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Expert Review

Review on Status, Opportunities and Challenges of Irrigation Practices in Awash River Basin, Ethiopia

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ABSTRACT

Awash River basin is one of the major 12 river basins in the country and it is the fourth populous basin in Ethiopia and ranks the 3rd of all basins of Ethiopia in terms of population density and stands 4th and 7th in its area and volume of water respectively. The relative surface water resource of the basin is about 4.65 billion m3, it is the most developed and utilized since 77.4% of the irrigable land in the basin has been cultivated. About 60% of the large-scale irrigated agriculture and more than 65% of the national industries are located in the basin. This Current Topic aims to review literatures information related to irrigation potential of Awash River, status, challenges and opportunities irrigation practices in Awash River Basin. Awash River basin has 37 irrigation potential sites are identified out of which 5 are small-scale, 18 are medium-scale, and 14 are large-scale. The estimated irrigation potential is 134,121 hectares. Out of these, a potential, 30,556 hectares are for small-scale, 24,500 hectares for medium-scale and 79,065 hectares for large-scale development. However, the Awash River Basin faces difficulties in sustaining its' services due to technical gabs like: lack of strategically directed, supervised and integrated with other social, economic and environmental sectors, and ensuring effectiveness of the water policy and the legislative framework and Improve capability of involved organizations to better realize the potential of the water system; Water governance issues such as Management gap, Administrative gap, Policy gap, Information gap, financial gap and Communication gap, and severe environmental challenges such as Population and population density, wet land degradation, Salinity and water logging, water borne diseases, desertification, flooding, change in water quality and invasion of Prosopis Julifora and Expansion of lake Besaka expansion are the major treat of irrigation in awash river basin.

Keywords: Awash river basin; Challenges of irrigation; Environmental impacts; Status and opportunities

INTRODUCTION

General back ground

Ethiopia has an estimated 3.7 million hectares of irrigable land, yet only about 200,000 hectares (5.4%) is presently irrigated and only provides Fapproximately 3% of the country's food crop requirements [1]. Awash River basin is one of the major 12 river basins in the country and the most utilized River basin so far. Awash Basin covers parts of Afar, Amhara, Oromia, Somali Regional States, SNNP and Addis Ababa and Dire Dewa Administrative councils. It is the fourth populous basin in Ethiopia and ranks the 3rd of all basins of Ethiopia in terms of population density and stands 4th and 7th in its area and volume of water respectively [2].

Awash River Basin, with a total catchment area of 113,304 km^2, is located between latitudes 7°53′N and 12°N and longitudes 37°57′E and 43°25′E in Ethiopia (Figure 1). The Awash River originates from the high plateau Ginchi of 3000 m.a.s.l, 80 km west of Addis Ababa and terminates, after travelling about 1200 km, at Lake Abe of 250 m.a.s.l., at the border of Ethiopia and Djibouti [3-5]. With extreme ranges of topography, vegetation, rainfall, temperature and soils, the basin extends from semi-desert lowlands to cold high mountain zones. Land use in the catchment is mainly agricultural and shrub lands used for rain-fed crops, irrigation and grazing. Various crops are cultivated ranging from cereals, vegetables, flowers, cotton to perennial fruit trees and sugarcane [3,6]. Although the relative surface water resource of the basin is about 4.65 billion m^3, it is the most developed and utilized since 77.4% of the irrigable land in the basin has been cultivated. About 60% of the large-scale irrigated agriculture and more than 65% of the national industries are located in the basin. The rainfall pattern is bimodal with the first being the short season of March to May while the second and the main one is from July to September [3]. Annual average temperature ranges from 16.7 to 29°C and the annual mean relative humidity in the basin varies from 60.2 to 49.7%. While the mean annual wind speed is 0.9 m/s, the mean annual rainfall varies from about 1600 mm at Ankober to 160 mm at Asayita [4].

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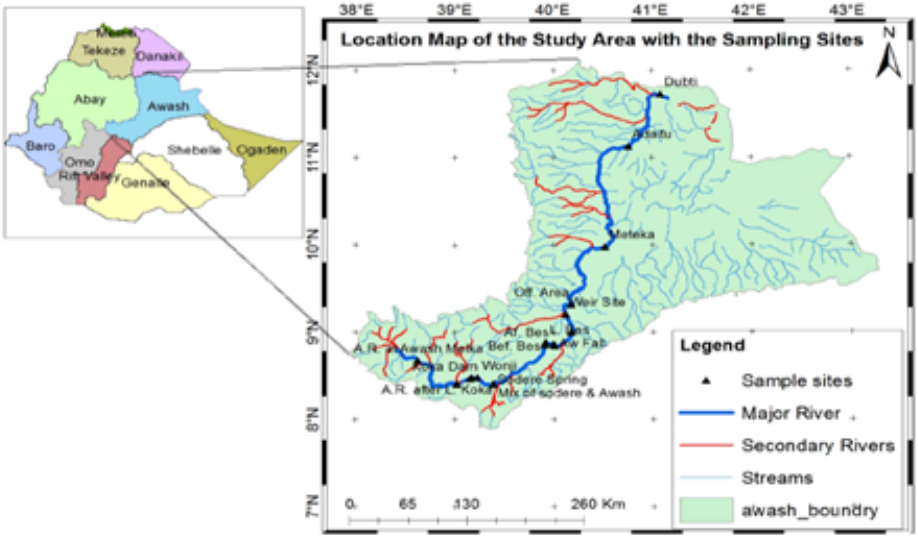


Figure 1: Location Map of Awash river basin.

