Ethiopia Water Resources Quantitative Potentials, Management Issues and Challenges. A literature Review Article Paper

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***Abstract*-** Ethiopia is the "water tower" of East Africa. Ethiopia is blessed with a vast array of waters called "White Oil" or "Blue Oil" and has 12 major rivers and 11 large lakes. The country's maximum water supply is only 44%, the country's annual clean water capacity is 123 mm^3, of which only 3% remains in the country. It has a surface capacity of 54.4 bm^3 and 2.6 bm^3 of groundwater. In general, less than 5% of the surface water is used. It is estimated that 3.7 million hectares of land can be used for irrigation development. Water is an invaluable resource and is essential for sustainable developments and livelihoods. Ethiopia has vast potential for water resources, but it has not used water resources properly or wisely. Achieving the goals of household consumption and sustainable development, access to adequate water will contribute significantly to improved economic sectors. The main management issues and challenges are climate change, transboundary water resources conflicts, drawbacks of institutions, and water weeds.

Keywords- Water Management Issues, Quantitative Potentials, Challenges, Ethiopia.

I. INTRODUCTION

Ethiopia has gifted naturally big water resources that can effortlessly satisfy domestic requirements, irrigation, and hydropower, and with main rivers. A significant quantitative potential of water is named ‘white oil’ or ‘blue oil’[1]. Ethiopia covers to 99.3% of the landmass and water bodies contain the last 0.7%. Available water resources provide usable groundwater and provide accurate rainfall transmission to charge up aquifers that generate and sustain springs late-season river banks. Groundwater is still playing a significant role in household and commercial tool purposes in almost all areas of the country, in particular in rural countryside sections and urban communities[2]. Ethiopia stands in the latitude 3^0 and 15^0 North and the longitude 33^0 and 48^0 East in what is generally called a "Horn of Africa". Water is an armature resource class; is the foundation of all life varieties and the economic roles. The vital standards are aimed to inform inclusive, sustainable, and environmentally friendly development, use, and conservation of water resource troubles in different phrases want to be viewed from a wider standpoint, each in phrases of the area and livelihoods[3].

The emphasis of this paper to take an introductive overview of Ethiopia's water resources management issues, quantitative potentials, and their development potential and to inform the challenges and opportunities. The materials used for review websites, Google scholar literature journals, and official government reports. To identify the quantitative potential of water resources and elements that need to be explored to meet the growing water demand and to develop and manage the necessary plan in the sector. In all of this, it is too significant to assess what challenges of water management issues and sectoral further opportunities. Historically, the production and management in Ethiopia's water field have affected many factors.

II. QUANTITATIVE POTENTIALS OF WATER RESOURCES

Ethiopia has twelve foremost river basins/valleys, eleven lakes, nine saline lakes, four crater lakes, and over twelve foremost swamps/wetlands in (Table 1 and 2). The country can solely be a water tower in phrases of receive enough water and donate it to neighboring nations, however, no longer in phrases of adequate water resources that are comfortably in hand for use[4]. Approximately 90% of Ethiopia's water sources are located throughout in the four river basins, Abay (Blue Nile), Tekeze, Baro Akobo, and Omo Gibe, in Ethiopia's Western and Southwestern transitions. Whereas 90-95% of the people in these basins live[5, 6]. The contribution of each of the Nile's main tributaries rivers Blue Nile 50 bm^3 (59%), White Nile 11.5

bm^3 (14%), Sobat 11.5 bm^3 (14%), and Atbara 11 bm^3 (13%) [7]. Below (Table 1) shown Ethiopia's geographical distributions and surface water shares.

Table 1: surface water potential contributions

Flow direction	Basins	Area Coverage share	Surface water share
West	Abbay, Tekeze, Baro-Akobo and Mereb	38.75%	69.83%
East	Wabi-shebele and Genale-Dawa	33.34%	7.58%
South	Rift valley lake basin Omo-Gibe	5.15%	17.94%
Northeast	Awash basin	9.79%	3.95%
No flow	Ogaden, Dinake and Aysha	12.96%	0.69%

Sources; Surface Water Geographical Heterogeneity[2]

Table 2, Quantitative Potential List of Ethiopia Lakes, Located within the boundaries of the Country.

