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## The Current Irrigation Potential and Irrigated Land in Ethiopia-A Review

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### Abstract

Ethiopia is noted for having abundant surface and ground water resources, earning it the nickname "the water tower of East Africa." A large number of lakes, dams, and reservoirs may also be found throughout Ethiopia's diverse regions. Despite significant investment, public engagement, and government strategic support, irrigated agriculture is far from satisfactory. In comparison to Ethiopia's irrigation potential, the country's current irrigation development is insignificant. As a result, irrigation must play a key role in reducing food insecurity and thereby poverty. When analyzing Ethiopian irrigation, different literatures reflect varying amounts of irrigation water resources as irrigation potentials, current irrigated area, and so on. As a result, there is no systematic and trustworthy inventory of water and irrigation-related potentials in Ethiopia that has been well-studied and documented. In comparison to Ethiopia's irrigation potential, the country's current irrigation development is insignificant. Furthermore, even if the present and potential irrigated area is not well explored. The data and information needed to fully understand the present irrigation schemes are not uniformly available. While data for medium and large schemes can be accurately captured, accounting for small-scale irrigation development, particularly traditional irrigation development and privately developed household-based irrigation schemes that use traditional diversions, water harvesting, and ground water development, is difficult. Different sources report different amounts of irrigation water resources as irrigation potentials, current irrigated area, and so on. This means that Ethiopia's irrigation water resource potential has not been thoroughly researched and documented. As a result, a thorough investigation is required to reach a consensus among researchers. When it comes to irrigation in Ethiopia, different literatures state differing amounts of irrigation water resources as irrigation potentials, as well as the current irrigated area. This means that Ethiopia's irrigation water resource potential has not been thoroughly researched and documented. This requires a thorough investigation that leads to a consensus among researchers. There is no regular and dependable inventory that has been thoroughly researched and documented. Furthermore, even if the existing and potential irrigated area is not precisely explored.

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irrigation potential, water resource, lakes, dams, reservoirs.

### Introduction

Ethiopia is noted for having abundant surface and ground water resources, earning it the nickname "the water tower

of East Africa." A large number of lakes, dams, and reservoirs may also be found throughout Ethiopia's diverse regions. Estimates of Ethiopia's irrigation potential vary from one scholar to the next.

Ethiopia's water and land resources have enormous potential. It has a high water resource potential, accounting for 122 billion cubic meters of annual surface runoff and 2.9 billion cubic meters of groundwater, despite uneven geographical and temporal patterns (Tesfa and Tripathi, 2015). Ethiopia, on the other hand, is only employing a small portion of its tremendous water resource potential for irrigated agriculture (ATA, 2016). Ethiopia has a tremendous irrigation potential, despite the fact that there is no consistent information from various sources. Ethiopia is renowned as Africa's water tower because of its rich water resources, which include more than ten river basins and 22 natural and artificial lakes (ADF, 2005). There are more than ten river basins in the country, with a total annual runoff volume of 122 billion m<sup>3</sup> of surface water and an estimated 2.6 billion m<sup>3</sup> of ground water potential, providing an average of 1557.5 m<sup>3</sup> water per person per year. This is a significant amount of water. The country's largest four river basins, Abay, Baro-Akobo, Tekeze, and Omo-Ghibe, account for 80 percent to 90 percent of the country's water resource. Seleshi (2010) estimates that the country contains roughly 5.3 million hectares (Mha) of potential irrigable land. Despite this, only roughly 640,000 hectares are irrigated, with 241,000 hectares from small-scale, 315,000 hectares from medium-scale, and 84,000 hectares from large-scale projects.

### **Irrigation potential and irrigated land in Ethiopia**

Ethiopia has an estimated irrigation potential of 3.5 million hectares, according to Hagos *et al.*, (2009b). Only 5.2 percent of the total irrigation potential was reported to be exploited during the 2015/16 crop year (Central Statistical Agency (CSA), 2016). The lowland areas include the majority of the country's potentially irrigable land, which is estimated to be between 1.0 and 4.3 million hectares (World Bank, 1973, IFAD, 1987). Only 5% (approximately 164,348ha) of the potential irrigable land has been irrigated, according to the Ministry of Water Resources. Ethiopia's overall irrigable land potential is estimated to be 5.3 million hectares (mha), with 1.6 million hectares available through rainwater harvesting and groundwater (Awulachew, 2010). According to a recent source, Ethiopia's total amount of irrigated land expanded from 885,000 ha to 2.4 million hectares between 2011 and 2015, with a goal of reaching 4 million ha by 2020 (ATA, 2016). This includes the 658,340 acres of land created with high and medium irrigation systems (NPC, 2015). Nonetheless, by the end of the GTP-II (2019/20), it is planned to grow the high and medium projects to roughly 954,000 acres.