Most of the irrigation developed to date in Ethiopia is located in the Awash River Basin. Awash Basin is the most developed basin in Ethiopia due to availability of land suitable for agriculture, water resources that can be easily tapped, and its strategic location. The estimated irrigation potential is about 206,000 ha out of which more than 160,000 ha or 77.7% (current survey excluding hectares less than 2.5 ha) is already developed by surface irrigation systems and it also serves for drinking water supply for big towns and rural community, hydropower and fisheries [7].

Despite its utilizability, the Awash River Basin faces land degradation, high population density, natural water degradation, and Salinity and wetland degradation. Already desertification has started at lower Awash River Basin. In the high land part deforestation and sedimentation has increased in the past three decades. As more water is drawn from the river there could be drastic climate and ecological changes which endanger the basin habitat and human livelihood. Draining the wetlands for irrigation could imbalance the sustainability of the basin.

Frequent and persistent droughts and the associated food insecurity have drastically affected the human and livestock population, especially in the Middle and Lower Basins of Awash River. As a result, the survival of thousands of people in the basin depends on international food assistance. The development of irrigation projects in the upper reaches of the basin, coupled with drought (climatic) occurrences have caused serious threat to the region's water resources, affecting the socioeconomic activity of the people and the diversity of ecosystem especially in the lower reach of the basin [8].

Based on physical and socio-economic factors the Awash Basin is divided into Upland (all lands above 1500 m masl), Upper Valley, Middle (area between 1500 m and 1000 m masl), Lower Valley (area between 1000 m and 500 m masl) and Eastern Catchment (closed sub-basin are between 2500 m and 1000 m masl), and the Upper, Middle and Lower Valley are part of the Great Rift Valleys systems. The lower Awash Valley comprises the deltaic alluvial plains in the Tendaho, Asayita, Dit Behri area and the terminal lakes area. The Rift Valley part of the Awash River basin is seismically active. The middle valley includes major irrigated areas from Metahara to Dubti, descending from an elevation of 1000 to 500 m. The lower valley forms alluvial plains in the Tendaho, Dubti and Asayita areas (Girma et.al, 2015).

Conventional climatic zones

One of the major factors determining climatic conditions in the Awash Basin, as elsewhere in Ethiopia, is altitude. Ethiopian tradition identifies four major natural zones according to altitude, climate, and to some extent, natural vegetation. These are described below.

Dega: This is the name given to tropical highlands above 2,500 m. 7%, of the Awash River catchment lies in this zone.

Woina Dega: This name is given to the tropical to sub-tropical plateaus altitudes from 2,500 m. down to 1,800 m. 13% of the awash catchment lies in this zone.

Kolla: This covers the agricultural lands lying between 1,800 m. and 1,500 m. 22% of the Awash River basin lies in the Kolla, of which 6% is in the humid valleys.

Bereha: This name is given to semi-arid and sub-desert lowlands at altitudes below 1,500 m. 58%; of the Awash basin lies in this zone (MOA, 1998).

Objectives

General objective: To Review Literatures regarding to the Status, Opportunities and Challenges of Irrigation practices in Awash River Basin, Ethiopia.

Specific objective: To find information on trends irrigation development in the basin,

To search findings related to water governance gap and Environmental issues of irrigation in Awash River basin.

Ecosystems and biodiversity in the basin

Vegetation: The dominant vegetation in the Upper and Middle Valley is grassland with some scrubland and riparian forest along the Awash River. The best wet season grazing areas here are the Alidge, Gewane, Awash and Amibara. Some of the plant species include Balanites aegypticus, Salix subserata, Flueggia virosa, Carissa edulis, Rumex nervosus, Tamarindus indica, Ulcea schimperi and Acacia spp. Lasiurus scandium, Pa nicum turgidum (highly palatable), in the plains of Gobbad and Hanle, associated with Acacia tortilis, Acacia asak (mainly present in the wadis), Cadaba rotund folia and Salvadora persica . Sporobolus spicatus, which is typical of saline depressions and swamps, bears signs of

some degradation. Hyphaene thebaica (Doum palm) formations are characteristic but strongly degraded over the area. Lake Abe is a large (180 km), shallow and saline (170 g/l NaCl) lake, shared between Djibouti and Ethiopia.

Animal diversity: The wild ass lives in open desert country and in lava-strewn hills among the rocks and cliffs, across the plains of the Danakil region and the Awash Valley. The Somali wild ass (Equus asinus somalicus) is of global significance as it is the only existing representative of the African wild ass with only a few hundred individuals left. Awash National Park is the oldest and most developed wildlife reserve in Ethiopia. Featuring the 1,800m Fantalle Volcano, extensive mineral hot-springs and extraordinary volcanic formations, this natural treasure is bordered to the south by the Awash River and lies 225 kilometers east of the capital city, The wildlife consists mainly of East African plains animals, but there are now no giraffe or buffalo, Oryx, bat- eared fox, caracal, aardvark, colobus and green monkeys, Anubis and Hamadryas baboons, klipspringer, leopard, bushbuck, hippopotamus, Soemmering's gazelle, cheetah, lion, kudu and 450 species of bird all live within the park's 720 square kilometers [9].

