hinterland as well as for export (Metaferia, 2004). Although certain aspects of the development during the pre-Derge era have wrong doings in terms of property and land rights, there has been remarkable emergence of irrigation development and establishment of agro industrial centers. Teshome (2003) has reviewed and discussed the land tenure system in the various regimes in Ethiopia. These establishments were highly motivated private sectors, which are both export and domestic market oriented.

During the Derge era, all private farms were nationalized to establish the so-called state farms, thereby ending the embryonic private sector. The government pursued the development of medium and large-scale irrigation schemes in a number of river basins in addition to expansion in the Awash Valley. The Amibara Irrigation Project in the Middle Awash, Alwero Irrigation Project in Gambella, Gode-West Irrigation near Gode town, the Omorrate Irrigation scheme in Southern Omo, the Tana Beles, the Fincha Suger State, etc are some of the expansions, most of which are suspended currently.

Following the downfall of the Derge, the current government withdrew from the expansion of State Farms and further construction of medium and large-scale irrigation (Metaferia, 2004). This has been the trend until the aftermath of the 2002/3 severe drought that has caused about 15 Million population under extreme food shortage. Not only the government hesitated to expand medium and large scale irrigation but also it has interrupted finalization of the above 5 major irrigation projects started in the former regime. On the other hand, the government indeed provided certain attention on small scale irrigation mostly in the food insecure areas. Nevertheless, in the water sector development program (WSDP) it was identified to expand large and medium scale irrigation by about 147,000 ha

and small scale irrigation by about 127,000 ha. As strategy of developing irrigation sector, the plan of the government targets to develop a total of additional 274,612 ha of land which brings the total irrigated area of about 478,000 ha by 2015. Despite ignoring the medium and large-scale sector for a decade long, recently after the development of the water sector development program, there is a growing attention to the irrigated agricultural sector. The revised strategy even plans to put more irrigated land in short period of time.

3.2 Water Resources, Irrigation Typology and Existing Schemes

Ethiopia has 12 river basins. The total mean annual flow from all the 12 river basins is estimated at about 122 BMC (WRMP, 1999); Figure 5 and Table 1 show the river basins and distributions of water resources in various basins. The water resources distribution shows slightly higher values as extracted from recent master plan studies.

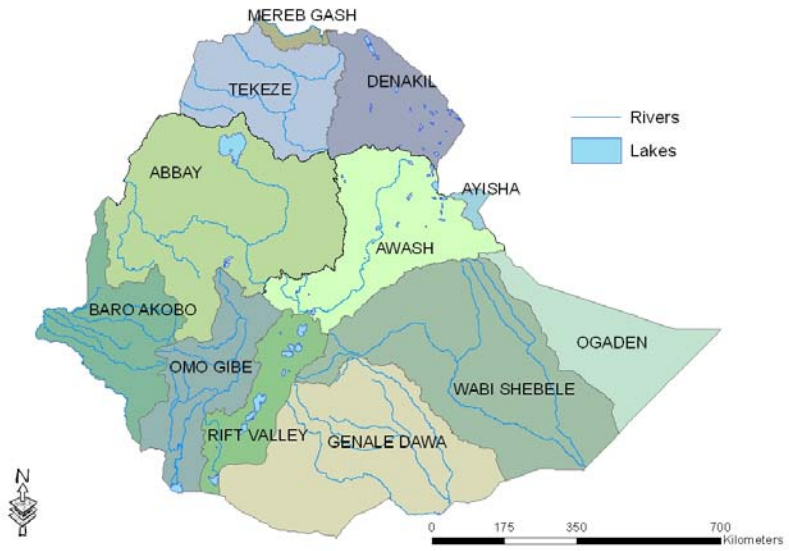

Figure 5: Ethiopia's River Basins

Table 1: Water resources distribution by river basins of Ethiopia

River Basin	Area (Km^2)	Runoff (Bm^3)	Estimated ground water potential (Bm^3)
Tekeze	82,350	8.2	0.20
Abbay	199,812	54.8	1.80
Baro-Akobo	75,912	23.6	0.28 0.13 Rech/yr
Omo-Ghibe	79,000	16.6	0.42 (.10) Rech /yr
Rift Valley	52,739	5.6	0.10
Mereb	5,900	0.65	0.05
Afar /Denakil	74,002	0.86	-
Awash	112,696	4.9	0.14
Aysha	2,223	-	-
Ogaden	77,121	-	-
Wabi-Shebelle*	202,697	3.16	0.07
Genale-Dawa*	171,042	5.88	0.14
Total	1,135,494	124.25	**2.86**