Evidence also reveals that the average farm size per household in Ethiopia is 0.5 ha, with irrigated land ranging from 0.25 to 0.5 ha (MoA, 2011).

According to MoWR (2005), Ethiopia has 3.7 million hectares of potentially irrigable land with abundant surface water resources, with 386,603 hectares irrigated through the establishment of traditional and modern irrigation schemes, accounting for around 10% of potentially irrigable land. According to the ministry's report, the government, nongovernmental groups, and private investors established 466 small, 102 medium, and 9 large irrigation schemes with total area coverage of 28,939, 71,924, and 49,675 ha, respectively, in modern irrigation. Rain-fed agriculture accounts for the majority of the country's food crops. Awulachew and colleagues (Awulachew *et al.*,) claim that (2007). Ethiopia's irrigation potential is estimated to be 3.5 million hectares. However, in 2005/2006, the total estimated area of irrigated agriculture in the country was 625,819 ha, accounting for around 18% of the potential (MOWR, 2007).

Ethiopia's present irrigation development is around 0.7 Mha, and the performance of the existing schemes is unknown. Only 46.8% of the projected beneficiaries have benefited from installed irrigation, despite the fact that 86.5 percent of schemes are operational and 74.1 percent of the command area is under cultivation. (Mekonnen Ayana and Selish Bekele Awulachew, 2010). The distribution of irrigation potential, according to Awulachew *et al.*, (2007), can be stated as follows: Rainwater harvesting, mostly based on limited technologies of water collection at 0.1 ha per household and five million farmers in unpredictable rainfall areas, covers 500 000 ha in 12 river basins on a big, medium, and small scale. And, based on a 6.5 km<sup>3</sup> water potential and a water demand volume of roughly 6000 m<sup>3</sup> per ha, groundwater development supplies irrigation for about 1.08 million hectares (Awulachew, 2010). In Ethiopia, there are approximately 6 million hectares of land suitable for surface irrigation. The Abay, Rift Valley, Omo Ghibe, and Awashi river basins contain a large amount of the suitable land (Abeyou, 2017).

Just 10% of Ethiopia's projected potential irrigable land is actually irrigated, and only 2% of agricultural land is irrigated (Gebremedhin and Pedon, 2002). (MoWR, 2001). Similarly, irrigated agriculture accounts for only 3% of overall food production in the United States (Bacha *et al.*, 2011). That is why, despite significant investment, public engagement, and government

strategic backing, irrigated agriculture remains unsatisfactory. In comparison to Ethiopia's irrigation potential, the country's current irrigation development is insignificant (MoA, 2011b). As a result, irrigation must play a key role in reducing food insecurity and thereby poverty. Varying literatures report different amounts of irrigation water resources as irrigation potentials, area irrigated right now, and so on when reviewing Ethiopian irrigation. This means that Ethiopia's irrigation water resource potential has not been thoroughly researched and documented. As a result, a thorough investigation is required to reach a consensus among researchers.

Ethiopia's ambitions to expand irrigation coverage from 640,000 hectares (4% of currently cultivated land) to around 1.8 million hectares (Mha) in the next five years will be difficult (Awulachew, 2010). According to current estimates, just 15 million hectares of land are under cultivation, whereas irrigation may possibly create over 3.73 million hectares of farmland (Makombe *et al.*, 2011). Despite the fact that the country's irrigation potential is estimated to be around 3.73 million hectares, only around 626,116 ha (5.6 percent) is currently irrigated, and the GTP plans to develop 15.4 percent of the potential by the end of 2015 (Hagos *et al.*, 2010). It will increase the country's irrigable land to 1,721,819 acres. This has a negligible impact on the country's agricultural output (MoWE 2013).

The entire irrigated area is now estimated to be around 250,000 hectares (Awulachew *et al.*, 2005). This equates to around 30 m<sup>2</sup> of irrigated land per person. The per capita irrigated area barely reaches 45 m<sup>2</sup> per head by 2015, which has little impact on the sector. Given Ethiopia's severe meteorological and hydrological unpredictability, it is critical that greater emphasis be placed on improving water control, use, and management of water resources for agricultural productivity through irrigated agriculture (Awulachew *et al.*, 2007). There are 12 river basins in the country. The overall mean annual flow from all 12 river basins is projected to be 122 BMC (MoWR 1999), and the annual rechargeable resource potential is estimated to be at 2.6 BMC (Billion Metric Cube) (Awulachew *et al.*, 2007). Ethiopia currently has roughly 12 million hectares of cultivated agricultural land (MoA, 2011a). Furthermore, even if the potential and actual irrigated area are not well explored (Belay and Bewket, 2013), estimates of irrigable land in Ethiopia range from 1.5 to 4.3 million hectares (Mha), with an average of 3.5 Mha (MoWR, 2001; Werfring, 2004; Awulachew *et al.*, 2005; Makombe *et al.*, 2011). However, it is astonishing that the entire area under