Hydropower on the Awash river basins: Though Ethiopia has substantial hydropower potential it has one of the lowest levels of per capita electrical consumption in the world. There are three functional dams in Awash River Basin, Aba Samuel (1.5 GWh/year) commissioned in 1939, Koka (110 GWh/year) commissioned in 1960, Awash II (165 GWh/year) commissioned in 1966, and Awash III (165G Wh/year) commissioned in 1971. Koka was built on the upper Awash for hydropower generation and irrigation development downstream. The dam has served for four decades. In the coming years five additional dams are proposed to be built for hydropower generation and irrigation development in the basin.

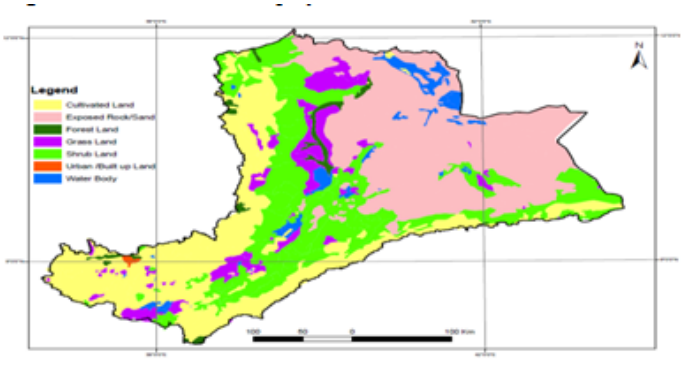
Environmental and social aspects: This presents a significant health hazard from the microbiological contamination to the surface and groundwater, and concerns that heavy metals are accumulating soils. Few rigorous investigations have been undertaken, but nitrate levels are reported to be above 10 mg/l in the surface water, and according to Biru and Itanna, arsenic (As) and zinc (Zn) are measurably higher in the soils irrigated by the Akai River [10,11]. Akaki River is one of the tributaries draining Addis Ababa City to the Awash River. In the middle and lower Awash the water-related health hazards are malaria and schistosomiasis, which are reported to be increasing in prevalence and severity. Basic requirements such as water supply, sanitation and health facilities are poor [12].

The single overriding factor in the ecology of the Awash Basin is the rapid and continuous increase in population and the adverse effects on the resources of the basin, in particular, on the rapid erosion and degradation of the upland soils. The high indication of the sediment load is a result of deforestation and less ground cover in the highland of the upper basin.

Cropping pattern and crop production: The state farms are generally found in the Middle and lower sections of the valley and the major Irrigators in the upper valley are the Ethiopian Sugar Corporation Ethiopian Share Enterprise (ESC) and Ethiopian Horticultural Corporation Share Enterprise (HCSE). Historically sugar and cotton have been the major crops grown in Middle and Lower Awash Valley .Fruit production has been increasing since about 1999, with the bulk of fruit and vegetables sold in the local market in all river Basins in Ethiopia. The production of high value vegetables for export has recently been introduced in the Rift Valley Lake Basin and Awash River basin. In 2001 and 2002 the exported vegetables has increased by 95 % as compared to 1998. Among this 45 % of the flower exported comes from the Awash River Basin. As the external market opportunity is growing several private flower enterprises are emerging. In the lower valley of the drier areas where moisture is critical summer cropping pattern is common such as cotton. However in the Upper Valley the highest percentage of cropping is occupied with sugar cane. Ethiopia is completely self-sufficient in cotton. This crop holds significant opportunities for export. Existing textile industries demand approximately 50,000 tons of lint cotton annually. In addition, there are good prospects for exporting lint. Opportunities for production and processing of cotton in Ethiopia are significant. The prevailing cropping pattern in the upper Valley is sugar cane (74%), in the middle Valley cotton (82%) and in the lower Valley cotton (75%).

The Middle and Lower Awash is one of the major cotton producing areas of Ethiopia. However, during the last decade's most of the agricultural land has been abandoned as a result of inherent soil salinity and saline shallow ground water. In most of the irrigation project development drainage system were not built. Thus the irrigated land did not change over time and expanded, as salinity became a major threat for development of agricultural land. Cotton produce after ginning is supplied to local textile industries.

Livestock: The Awash valley has historically been a main gateway for the caravan trade between the coast and the highlands of Ethiopia to Djibouti and Berbera. At present, the strategically important official import and export trade activities of the country take place through the pastoral areas of the Afar and Somali regions. Cross-border trade with neighboring countries is also an important aspect of the economic life in these pastoral areas of the country. In 2001, the total population of the Afar region was 1.24 million while that of the Somali region was about 3.9 million. In addition to the large human population, these regions also account for a large number of the livestock population of the country. The Afar region, which is part of Middle and Lower Awash River Basin , has 3.6 million cattle, which is 7.4% of the national total, while the region's sheep and goat populations are 2 million (7.8%) and 3 million (13.8%) respectively (Figure 2). Besides this, the Afar region has 192,872 pack animals, i.e., 3 % of the national total, and 871,832 camels, which is 27 % of the national total [13].



Source: MOA 2001

Figure 2: Land use/cover map of Awash river basin.

TRENDS AND STATUS IRRIGATION DEVELOPMENT OF AWASH RIVER BASIN

Trends of irrigation development in Awash river

The history of modern irrigated agriculture in Ethiopia dates back to 1960 when it started with the production of industrial crops (sugar and cotton) on large-scale farms by private investors in the Awash area. However, local farmers had already been practicing traditional irrigation during the dry season using water from river diversions for subsistence crop production [14]. Private concessionaires who operated farms for growing commercial crops such as cotton, sugarcane and horticultural crops started the first formal irrigation schemes in the late 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. Modern small-scale irrigation (SSI) development and management started in the 1970s initiated by the Ministry of Agriculture (MoA) in response to major droughts, which caused wide spread crop failures and food insecurity. 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 [14]. 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 [15] (Figure 3 and Table 1).