Source: IWMI Working paper 123 (Awulachew et. al, 2007)

In addition, Ethiopia has also 11 fresh and 9 saline lakes, 4 crater lakes and over 12 major swamps or wetlands. Majority of the Lakes are found in the Rift Valley Basin. For details refer Awulachew et al (2007). The total surface area of these natural and artificial lakes in Ethiopia is about 7,500 km2, representing about 0.67% of area of Ethiopia. Most of the lakes except Ziway, Tana, Langano, Abaya and Chamo have no surface water outlets, i.e. they are endhoric. Lakes Shala and Abiyata have concentrations of chemicals.

3.2 Irrigation Typology

The irrigation schemes in Ethiopia are divided according to the following typology:

- Small scale: These are schemes less than 200ha. Two major categories under this are modern schemes which usually have fixed or improved water control/diversion structures and water users associations that have by laws and traditional schemes – developed and managed by community tradition and usually characterized by non fixed structures and practiced traditionally.
- Medium scale: Schemes exceeding 200ha but less than 3,000ha
- Large scale: schemes exceeding 3,000ha

The latter two are mostly public schemes, owned and managed by the government, and in certain cases by large communities.

There are also irrigation typologies that are not clearly captured in policy and strategy documents. These are

- Water harvesting based irrigation; e.g. Household based minute irrigation;
- Ground water irrigation;
- In-situ Agricultural Water Management.

3.3 Existing Irrigation Schemes

One of the objectives of impact of irrigation on poverty and environment project is to develop GIS database of irrigation schemes to understand the spatial distributions and their characteristics. Accordingly, a database have been developed for about 790 modern irrigation schemes having various attributes such as name, administrative locations, georefenece, type of irrigation, typology, etc. For details refer Awulachew et al (2007).

Based on this the following map is one of the products of the database, showing irrigation distribution in Ethiopia based on attribute of typology and regions. Note also that the map is not showing the complete list of the irrigation schemes, as some of the geo-referencing information is missing and the map represents 107 schemes of complete large and medium scale irrigation and some small-scale irrigation.

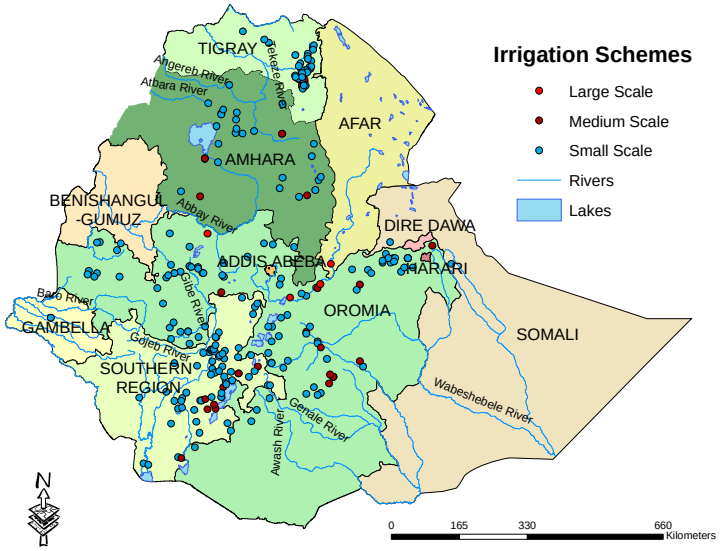

Figure 6: Existing Irrigation schemes distributed in the regional states of Ethiopia

According to MOFED (2006), with respect to irrigation development, within the program period of PASDEP 2004/2005 to 2009/2010, pre-design studies will be carried out for 17,988 hectares, full-fledged design studies will be undertaken on 464,051 hectares, and construction works will be completed for 430,061 hectares. Currently, actual implementation projects at Tendaho and Kessem totaling about 90,000 ha in the Awash Valley, 7,000ha Koga irrigation development in Blue Nile River Basin are actually near completion. There are also many additional scale development projects under construction invested by regional governments, donors and NGOs and private sector.

3.4 Irrigation Potentials by River Basins

In Ethiopia, under the prevalent rain fed agricultural production system, the progressive degradation of the natural resource base, especially in highly

vulnerable areas of the highlands coupled with climate variability have aggravated the incidence of poverty and food insecurity. Water resources management for agriculture includes both support for sustainable production in rain fed agriculture and irrigation (Awulachew et al 2005).