irrigation is currently believed to be between 160,000 and 200,000 hectares, or less than 5% of the country's irrigable land (Awulachew *et al.*, 2005, 2007; World Bank, 2006; Makombe *et al.*, 2007). However, according to the Ministry of Agriculture (2011a), about 10% to 12% of the entire irrigable potential is now under production using traditional and contemporary irrigation schemes. Furthermore, disparities in irrigation potentials and actually irrigated areas, such as 3.7 million ha and 197,000 ha according to Awulachew *et al.*, (2007) and 3.5 million ha and 626,116 hectares according to Hagos *et al.*, (2009), imply differences.

As a result, there is no systematic and trustworthy inventory of water and irrigation-related potentials in Ethiopia that has been well-studied and documented. In comparison to Ethiopia's irrigation potential, the country's current irrigation development is insignificant (MoA, 2011b). As a result, irrigation must play a key role in reducing food insecurity and thereby poverty. According to Tadesse (2004), at least 13.2 billion m<sup>3</sup> of water infiltrates into the groundwater system, of which 50% may be extracted.

Ethiopia currently has roughly 12 million hectares of cultivated agricultural land (MoA, 2011a). Furthermore, even if the potential and actual irrigated area are not well explored (Belay and Bewket, 2013), estimates of irrigable land in Ethiopia range from 1.5 to 4.3 million hectares (Mha), with an average of 3.5 Mha (MoWR, 2001; Werfring, 2004; Awulachew *et al.*, 2005; Makombe *et al.*, 2011).

Approximately 197,000 hectares of land are currently irrigated (Solomon *et al.*, 2006). The irrigated area is currently estimated to be between 150,000 and 250,000 hectares, or less than 5% of theoretically irrigable land (Werfring, 2004; Awulachew *et al.*, 2005). According to this database (based on data provided by the MoWR), the irrigated area is estimated to be 107,265.65 hectares, which is less than 5% of the potential.

There is a lack of data and knowledge to accurately know the present irrigation schemes. While data for medium and large schemes can be accurately captured, small-scale irrigation development, particularly traditional irrigation development and privately developed household-based irrigation schemes that use traditional diversions, water harvesting, and ground water development, is difficult to account for. The country's entire irrigated agriculture area is expected to be 107,265.65 hectares, with 20,038.39 hectares from

small-scale farming, 30,291.26 hectares from medium-scale farming, and 56,936 hectares from large-scale farming (Awulachew *et al.*, 2007).

Different sources report different amounts of irrigation water resources as irrigation potentials, current irrigated area, and so on. This means that Ethiopia's irrigation water resource potential has not been thoroughly researched and documented. As a result, a thorough investigation is required to reach a consensus among researchers (Gebremedhin, 2015). In 2005/2006, the estimated total area of irrigated agriculture in the country was 625,819 ha, accounting for around 18% of the potential (MoWR, 2006). By 2010 (Atnafu, 2007; MoWR, 2006; MoFED, 2006), an additional 528,686 ha would have been added, accounting for around 33% of the potential (Atnafu, 2007; MoWR, 2006; MoFED, 2006).

### **Irrigation potential and irrigated land in each region of Ethiopia**

Irrigated agriculture is dominated by Afar and Oromia, which account for 45 and 31 percent of the total irrigated land, respectively. Amhara, the Southern Nations, Nationalities and Peoples' Region (SNNPR), and Tigray contribute for 8, 7, and 5% of the total irrigated land, respectively (Awulachew *et al.*, 2007).

#### **Irrigation in Amhara region**

To make use of these resources, a variety of development projects have been launched. In the Amhara region, there are now 310 irrigation systems under development. Irrigation projects created have watered an area of 8,469.26 hectares and benefited 17,443 persons. Small-scale irrigation schemes account for 5,718.68 hectares of the total irrigated area, while medium-scale irrigation schemes account for 2,750.58 hectares. Irrigated land 76,131ha (8063 ha modern and 68, 067 ha traditional), potential irrigated land 572,000 ha (Awulachew *et al.*, 2007). The region features four major river basins with tiny tributaries, including the Abay, Tekeze, and Awash River systems, as well as the Danakil depression, which has a total estimated yearly renewable potential of 35 billion cubic meters of fresh water (CoSAERAR, 2002). The region's catchment area, which contributes to

renewable potential surface water, is around 134,056 km<sup>2</sup> (MoWR, 2003).