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 number, 0.29 million ha [16]. Of the potential arable land for irrigation; the River Awash Basins represents 24% of the land nationally available for irrigation. Of the 0.29 million ha irrigated land in 2009, 29% in River Awash. The Ministry of Water and Energy has identified 560 irrigation potential sites on the major

Figure 3: Large scale irrigation in Awash river basin.

Table 1: Lists existing medium- and large-scale irrigation schemes in the Awash valley with Their respective gross command area, principal crops grows.

Location	Farm	Gross Area (ha)	Remark
Upper Valley	Wonji/Shoa Sugar Estate	6,000	Sugarcane plantation with two factories; pump supplied; Future expansion include Dodota and Welenchiti areas
	Upper Valley Agro Complex and other farms (Degaga, Tibila, Merti Jeju, Nura Hera & others)	1,100	Sugarcane plots run by farmers' associations/ Cooperatives
	Metahara Sugar Estate (Abadir & Merti)	10,000	Sugarcane plantation with a factory; limited orchard area (citrus fruit); diversion weirs; Future expansion areas include over 3,000ha in the immediate vicinity
	Upper Valley Agro Complex and other farms (Degaga, Tibila, Merti Jeju, Nura Hera & others	9,000	Horticulture (fruits & vegetables) and cotton; Merti Jeju farms located on the right bank of Awash while Nura Hera farms on the left bank; diversion weirs and pump stations
Middle Valley	Kesem-Kebena Schemes (Awara Melka and Yalo)	1900	Over 10,000ha additional area envisaged for irrigation development after completion of Kesem Dam
	Amibara Irrigation Schemes (Melka Sadi, Former, Melka Werer, Former Amibara Settlement, Werer Research Center, Ambash, Algeta & Sublale farms)	15,000	Reengaged in limited areas; Future plans include expansion and reinstatement of farm areas. Right bank schemes in Amibara area; Mainly gravity supplied, about 10,000ha (Melka Sadi diversion weir), while others are pump schemes; main crop grown is cotton; Sublale farm (about 600ha) is considered as part of Angelele farms in other studies
	Dofen Bolhamo-Gidaro	1,700	Left bank farms in Amibara area, abandoned for years; Considered in the future planned development areas of Kesem dam project
	Angelele and Haledebi	1,200	Except Asoba area (covered by cotton), the rest Abandoned
	Gewane Area Complexes including Bure Modaytu area (Kuda, Debel, Gewane, Ras Adas, Inta Adoyta, Ayroli, Gel Ela Dora & Others)	2,700	Considerable portions of the farms have been abandoned; very recently some farmers
Lower Valley	Mile Farm	1000	Abandoned farms; very recently limited area covered by crops
Lower Plains	Dubti, Dit Bahri, Tangay Kuma, Senbeleta, Awash Asayita & others	25,000	Cotton growing farms; Considerable area abandoned; Future expansion planned in the area include additional area of over 30,000ha, mainly for sugarcane plantation, after completion of Tendaho dam.

Source:
Gedion Tsegaye, 2009.

river basins. In Awash river basin 37 irrigation potential sites are identified out of which 5 are small-scale, 18 are medium-scale, and 14 are large-scale. The estimated irrigation potential is 134,121 hectares. Out of these, a potential, 30,556 hectares are for small-scale, 24,500 hectares for medium-scale and 79,065 hectares for large-scale development [14].

OPPORTUNITY FOR FUTURE IRRIGATION PRACTICES OF AWASH RIVER BASIN

The existence irrigation development in the basin

According to Taddese *et al.*, [1], there are three functional dams in the basin for hydropower generation and irrigation development. Furthermore, the majority (48 to 70%) of the existing large-scale irrigated agriculture of the country is located along this river [17,18].

Most of the irrigation schemes in Awash River Basin have good reputation in irrigation efficiency which varies from 30 to 55 %. In the early 50's the Koka Dam was built in the basin, which served for hydro - electrical generation and irrigation development in the downstream. Soon after the first sugar factory was established in the basin. Large- scale irrigated farming is common on the floodplain. State farms control some 80% of the irrigated area and smallholder farmers farm the remaining 20% (Table 2). Of the state farm area 92% is grown with cotton, 3% with bananas and 5% with cereals and vegetables.

Future irrigation development programs in Ethiopia

The Ethiopian Irrigation Development Plan (IDP) emphasizes the development of small-scale irrigation systems through giving highest priority for capacity-building in the study, design, and implementation of irrigation projects. Increasing emphasis will also be given to the development of large and medium-scale irrigation schemes. Ethiopia has designed a Water Sector Development Programmed for the period ranging from 2002–2016 [13]. Accordingly, new irrigation works will be undertaken to develop a total of 274,612 ha of farmland under the irrigation development plan by the federal government and regional governments for large and medium scale irrigation developments. By the end of the water sector development program (WSDP) in 2016, the total area under irrigation will be 471,862 ha [13]. However, due considerations should be given during expansion of irrigation infrastructures. Irrigation can have adverse effects on environment and public health, if it is not properly managed.

The basic opportunistic considerations regarding irrigation developments in Ethiopia are: (1) Emphasis and priorities are given to irrigation in the growth and transformation plan of the country, (2) Indigenous knowledge and introduction of promising household water harvesting and micro- irrigation technologies, (3) Government's strong political commitment and encouragement to private sector and public enterprises involvement in irrigation development, (4) Abundant water resources, climate and land suitability, (5) Availability of inexpensive labor.(6) Availability of suitable lands for irrigation developments especially at arid areas of the country [19].