Currently, the MoWR has identified 560 irrigation potential sites on the major river basins. The total potential irrigable land in Ethiopia is estimated to be around 3.7 million ha (Awulachew et al 2007). Table 2 and Figure 7 show the irrigation development potential by river basins in Ethiopia. Detail characterization of the potentials by basins is provided in Awualchew et al (2007).

Table 2: Irrigation Potential in the River Basins

Basin	**Catchment Area (Km^2)**	**Irrigation potentials (Ha) (Respective recent master plan studies)**				**WAPCOS, 1995**		
		Small scale	**Medium scale**	**Large scale**	**Total**	**Total Drainage Area (km^2)**	**Irrigable Area (Ha)**	**% Irrigable Area of the Country**
Abbay	198,890.7	45,856	130,395	639,330	815,581	201,346	1001000	27
Tekeze	83,475.94	N/A	N/A	83,368	83,368	90,001	317000	8.5
Baro-Akobo	76,203.12	N/A	N/A	1,019,523	1,019,523	74,102	985000	26.5
Omo-Ghibe	79,000	N/A	10028	57900	67,928	78,213	445000	12
Rift Valley	52,739	N/A	4000	45700	139,300	52,739	139000	3.7
Awash	110,439.3	30,556	24,500	79,065	134,121	112,697	205000	5.5
Genale-Dawa	172,133	1,805	28,415	1,044,500	1,074,720	117,042	423000	11.4
Wabi-Shebele	202,219.5	10,755	55,950	171,200	237,905	102,697	200000	5.4
Danakil	63,852.97	2,309	45,656	110,811	158,776	74,102	-	-
Ogaden	77,121				-	77,121	-	-
Ayisha (Gulf of Aden)	2,000				-	2,000	-	-
Total	1,118,074.53				3,731,222	982,060	3,715,000	100

Note: The national water resources master plan (WAPCOS, 1995) was a desk study without significant field investigation.