Name of Lakes	Area (km^2)	Elevation (MAMSL)	Type of lake	Name of Regions	Coordination
Abaya	1162.00	1285.00	freshwater	SNNPR	latitude 6.4333°N and longitude 37.8833°E
Abbe	320.00	243.00	salt	Afar	latitude 11.1666°N and longitude 41.7833°E
Abijatta	205.00	1573.00	salt	Oromia	latitude 7.6166°N and longitude 38.6°E
Afambo	35.00	339.00	freshwater	Afar	latitude 11.4166°N and longitude 41.6833°E
Afrera	100.00	-102.00	salt	Afar	latitude 13.2833°N and longitude 40.9166°E
Ashenge	20.00	2409.00	salt	Tigray	latitude 12.5805°N and longitude 39.5°E
Hawassa	129.00	1686.00	freshwater	SNNPR	latitude 7.0401°N and longitude 38.4879°E
Bario	22.16	339.00	-	Afar	latitude 11.3753°N and longitude 41.6258°E
Basaka	42.60	950.00	salt	Oromia	latitude 8.8666°N and longitude 39.8666°E
Chamo	317.00	1110.00	freshwater	SNNPR	latitude 5.8333°N and longitude 37.55°E
Chew Bahir	343.00	570.00	salt	SNNPR	latitude 4.7166°N and longitude 36.95°E
Chomen	180.00	2224.00	reservoir	Oromia	latitude 9.5199°N and longitude 37.2159°E
GERD	1874.00	155.00	reservoir	Benishangul-Gumuz	latitude 11.2014°N and longitude 35.1088°E
Gummare	60.00	0.00	freshwater	Afar	latitude 11.5333°N and longitude 41.6666°E
Hayq	23.00	2030.00	freshwater	Amhara	latitude 11.3333°N and longitude 39.7166°E
Hardibo	16.00	2136.00	freshwater	Amhara	latitude 11.2333°N and longitude 39.7716°E
Haramaya	0.00	2010.00	freshwater	Oromia	latitude 9.4049°N and longitude 42.0045°E
Kadabassa	0.00	562.00	-	Afar	latitude 10.203°N and longitude 40.4914°E
Karum	50.00	-120.00	salt	Afar	latitude 14.0166°N and longitude 40.4166°E
Koka Reservoir	180.00	1595.00	reservoir	Oromia	latitude 8.4333°N and longitude 39.0333°E
Langano	230.00	1585.00	freshwater	Oromia	latitude 7.6°N and longitude 38.7166°E
Shala	329.00	1558.00	salt	Oromia	latitude 7.4833°N and longitude 38.5333°E
Tana	3060.00	1788.00	freshwater	Amhara	latitude 12°N and longitude 37.5°E
Turkana	6405.00	361.00	salt	SNNPR	latitude 3.5833°N and longitude 36.1166°E
Zway	440.00	1636.00	freshwater	SNNPR, Oromia	latitude 8°N and longitude 38.8333°E
Zengena	1.00	2500.00	freshwater	Amhara	latitude 10.9138°N and longitude 36.9666°E

Sources: ***https://List_of_lakes_of_Ethiopia*** **https://www.worldatlas.com/articles/major-lakes-of-the-ethiopian-rift-valley.html**

The Ethiopian highlands, which are the core of primary water-based development and monetary practices, supply a significant amount of the water that flows into the lowland areas, like Egypt and Sudan. The BNR or Abbay basin contributes 85% of the Nile drift and raises to 95% throughout the rainy season. It has experienced soil loss of about one hundred forty million tons annually, or about 7 tons per hectare per year[8]. But it's varying quantitatively and qualitatively effects in the mismatch of grant and demand. Throughout the literature, that management is an important tool in all water production schemes, which assess success or failure. The water resources development potential of both rivers and streams is shown in (Table 3), river basin potential information of Ethiopia[9, 10].