Table 2: Existing and potential large scale irrigation in Awash river basin.

Location	Existing (ha)	New expansion (ha)	Total (ha)
Upper Awash	23300	10600	33900
Middle Awash	19900	35100	55000
Lower Awash	25600	36900	62500
Total (ha)	68800	82600	151400

Water partnership agreement and water governance program

To improve the water related living conditions for the people in the Awash River basin, by improving the performance of beneficiary partners on water governance, several Dutch and Ethiopian water institutes signed a Water Partnership Agreement on 1 March 2013. The partners agree to cooperate to improve the water governance situation in the Awash River basin, by setting up a Water Governance Program and Action Plan and the subsequent implementation of these plans. In the project "Set up of a Water Governance Program in the Awash river basin, Central Ethiopia" the Regional Water Authorities of the above-mentioned Water Partnership Agreement and the WGC cooperate with the Awash Basin Authority (AwBA) [20] and the Ministry of Water and Energy (MoWE) to identify the main water governance challenges, execute an assessment on water governance capacity and existing the Water Governance Program [2].

Challenges of irrigation in Awash river basin

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 [15].

Technical gabs

There are four main challenges for the sustainable development of the Awash River basin:

1. Ensuring that the Awash River basin water resources management is strategically directed, supervised and integrated with other social, economic and environmental sectors.

2. Ensuring effectiveness of the water policy and the legislative framework already put in place by involving competent organizations in development and management of water resources and water related services.

3. On the long run: ensuring Awash river basin functional and operational full capacity as it is planned, designed and formulated in the water policies and regulations (facilities, staff, budget, planning, financial management).

4. Improve capability of involved organizations to better realize the potential (hydropower, irrigation) of the water system and to improve the situation on WASH (Water, Sanitation and Hygiene), in order to foster livelihood and wellbeing of local communities [2].

Water governance gaps

Management gap: Watershed management is poorly carried out. This may further aggravate the environmental degradation and pollution of the river having negative consequences in terms of both water quantity and quality in the basin.

Administrative gap: The policy implicitly recognizes the integrated

management of water with other natural resources within a river basin. This is made more explicit in de Environmental policy. It does not however address the administrative linkage of water resources to land management and spatial planning, while this has an important bearing of the availability and quality of water resources within a given basin.

Policy gap: The fact that EIAs are not conducted prior to the implementation of water resources projects, for instance, in a river basin context such as the Awash may further exacerbate the environmental degradation and pollution of the river having negative consequences in terms of both water quantity and quality in the basin.

Information gap: The AwBA has given the mandate to establish a basin-wide information system and to develop river basin models. There is no question that establishing such knowledge base and analytical methods at the basin level are important as a planning tool and decision-making as well as for effective water resources management and development. However, huge investment is required for the collection and processing of hydrological data and for monitoring the impact of water resources developing in the basin. Currently, most of this function is done at the Federal level by the MoWE. There is still lack of knowledge on the available water resources in the basin and the amount of water is currently being utilized by various users.

Decision making gap: The Awash BHC, which is the highest policy decision-making body regarding most of the functions of the Basin Authority, has not been established yet and may prove a constraint for the AwBA to discharge its newly mandated regulatory functions since it needs the approval of the BHC. Most of the matters to be deliberated upon and/or decided by the BHC are to be submitted to it by the RBA which is to serve as the secretariat (administrative and technical arm) of the BHC. The RBA will have dual accountability, firstly, to the BHC on matters that fall within the mandate of the latter. Secondly, it is accountable to the MoWE on matters falling under its jurisdiction.

Target gap: While being aware that the AwBA is newly mandated to play as regulatory body, the authority has not so far prepared any forum to introduce its new mandate and discuss on how to discharge its responsibility. The AwBA still continues largely to focus on its operational functions such as the maintenance of and the collection of water charges from some large scale irrigation enterprises.

Capacity gap: The AwBA is still far from being considered as a full-fledged basin authority because of several constraints it is faced with to discharge its newly mandated regulatory functions under its establishment regulation. Most of its new mandates require that it has sufficient capacity both in terms of manpower and financial resources as well as logistics to carry out its functions adequately.

Location gap: Another major constraint of the AwBA is the current location of its Head Office in Melka Werer which is quite remote from the major city centers in the Basin and that communication networks such as the internet are lacking thus posing difficulties to effectively communicate with the relevant regional bureaus and other stakeholders in the basin. Not only communication but the location of the Head Office does not also attract professionals. To solve this problem it may be recommended to change the Head Quarters to a convenient place which has the required services and would be an ideal venue to network with the necessary stakeholders in the future. Another option is to establish hubs in the main city centers.

Financial gap: One of the most challenging aspects for the AwBA would be to ensure its financial stability and independence by having their own source of income. One of the major source of their income is from the water charges they tariff from water users in the basin. However, this is unlikely to be significant in the short term since there is as yet no well-functioning system. Thus, the RBOs may have to depend on the budget that will be allocated from the Federal Government for some time in order to operate effectively.

Coordination gap: There is as yet no coordination mechanism established between the AwBA and the respective Regional States and other stakeholders within the Basin to manage the water resources of the Awash in an integrated manner. In the absence of inter-regional coordination and also lack of coordination within the respective bureaus of the regions themselves, there is bound to be conflict among water particularly between upstream and downstream users.