#### **Irrigation in Oromia regional state**

Irrigation development has been a priority for the Oromia regional state. In the region, there are currently 199 irrigation schemes. These irrigation schemes constructed in the region irrigated 33,765.19 hectares of land, with 4,627.29 hectares from small-scale irrigation, 2,800.01 hectares from medium-scale irrigation, and 26,338 hectares from large-scale irrigation, benefiting 37,479 people (Awulachew *et al.*, 2007).

#### **Irrigation in Tigray regional state**

In the Tigray regional state, 103 irrigation schemes have been established. Irrigated land totals 4,932.8 hectares, including 3,956.80 hectares from small-scale farming and 976 hectares from medium-scale farming (Awulachew *et al.*, 2007).

#### **Irrigation in SNNPR regional state**

In the SNNPR Regional State, there are now 107 irrigation schemes. Modern irrigation schemes have cultivated a total of 7,931.5 hectares of land, benefiting a total of 38,230 households. Small-scale agriculture accounts for 4,371 hectares, while medium-scale agriculture accounts for 3,560 hectares (Awulachew *et al.*, 2007).

#### **Irrigation in Afar regional state**

There are 29 irrigation systems in the Afar Regional State, 20 of which are medium-scale and 9 of which are large-scale. The region reported a total of 48,311 hectares of irrigated land, with 17,713 hectares from medium-scale irrigation development and 30,598 hectares from large-scale irrigation development (Awulachew *et al.*, 2007). There are 29 irrigation systems in the Afar Regional State, 20 of which are medium-scale and 9 of which are large-scale. The region reported a total of 48,311 hectares of irrigated land, with 17,713 hectares from medium-scale irrigation development and 30,598 hectares from large-scale irrigation development (Awulachew *et al.*, 2007).

**Table.1** Major river basins in Amhara regional state

No	River basin	Catchment area (Km <sup>2</sup> )	Annual Runoff (Bm <sup>3</sup> )	Groundwater (Bm <sup>3</sup> )
1	Abbay	199,812	52.6	1.23
2	Tekeze	89,000	7.63	0.18
3	Awash	112,700	4.6	0.13
4	Danakil	74,000	0.86	0.00
<b>Total</b>		<b>475,512</b>	<b>65.69</b>	<b>1.54</b>

Source: Muluken Lakachew

**Table.2** Current irrigation activities in Ethiopia

Region	Current Irrigation Activities			Total Developed	Irrigable Potential	Un-developed	RANK
	Traditional	Modern Irrigation					
		Small	Medium/ Large				
Oromia	56,807	17,690	31,981	106,478	1,350,000	1,243,522	1
Amhara	64,035	5,752	-	69,787	500,000	430,213	5
SNNP	2,000	11,577	6,076	19,653	700,000	680,347	2
Tigray	2,607	10,000	-	12,607	300,000	287,393	5
Afar	2,440	-	21,000	23,440	163,554	140,114	6
Ben Shangul G.	400	200	-	600	121,177	120,577	7
Gambella	46	70	-	116	600,000	599,884	3
Somali	8,200	1,800	2,000	12,000	500,000	488,000	4
Hareri	812	125	-	937	19,200	18,263	8
Dire Dawa	640	860	-	1,500	2,000	500	9
Addis Ababa	352	-	-	352	526	174	10
	<b>138,339</b>	<b>48,074</b>	<b>61,057</b>	<b>247,470</b>	<b>4,256,457</b>	<b>4,008,987</b>	

ILRI Workshop, March 14-16, Addis Ababa, Ethiopia

**Table.3** Irrigation potential each region of in Ethiopia

Region	Current Irrigation Activities			Total Developed	Irrigable Potential	Un developed
	Traditional	Modern Irrigation				
		Small	Medium/ Large			
Oromia	318,364.66	73,482.38	0	391,847	1,700,000	1,308,153
Amhara	619,876	218,174	21,200	859,250	1,200,000	340,750
SNNP	270,000	23,005	28,780	321,785	700,000	378,215
Tigray	2,607	10,000	0	12,607	350,000	337,393
Afar	2,440	0	21,000	23,440	163,554	140,114
Ben.Sh.Gu	400	200	0	600	121,177	120,577
Gambella	2014	200	0	2,214	780,000	777,786
Somali	8,200	1,800	2,000	12,000	500,000	488,000
Hareri	812	125	0	937	19,200	18,263
Dire Dawa	640	860	0	1,500	2,000	500
Addis Ababa	352	0	0	352	526	174
	<b>1,225,706</b>	<b>327,846</b>	<b>72,980</b>	<b>1,626,532</b>	<b>5,536,457</b>	<b>3,909,925</b>