Table 3: River basin potential information about Ethiopia

River basin	Basin Area (km^2)	Run-off (bm^3)	Irrigable potential land (Ha)	hydropower potential Gwh/year
Wabi-Shabelle	202,697	3.40	23890	5,440
Abbay	199,812	54.40	81560	78,822
Genale-Dawa	171,042	6.00	107450	9,270
Awash	110,000	4.90	13410	4,470
Tekeze	82,350	8.20	15880	5,980
Afar/Denakil	74,002	0.86	52300	0
Ogaden	77,121	0.00	0	0
Omo-Gibe	79,000	16.60	6790	36,560
Baro-Akobo	76,000	23.24	101950	13,765
Rift valley	52,739	5.64	13930	800
Mereb	6,900	0.72	6760	0
Aysha	2,223	0.00	0	0
Total	1,133,886	123.96	423,920	155,107

Source; MoWIE (2015)

The total projected annual resources of available surface water across 12 major river basins and lakes with per capita freshwater capacity measured at 155,107 gross hydropower potential per year are measured at 123 billion m^3 and 423,920 ha irrigable potential land. Above (Table 4) shows the country's capacity for development information in river basins becomes substantial. However, the country's water-useful resource is extraordinarily time- and space-variable. About the quantity of surface water supplies, 90 percent of the country's water resources are concentrated in four river basins, Abbay (Blue Nile), Baro-Akobo, Omo-Gibe, and Tekezze, 40 % of the population lives there, while 60% of the country's people living in disproportionate Eastern and Central River basins and relies on water usage even less than 20 percent of the country. The three river basins have a strong discharge (Abbay, Baro-Akobo, and Omo-Gibe) is demonstrated by using that the latter was river basins occupy the largest concentration of rainfall occurs in the Western and Southwestern part of Ethiopia. Development and abstraction of water resources should be aligned with the whole development goals of Ethiopia, and driven by those goals on the region and district level. Alternate solutions are enhancements of water supplies must be evaluated systematically, because giving equal interventions for supply and demand is necessary. Since a few years ago Ethiopia went to the scene with a wide-ranging water resource for development plan. Although the activities for growth encompass all of the country's major river basins, the huge potential of agribusiness and hydroelectricity in the Abbay Basin (Upper Blue Nile) has attracted considerable attention[11].

III. Water Resources Management Issues

The management and conservation of the environment are the key issues about social and economic development. Thus, the country's water assets, all surface and groundwater waters, are available to the general public and are thus secured in the national government[12]. Any action in water management will tackle the root causes of change of land, habitat destruction, agricultural runoff, and depletion of soil nutrients and another issue that does not been deeply discussed in the literature contains consequences of multidirectional adverse effects, such as streams and rivers downstream. Theoretically, if properly handled, externalities may be raising the tendency of cooperation by seeking compensation mechanisms or the negative consequences simultaneously[13]. Ethiopia water resources management issues are;

Water Pollution (Contamination) and waste disposal

Ethiopia has potential lakes and rivers. However, in rural and urban areas, water bodies are often used as waste disposal and other dead materials disposal sites. This is still the challenge of water resources management, as well as in most parts of the countryside, trends continue. At the root of this issue, there are fundamental problems that arise when there is a cultural attitude attached to society and when it comes to water pollution, it is a serious threat to human health and the natural resources of the environment. One thing that has been neglected is the current view, but the long-term consequences of pollution seem to have been forgotten. Many people only talk about air pollution and are associated with vehicle smoke. However, the actual understanding of water pollution is much lower. Water pollution or contamination is more dangerous for aquatic food webs to the marine ecosystem or water biodiversity. Therefore, there is a need to raise awareness about water pollution on a social basis, especially in lakes and rivers, where private, public and private institutions contribute significantly to water pollution[14-16].