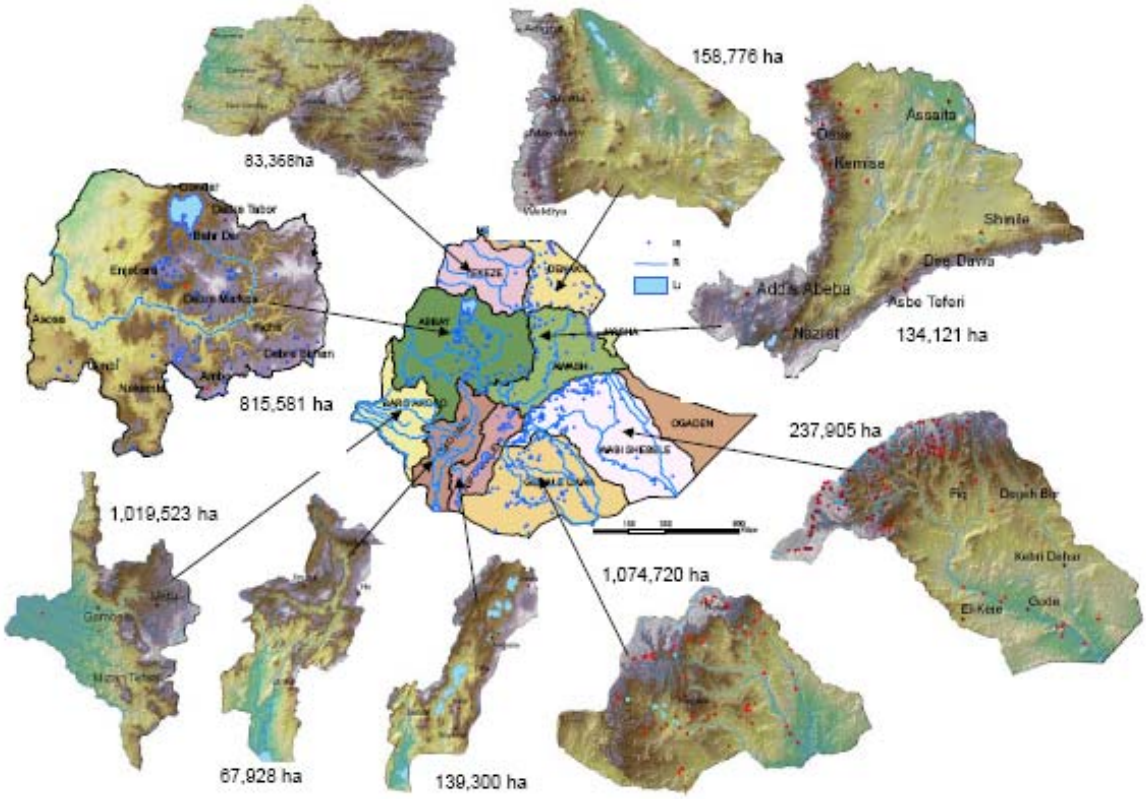

Figure 7: Irrigation Potentials in Ethiopia by River Basins

The complete database is developed for existing irrigation development and irrigation potential. We trust that this database creates important information system and a foundation for complete and comprehensive database that can be updated continuously for irrigation development in Ethiopia. The database is also made available to regional irrigation development bureaus and federal institutions for use and further updating. This information system establishes a public good and any interested institution or individual can receive a copy. The available formats for sharing include GIS products, Microsoft Excel or Microsoft Access database categorized per typology, river basins and regions.

4. General performance of the irrigated systems

The performances of the existing irrigation schemes are highly variable. Some of the schemes from all typologies in terms of water use efficiency, productivity, sustainability are performing very well, while some are not performing efficiently, interrupted while under construction, abandoned after implementation, or transferred from public to private or community and their performances are not known. Many successful schemes are providing increased income, higher productivity, significant job opportunity and considerable contribution to the economy. The existing irrigated schemes are estimated at about 2% of the total agricultural land but contribute over 5% of the agricultural production. On the other hand, there are also a number of schemes with critical problems leading to complete abandonment or under performance, missing the targets of performance in terms of land area developed, number of beneficiaries or sustainability. The assessment related to the database development, see also Awulachew et al (2007) reveals that 17% to 22% of schemes in the Amhara, SNNPR, Oromia and Tigray, particularly small scale irrigation schemes fall under this category.

A number of medium and large irrigation schemes, with a total area of 44,050 hectares, that were under construction, during the previous government, were suspended by the present one. The underlying reason seems to be the policy of market economy precluding government involvement in such economic activities added with the complexity of the projects that were under establishment at remote areas with low infrastructure, insufficient labor and market linkage. However, the wisdom of the decision, for abandonment of development schemes on which hundreds of million have been invested, remains to be questionable. It might be wiser to finalize the schemes and settle smallholders of the area and/or encourage private operators to take over under an attractive/ acceptable arrangement. On the contrary, private initiatives to takeover and finish some of the schemes - Meki-Zeway, Belbela & Wedecha, Alwero - either have not been accepted or have failed of their own accord until recently whereby the former two have attracted the attention of flower farmers. According to MCE (2004) some of the schemes have been turned over to party affiliated companies with limited success. These projects represent priority schemes for rehabilitation and completion.

Besides the suspended schemes a total of 26,347 ha are transferred from public to private or communal developers. The operation of this transferred schemes are variable. Some are successful, some are failed after transfer and the performances of some are not known. MCE (2004) and Awulachew et al (2007) discuss these.

5. Conclusion

This paper, which is related to the wider impact of irrigation on poverty and environment research project, provided information and database on the water resources of Ethiopia, potential of development, extent of existing development focusing on irrigation development. It also discussed irrigation development categorized by various river basins and regions. Discussions were also made on schemes that are non-operational or transferred to community and private sector and their implication on performance.

Specific database is also developed for existing irrigation schemes having a number of attributes. The developed database has information about the existing irrigation

schemes and potentials. The database under GIS environment, maps their spatial distribution using point maps from those schemes for which geo-refenced data is available.

It is obvious that Ethiopia is extremly dependent on rain fed agriculture; its majority of population are dependent on agriculture without limit to move out of the sector, agriculture being at low productivity, rapid population growth and lack of innovation to maximize the benefit of the combination of population, land and water. Hence, most of the population are poor and agriculture and overall economy is vulnerable and remains very weak against the shocks of the climatic variability.

The last five years attentions towards development taking the rural development policy and strategy, the water sector policy, the irrigation development strategy, the PASDEP actions are encouraging and hoped to accelerate development endeavors. Ethiopia's challenges towards development are immense and require significant actions and efforts addressing the various problems from various sectors that speed up rapid development.

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