Communication gap: Many of the water users in the basin or regional water related government bodies are not yet aware of what the mandates of the AwBA or, in some cases, even of its existence. This calls for a two-way communication flow with stakeholders and the inter-institutional cooperation. It also calls for cooperation at project / implementation level. AwBA should be involved in all major projects and developments: RWBs, sub-regional institutions, NGOs, other stakeholders such as government and private commercial farms; community-based WUAs, etc. In the case of unwillingness to cooperate, the BHC may intervene [21-23].

Environmental challenges

Water borne diseases: In the Awash Valley, Schist-soma mansoni is found at the higher altitudes (the upper valley) where the intermediate host, Biomphalaria pfeifferi profusely breeds in tertiary and drainage canals of the sugar estates. Schistosoma haematobium, causing urinary schistosomiasis, occurs in the middle and lower valley (where average temperatures are higher) where the intermediate snail host Bulinus abyssinicus breeds in the clear marshy waters of swamps in undeveloped flood plains. Health records show that before the development of sugar estates, prevalence was limited to the provinces of Harar, Tigray and the Lake Tana Basins of Gojam and Gondar. Agricultural development attracted people from these areas, including people infected with the parasit.

Malaria is a serious problem within the Awash River basin, the disease being present in all areas below 2000 a.m.l, frequent epidemics having been reported from areas within the basin [24]. Some areas showing no incidence of Malaria in the South Western parts of the basin, between Nazareth and the border of Addis Ababa up to 2000 (a.m.l.).

Wetland degradation: Ethiopia adapted, the Awash Basin Surface Water Resources Master Plan, originally adopted in 1989, the plan focusing on management of the upper parts of the watershed, including development of irrigation, hydropower and livestock in the catchments area. Three wetlands were proposed for irrigation development. They are: the Becho Plains, the Gedebassa Swamp and the Borkena Swamp. At present some other small wetlands are being turned to agricultural lands and reservoirs for power generation or irrigation. At a smaller scale, wetlands are being drained resulting in degradation and destruction of the natural ecosystem of the basin. Attempts at draining swamps have not taken into consideration the existing intensive role of the wetlands

in providing dry season grazing and other benefits to local communities. In effect the great pluvial lakes in the Afar region are reduced to a few small lakes and swamps, turned into fragile confined ecosystems. The size of Lake Abe has decreased by 67% since the 1930s. For many years, water from the Awash River was used for irrigation. This situation as well as recurrent droughts has contributed to the progressive drying up of the lake exacerbating the situation.

Desertification: Manifestations of desertification in Awash River Basin include accelerated soil erosion by wind and water, increasing salinization of soils and near -surface groundwater supplies, a reduction in soil moisture retention, an increase in surface runoff and stream flow variability, a reduction in species diversity and plant biomass, and a reduction in the overall productivity in dry land ecosystems with an attendant impoverishment of the human communities dependent on these ecosystems. The lower Awash River Basin is under severe land degradation and desertification. As the few trees are removed for charcoal and fuel wood, salt patches and salt accumulation is appearing over large areas killing the vegetation cover. In both Middle and Lower Awash River Basin Prosopis Juliflora, an aggressive exotic plant species, is spreading at alarming rates in alluvial fertile land, around homesteads, and in drainage canals and roads. Prosopis Juliflora believed to have allelopathic potential on indigenous vegetation (Figure 4).

Source: Girma Taddese (2002)

Figure 4: Desertification in lower Awash basin.

Table 3: Average area coverage of salt affected soil in Irrigated area of Awash basin.

Scheme Name	Altitude (m amsl)	Net irrigated area (ha)	Saline area (ha)
Degaga	1350	171	20
Awara Melka (Kesem	850	1140	145
Yalo(Kebena)	850	410	220
Melka Sedi	750	3047	1165
Amibara	750	434	56
Gewane/Maro gala	550	2071	56
Mile(SF)	400	580	20
Dupti(SF)	400	5300	300
Awssa Asaita	350	2631	20
Karadura	350	163	80
Total		15947	2126

Soil salinity and water logging: Salinity problems are recognized throughout the Lower Awash Valley. Another common problem in drained marshes and swamps is that soils become infertile and acid because of oxidation of sulphur and production of sulphuric acid in the drained soils. In poorly drained soils wilt syndrome to cotton is produced under anaerobic condition in the presence of easily oxidize-able-organic matter, presently hydrogen sulphide and reduction of NO3, Fe, Zn and Cu, this process affects growth of cotton root causing damage and other deformation in plants (Table 3).

Development of large scale irrigation projects without functional drainage system and appropriate water management practices have led to gradual rise of saline ground water in the Middle Awash region (Table 4). In effect, development of persistent shallow saline groundwater, capillary rise due to high evaporation and concentration of the soil solution together with the natural some seeps contributed to secondary Salinization [25,26].

Population and population density: The overall population of the River Awash Basin is currently estimated to be around 14 million as derived from the 1994 population and housing census (Ministry of Water and Energy, 2010) and more than 65% of this concentrated in the Upper Awash (Awash Basin Authority, 2015). Main population centers reside in the Upper Basin and in upland areas above 1,500 m.a.s.l, the lower limit of rain fed 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 20 road network near irrigation projects but, below Nazareth, there are no significant population centers. 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.