Over-abstraction of Water utilizations

Water is a resource that has the potential to sustain an economy that is large enough to store a large amount of water in a water cycle. Water bodies as a whole have two main roles or benefits. First of all, it can increase the flow of the river, protect the springs and swamps and benefit the environment. Second, it can provide important water supply to meet the growing human needs of domestic use, crop irrigation, and

industrial demand. Reconciling these different roles. The use of land resources, especially in a developing country like Ethiopia, has its negative effects over time for example, it has a large population, diverse and deep economic activities, and is close to the rivers. Therefore, the overuse of water resources is a major disadvantage for those who want to ensure the sustainable use of water resources for sustainable management. Otherwise, access to safe water products can be a source of doubt and pressure. Although any significant over-abstraction can have some environmental impact, it is necessary to distinguish the benefits of water utilization from the negative effects of over-exploitation[17].

The concept of sustainability has recently become the goal of sustainable development, and groundwater management that meets the needs of the next generation will be more important than ever before, regardless of its ability to meet the needs of future generations. This is because while maintaining economic, equitable, and diverse consumer rights, the use of any over-the-counter water resource, such as irrigation, deep and groundwater development, can be a significant economic (and sustainable) source of income for both farmers and investors in the local economy. However, the negative side effects of water over-abstraction may further reduce its usefulness[18].

Sedimentation Overloading in Water bodies

Sediment sources are often associated with irrigated agriculture. When water systems flow directly from the canals, the water from the upper basin creates sediment accumulation in the lower streams through the lower basin by irrigation streams. This results in the formation of sedimentary sediments in the area, subsequent overflow of sedimentation loads, especially in the riversides, and damages irrigation canals, including associated siltation. Unexpected flooding risks in the lower riparian communities, and causes soil erosion on croplands, and siltation at marine ecosystem. Understand that sediment events do not occur only in irrigation practices, however, activities that contribute to sediments are environmental degradation, slope farming activities, landscapes depletion, and so on. Therefore, balanced and sustainable water resources management as well as agricultural activities need to be given special attention to reduce and manage sediment pressure on water intake[19].

Water Weeds and Invasive Species/Water Hyacinth

Water hyacinth has many influences on the socio-economic, community livelihoods, and aquatic ecosystems. The proliferation of hyacinth in water bodies or rapid expansion in the basins and Rift Valleys has developed into a critical crisis on water resources management (WRM). Water hyacinth has invaded the absolute Ethiopian Rift Valley basin systems to date and is related to a decline in aquatic plant biodiversity [20, 21]. The invader has been the major challenge facing the nation's water bodies, as they form a dense float surface on the water face that threatens to decrease the throughput of sunlight. The specific occurrence and source of water hyacinth infestation is no longer understood, but factors such as sedimentation, agricultural components of the contaminants (organisms), and catchments from the neighboring areas[22].

In early periods, Ethiopia's lakes and rivers are well known as free from any waste disposal and proliferation of water hyacinths. However, currently, water bodies have their surrounding impacts faced today. The lakes are mainly known for fish resources and the richest in biodiversity functions. But now the areas are talking about the decline in fish resources, wastewater issues, and other invasive species infestations. Especially at Amhara, Oromia, and SNNPR lakes Tana, Koka, Abaya, Zeway most parts are covered by water hyacinth species. The bodies of water are one of the nation's potential tourist attraction opportunities, but current problems are barriers to destination income. This amazing lake is at risk of the disturbing expansion of water hyacinth weeds on its wetland and surface areas of lakes[20, 23, 24].

IV. Water Resources management Challenges

Almost every part of production is surrounded by water. It contributes to economic development, leads to healthy environments, and is vital to life. Water-related trends and challenges lots of people have accounted for 9 out of 10 natural disasters, such as floods, landslides, and droughts[25]. Climate alternate is predicted to extend this chance and vicinity more stress is placed on scant supplies of water. The plausible influences of climate alternate within the basin area of particular issue given their geopolitical and socioeconomic implications. Water access underpins human prosperity throughout the countries, with priority given to water development for agriculture, domestic utilization, electricity, and industry. Competition for water amongst people and countries creates local weather of struggle that discredits human wellbeing and the functions of the ecological system[26].