Fig.1 Irrigation potential % of each Region

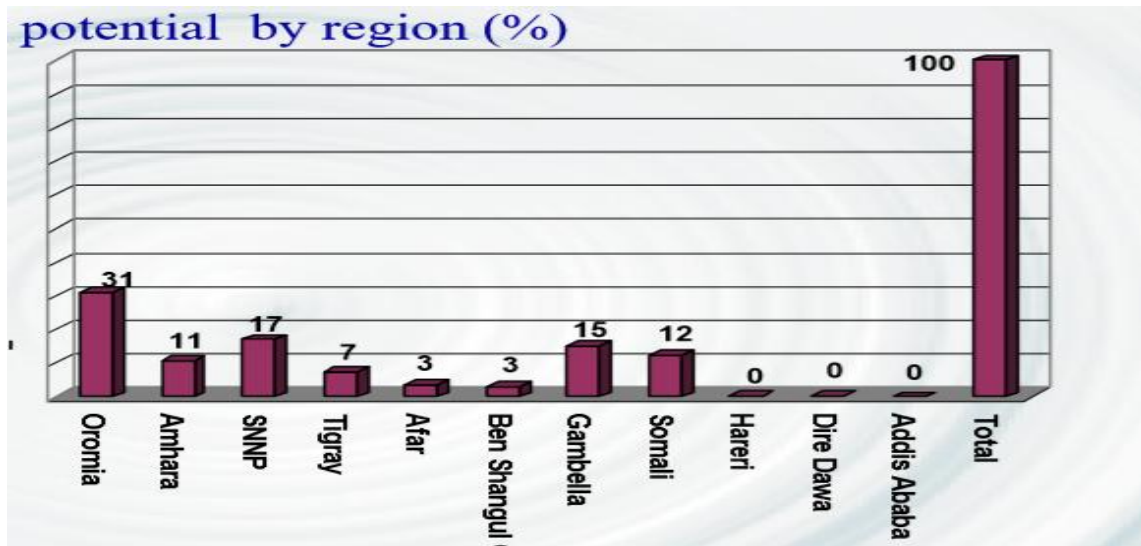


Fig.2 Irrigation potential of Ethiopia

Regional States	No.of Schemes	Planned Irrigable Area	Total Actual Irrigated Area	Actual Irrigated Area			Planned No. of Beneficiaries
				Small-scale	Medium-scale	Large-scale	
Afar	29	56,849	48,311	0	17,713	30,598	2,320
Amhara	310	5,542	8,469.26	5,718.68	2,750.58	0	17,443
Benishangul Gumz	2	186	NA	NA	0	0	744
Dire Dawa	25	283	671	671	0	0	869
Gambella	5	NA	1,315	415	900	0	NA
Hareri	5	240	NA	NA	0	0	NA
Oromia	199	30,760.44	33,765.19	4,627.29	2,800.1	26,338	37,479
SNNPR	107	14,365	7,931.50	4,371.50	3,560.00	0	38,230
Somali	5	2,790	1,332.80	NA	1,332.80	0	3,580
Tigray	103	4,082	4,932.80	3,956.80	976.00	0	6,670
Total	790	115,097.44	107,265.65	20,038.39	30,291.26	56,936	107,335

### Irrigation in Gambella regional state

The Gambella regional state has also reported the creation of irrigation projects with a total irrigated area of 1,315 hectares, comprising 415 hectares from small-scale farming and 900 hectares from medium-scale farming (Awulachew *et al.*, 2007).

### Irrigation in Benishangul-Gumz regional state

In the Benishangul-Gumz regional state, there is an estimated total irrigable area of 240 hectares (Awulachew *et al.*, 2007).

### Irrigation in Dawa and Harari regional state

Small-scale irrigation development has resulted in 671 hectares of irrigated land in the Dire Dawa administrative state. Harari was stated to have 186 hectares (Awulachew *et al.*, 2007).

Irrigation must have a substantial role in reducing food insecurity and, as a result, poverty. When it comes to irrigation in Ethiopia, different literatures state differing amounts of irrigation water resources as irrigation potentials, as well as the current irrigated area. This means that Ethiopia's irrigation water resource potential has not been thoroughly researched and documented. This requires a thorough investigation that leads to a consensus among researchers. There is no well-studied and documented inventory that is consistent and dependable. Furthermore, even if the present and potential irrigated area is not well explored.

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