Occurrence of baseka lake: Most of the previous studies Halcrow [27]; Ayenew [28]; Georner *et al.*, 2009 [29]; Dinka [30-32] were addressing aspects of the Lake Baseka expansion. In fact, most of the previous research findings are contradicting each other. A study report made by Halcrow [27] and Ayenew [28] have suggested that the nearby irrigation farms (Abadir and Nura-Era) are discharging excess irrigation water into Lake Baseka and are responsible for its expansion. On the other hand, Georner *et al.*, [29] and Dinka [32] reported that Abadir farm has little effect on hydrochemistry of Lake Baseka (Figure 5).

In the period between1986 to 2000 the lake surface area increased

Table 4: Average area coverage of salt affected soil in Amibara irrigation schemes.

No.	Salt affected soils Class	ECe (dS/m)	SAR	Area (ha)	% Area
1	Non Saline –Non Sodic Soils	< 4	< 13	10007.3	65.6
2	Saline Soils	> 4	< 13	5239.79	34.34
3	Saline Sodic Soils	> 4	> 13	9.13	0.06
Total Area (ha)				15256.22	100%

Source: (Frew et.al, 2015)

by about (11.6 km 2), where the expansion direction is restricted almost towards the South (Abadir farm) and towards the West. In this period the Lake almost established its current shape. Between2000-2008 the expansion of the lake is further restricted towards Abadir Farm in the south and towards Metahara Town in the North East (Table 5). In general, the recent expansion trend of the lake is in the south, east and northeast directions [33].

According to Olumana *etal.,* (2009), the significant expansion of Lake Baseka during the past 35 years started after the introduction of MSE. The expansion is affecting both the groundwater dynamics and soil salinization of the nearby sugarcane plantation and, if it continuous, the sustainability of the plantation itself is under great risk.

The future expansion of the highly saline lake may be aggravated towards the east and northeast direction due to the topography of the area. This has the potential to displace Metahara town and impact the sugar plantation during the next 25-30 years. Assuming the past trends, the lake is expected to join Awash River, there by impacting all downstream irrigation developments in the Awash Basin, and affecting the livelihood of the people depending on the water resources of this basin.

Over the last about a half century, Lake Baseka has expanded at a very fast and dramatic rate [34-37]. The expansion of the lake with its poor water quality (EC~6.3 dS/m1, SAR~300 and pH=9.6) is expected to create various negative impacts on ecosystems.

To conclude the source of the lake is irrigation excess only since the area is prone to different tectonic activities as it is situated in central rift valley region [19]. If the lake expansion trend continues, intrusion of lake water into the groundwater system of the sugar plantation may occur, resulting in certain economic and environmental consequences on the soil and water (such as water logging, Stalinization, sodification and alkalinization).

Table 5: Surface area of the lake Baseka in different periods.

Year	Area (km^2)	Incremental area (km^2)	Cum. incremental area (km^2/year)
1957*	3	0	0
1973	8.4	5.4	0.3
1975**	10.2	1.8	1.2
1986	29.5	19.3	3
2000	41.1	11.6	3.8
2008	42.6	1.5	4

Source: Gulilat, 2000; * processed from 1975 topo-sheet

Figure 5: Lake Baseka and Metahara Abadir Irrigation Schemes.

Table 6: Mean values for some of the water quality parameters for different water types.

Type of water	PH	EC	Na+	Ca2+	$HCO3^{-2}$	Cl^-	SAR
Awash River	7.73	0.38	1.58	1.52	2.70	0.50	1.6
Irrigation Canals	7.83	0.40	1.77	1.67	2.83	0.42	1.7
Reservoirs	8.10	0.38	1.70	1.41	2.60	0.21	1.8
Drainage Water	8.10	1.26	24.31	0.36	1.65	0.49	2.5
Factory Waste	7.92	0.40	57.03	1.59	2.90	0.54	57
Ground Water	8.23	2.38	25.09	1.08	15.28	3.04	30
Baseka Lake	9.58	10.70	159.7	0.38	20.65	39.42	307

*All the units are in meq/L, except EC (dS/m) and PH.

Change in water quality: The summary of the mean water quality for the different water sources are presented as in Table 6. The effects of the highly saline (EC~11 dS/m) lake on the different water sources, especially drainage and ground water, in terms of salinity (EC), sodicity (SAR) and specific ion toxicity (Na and Cl) is clearly observable from the table.

Recently, the river faces a great environmental concern; mainly the saline water of Baseka lake expansion affects the surface and ground water dynamics and soil properties of the region and the condition is specifically dangerous for the sustainability of Metahara Sugar Estate and Metahara town in particular, and the Awash river basin in general [7].

Flooding: The Awash River basin frequently floods in August/ September following heavy rains in the Eastern highland and escarpment areas. A number of tributary rivers draining the highlands eastwards can increase the water level of the Awash River in a short period of time and cause flooding in the low-lying alluvial plains along the river course. Certain areas which frequently, almost seasonally, get inundated are marshlands such as the area between the towns of Debel and Gewane in the vicinity of Lake Yardi and the lower plains around Dubti down to Lake Abe. The third area which often floods is, about 30 km north of awash town in the vicinity of Melka Werer. Flooding along Awash River was mainly caused by heavy rainfall in the eastern highlands and escarpment areas of North Shewa and Welo and not because of heavy rain in the upper watershed areas (i.e. upstream of the Koka Reservoir). Over the year's soil and water run -off in the escarpment areas have steadily increased as a result of deforestation, the most serious environmental degradation in the escarpment areas being caused by overpopulation in the highlands (Figure 6). Tributaries to Awash river such as Kessem, Kebena, Hawadi, Ataye Jara, Mille and Logiya rivers contributed most to the lowland flooding in Afar.