The community survey identified water issues in the society and their functionality, management, benefits of practical water factors to the community, the effect of natural mess-ups on functionality, things to do linked to water during the final two years, and the predominant areas for perceived improvement wished from water points[27]. In Sudan and Ethiopia, water accessibility is a greater problem than in Egypt. Rainfall is unpredictable and is both occasional and structurally variable in each region. This extreme change in climate makes time-honored droughts and floods an issue of place. Rainfall-induced flooding in Ethiopia has been hampered by habitat destruction, agricultural expansion, and fragmented land use[28].

V. Challenges of Water Resource management

Challenges of water resources problem are the extreme and unusually escalating climate change trends and challenges, the invasive weeds in especially lakes, the challenges of government institutions drawbacks and the conflicts of transboundary water bodies in neighboring countries. All this has led to long-term internal and external challenges on management and development that create distrust for future perceptions[29-31].

Climate Change Trends and Challenges

Climate change and extremely increase are projected to amplify water shortage concerns by 2050, an estimated 4.8 to 5.7 billion humans will be residing in probably water-scarce parts of the country at least a month year[32]. The Awash river basin, Ethiopia, is a problem of excessive local weather variability, experiencing prevalent floods and droughts[33]. The extreme and unusually escalating climate change trends and challenges will considerably impact water resources. There is a need to graph how to adapt to these changes, and how to mitigate the adjustments for water resources. There are many other high-risk river basins in Ethiopia[34-36].

Climate trends that reduce both the typical availability of water or the nature of the use of water would have a significant impact on agricultural production and industry and city improvement[37]. In Ethiopia extra than 80% of the populace is worried about agriculture and crop production that is normally practiced under rain-fed conditions; most of which are marginalized through moisture stress. Yet economic growth, environmental efficiency, social well-being, and their sustainability periodically decline[38]. Due to man-made and natural variation local weather changes, the variation in streamflow makes water resource administration in those areas difficult, in particular with developing water demands. Most regions within the Nile Basin are vulnerable to climate fluctuations and flooding disasters[39].

Conflicts between Transboundary Water Resources Utilization Rights

The four most common types of conflict in sub-Sahara Africa occur at different levels, both internally and externally. Conflicts in Africa seem to have come from a variety of factors, such as resource shortages, border conflicts, inter-ethnic conflicts, unusual political instability, corruption, and obligations internal of situations and poverty crisis. The current escalation of water resource utilization conflicts between riparian countries is being waged by elite people groups and politically motivated rivals around the neighboring countries[40].

Historically, the use of Nile water resources, rather than shared interests, has been a lifelong opposition to the Nile Basin countries, driven by one-sided and contradictory national interests. Throughout the twentieth century, the downstream international locations (Egypt and Sudan) have claimed a monopoly of the Nile water. The down-stream international locations have used a range of technical, political, and army skills with the purported purpose of securing a secure provide of water which in reality originates outside their borders. Ethiopia, an upstream country, has not only repudiated the downstream declare but has, in response to it, head to the “equitable rights” doctrine. Ethiopia and other upstream international locations stress that utilization of the Nile must meet the developer desires of all basin countries and that “water security” can solely be finished. The political expression of these national interests has characterized the traumatic relationship and a lack of cooperation[41, 42].

Today, the developers want for water resources development has added excessive political and financial conflicts between rivers-sharing nations that float between countries. The intention to perceive the economic, social, and political benefits of transboundary cooperation through using the Nile Basin Initiative (NBI) as a case study. The argues that in the riparian countries need to work for "benefit-sharing" as a substitute than "water-sharing". It additionally claims that applying the thinking of benefit-sharing would assist in fixing issues that are triggered via divergent hobbies amongst the riparian countries in the upstream and downstream conflicts regularly manifested in the place[18, 43, 44].

Because water is in constant movement, regulatory oversight, governance, and sovereignty issues are far more troublesome than when dealing with static land and water resources. Other primary difficulties in the administration of its overwhelming size and the transboundary water supplies accepted policy gaps, plans, and practices. However, the many sectors which command the administration of transboundary water assets factor to the extent how the countries that have several river basins are in a position to transcend their differences and collaborate to the benefit of everybody[45, 46]. Nile Basin for decades, and which has rendered the place a flashpoint for workable conflict, is today perhaps more reported than ever. At its core, the dispute negotiations on the conflicting agendas and desires of the river's upstream and downstream riparian, and the struggle to provide river management in agreement with the concept of fair use, a lodestar of worldwide watercourse regulation[47].

Institutional Drawbacks in Water Sector

Emphasis on the role of water management and stakeholder engagement in formulating and implementing solutions to critical water challenges in Ethiopia will make the water sector a milestone. Therefore, significant efforts are required from government institutions to support efforts to improve water management[48]. Although these efforts and water resources have doubled the value of experiences and lessons learned to share a variety of good experiences on a variety of geographical scales, the weakness of individuals in the sector and the institution itself remains a challenge to modernize the water sector. For example, Ethiopia is a water tower in Africa, but water shortages and sanitation problems continue. The government's plan is not being implemented as intended due

to the lack of a stakeholder body to engage in alternative approaches to address challenges[49].

A good water management institution and effective stakeholder engagement are inseparable, and the strengthening of an institution plays an important role in sharing results and informing the community about water management goals[50]. Several factors hamper the work of the WRM framework in Ethiopia. First and foremost, there is a very limited coordination between planning units at various levels (especially between the region and local states) and through sectors (e.g., Land and water management); Second, expert staff, equipment, and resources are inadequate to track the consistency and availability of both surface and ground waters. The lack of a water-use and emissions release permit program makes it difficult to understand who is using how much water[51]. Among the most integral challenges going through communities is the failure to preserve and enhance the environmental first-rate to acquire sustainable development. More of these water and environmental policies and legal guidelines of growing countries are based on these developed countries with slight amendments without considering the availability of local applied sciences and resources. This might be another institutional challenge of the hindrances, their implementation. Governments in growing countries are anticipated to design and put into effect policies to expand institutional growth and at an equal time to protect the enabling environment[52, 53].

VI. CONCLUSION

I. It seeks to select water management equipment and techniques in any development path that is essential for the development of water resources. To modify and organize safe and effective institutional structures to control institutional structures, weaknesses, ensure sustainable development and water supply activities. Strong participation of local, regional and national to warding bodies by implementing good governance and creating an effective institutional framework for governance structures at the local and regional levels.

II. The situation with neighboring countries has long been argued that there is a lack of technical consultation and not enough quantitative potential data to help select appropriate interventions. Quantitative potential based interventions on the utilization of water resources, institutions, and political actors, and the significant and disproportionate distribution of water management costs and benefits for national use only are governed by international agreements, and there are conflicting views that prevent Ethiopia from asserting rights, Extensive efforts should be made to facilitate cross-border cooperation with riparian countries to use cross-border waters more effectively.

III. The Ethiopian Water Police was established in 1999 and was enacted by the 2000 Proclamations and the 2005 Regulations. whereas mainstreams on improving policy, strategy, and regulations in a coordinated manner with management and utilization. Given the current state of mindset and utilization and the conflicts between transboundary rivers from neighboring countries, it is necessary to focus on improving the policy's, strategies, and regulations to ensure that sustainable water resource management and utilization is effective from the bottom to up and functionality with coordinated manner to especially the river basin management, and utilization it needs reform and strategic transform.

IV. To tackle these challenges and aid the scale-up of best practices, this review recommends; linking catchments physical and biological conservation structures things to do with peoples income-generating and livelihood enhancement activities; tailoring applied sciences, and implementation processes, and co-management the surface and subsurface water reservoirs to increase water performance; enhance institutional frameworks to promote cooperation between stakeholders and ensure sustainable water management with behind the sustainable development goals.

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