Invasion of prosopis julifora in the middle Awash valley: Currently, Prosopis Julifora poses a threat to indigenous biodiversity where ever it is established in Ethiopia in general, in the Middle Awash area in particular because of its weedy and invasive nature. In the Middle Awash, about 30,000 hectare of grass land, rangelands, water points and croplands are estimated to be occupied by Prosopis Julifora [38].

It impacts the plant biodiversity by creating a physical barrier on seedlings of other plant species, preventing sunlight to reach to the under canopy vegetation, lowering the water table and by releasing various chemicals that may have negative effect on the native plant species. Now Prosopis Julifora has become the national no. 1 invasive species in Ethiopia [39].

According to Tessema 2007, Prosopis is an invasive plant that discourages undergrowth of other plants or grasses. In both Middle and Lower Awash River Basin Prosopis Juliflora, an aggressive exotic plant species, is spreading at alarming rates in alluvial fertile land, around homesteads, and in drainage canals and roads (Figure 7).

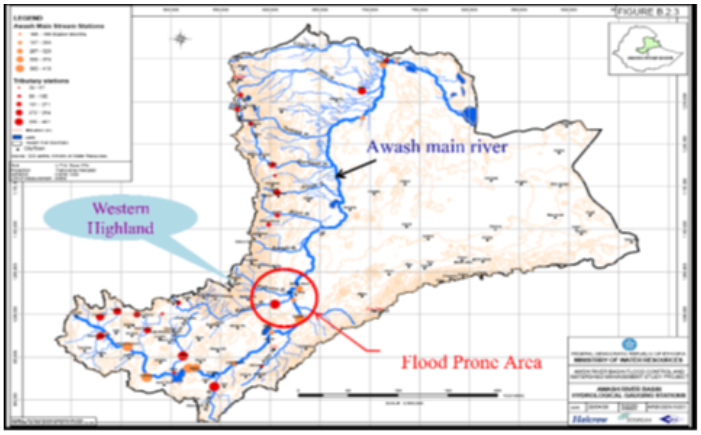


Figure 6: Location of middle Awash river basin flood prone area along with discharge measuring stations.

Figure 7: Prosopis juliflora infestation in middle and lower Awash valley.

The invasive Prosopis Julifora plant widely occurs in Ethiopia's Afar region where it currently occupies an estimated 360,500 ha of arid and semi-arid lands [40]. The species has several documented uses, both in its native and introduced ranges. In its native range, the species is exploited for human food, animal feed, medicine, timber, honey and energy products [41].

SUMMARY AND CONCLUSION

There are twelve major river basins in Ethiopia of which Awash Basin is one and the most utilized River basin so far. Awash Basin covers parts of Afar, Amhara, Oromia, Somali Regional States, SNNP and Addis Ababa and Dire Dewa Administrative councils. Awash River Basin, with a total catchment area of 113,304 km^2, is located between latitudes 7°53′N and 12°N and longitudes 37°57′E and 43°25′E in Ethiopia. This current topic aims to review literatures information related to the Status, Opportunities and Challenges of Irrigation Practices in Awash River Basin, Ethiopia.

The relative surface water resource of the basin is about 4.65 billion m^3, it is the most developed and utilized since 77.4% of the irrigable land in the basin has been cultivated. About 60% of the large-scale irrigated agriculture and more than 65% of the national industries are located in the basin. The Awash River Basin faces Technical Constraints and Environmental challenges such as land degradation, high population density, natural water degradation, Salinity and wetland degradation, desertification, flood, water quality changes and invasion of Prosopis Juliflora. Already desertification has started at lower Awash River Basin. In the high land part deforestation and sedimentation has increased. As more water is drawn from the river there could be drastic climate and ecological changes which endanger the basin habitat and human livelihood. Frequent and persistent droughts and the associated food insecurity have drastically affected the human and livestock population, especially in the Middle and Lower Basins of Awash River.

The history of modern irrigated agriculture in Ethiopia was started with the production of industrial crops (sugar and cotton) on large-scale farms by private investors in the Awash area during 1960s. The arable land under irrigation amounted to just 11% of this number, 0.29 million ha. Of the potential arable land for irrigation; the River Awash Basins represents 24% of the land nationally available for irrigation. Of the 0.29 million ha irrigated land in 2009, 29% in River Awash.

There are three functional dams in the basin for hydropower generation and irrigation development. The majority (48 to 70%) of the existing large-scale irrigated agriculture of the country is located along this river.

Therefore, from these findings I conclude that the Awash River Basin is the most intensively utilized river basin in Ethiopia due to its strategic location, access roads available land and water resources. 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. The basin has opportunity, because the Ethiopian Irrigation Development Plan (IDP) emphasizes the development of small-scale irrigation systems through giving highest priority for capacity-building in the study, design, and implementation of irrigation projects. However, the Awash River Basin faces difficulties in sustaining its' services due to technical gabs like:

✓ Lack of strategically directed, supervised and integrated with other social, economic and environmental sectors.

✓ Ensuring effectiveness of the water policy and the legislative framework and Improve capability of involved organizations to better realize the potential of the water system

Water governance issues such as Management gap, Administrative gap, Policy gap, Information gap, financial gap and Communication gap, and severe environmental challenges: - Population and population density, wet land degradation, Salinity and water logging, water borne diseases, desertification, flooding, change in water quality and invasion of Prosopis Julifora and Expansion of lake Besaka expansion are the major treat of irrigation in awash river basin.

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