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Comparison of Water Availability and Water Management between Turkey and Ethiopia

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Abstract

This study highlights comparison of water availability and management between Turkey and Ethiopia. The paper primarily focuses on the assessment of water resources of Ethiopia and Turkey and their approach to transboundary problems with the other riparian countries. This manuscript aims to understand the water availability, potential and management status of the two countries. In terms of water potential, both Turkey and Ethiopia have relatively abundant water resources. However, it was found that both countries could face serious water scarcity in the near future unless immediate measures are taken to conserve the available resources and insightful water saving strategies are implemented.

Keywords: Ethiopia; Turkey; Water Availability; Trans-Boundary Waters; Water Projectory

Introduction

The intricacy of water as a multidimensional strategic resource has been widely debated in many parts of the world. The issue of contested sharing of common water resources is rising as a core problem between upstream and downstream countries in recent years. In Turkey, the Euphrates and Tigris/Fırat & Dicle (Turkish) rivers are considered as the origin of ancient civilizations and crucial for the socio-economic development of the country. The country has initiated a huge project called GAP/Southeast Anatolia which consists of various dams and hydraulic projects to irrigate its vast arid and semi-arid regions (Daoudy, 2004) [7]

Water, which is an indispensable part of human life, is the most important and most fundamental natural resource on earth. As water is a limiting factor for the socio-economic development of any country, neither biodiversity nor social and economic development can be sustained without water. (Jongerden, 2010; Tashtoush et al., 2019) [16,. 30]. Another perplexity is that the way in which this limited natural resource should be fairly shared among different regions and competing users to meet basic human needs has long been a matter of controversy. In this case, the adverse effect of such discord has some marginal implications for resolving current and future water conflicts (Schelwald-van der Kley, 2009; van Oel et al., 2013) [28, 32].

In sub-Saharan Africa, 69 percent of the population lacks adequate sanitation and hygiene facilities and 40 percent lack access to clean water. While Ethiopia has relatively adequate water resources comprising about 124 billion m^3 of surface water and 30 billion m^3 of groundwater (Angassa et al., 2020; Worku Ayalew, 2018) [3, 37], Turkey has 94 billion m^3 of surface water and 18 billion m^3 of groundwater (DSI, 2020) [10]. The average annual per capita water availability in both Turkey and Ethiopia is quite low and below the global average of 6498 m^3/person/year. According to the Millennium Development Goal, Ethiopia's access to safe drinking water is 57%, while access to sanitation is only 28% across the country (Abebe & Tucho, 2021) [2].

At least 310 of the world's river basins are shared and used by more than one country (McCracken & Wolf, 2019) [22]. Many of these countries have signed international agreements and established cooperation institutions such as river basin management to coordinate their water-related activities and ensure the joint management of these resources. It is alarming, however, that not all countries involved in transboundary waterways disputes have yet ratified the 1997 General Convention UN on the Non-Navigational Use of International Waterways.

Stemming from evolvements such as rapid population growth, industrialization and urbanization many of the world's water resources are under increasing pressure nowadays (Felisa et al., 2022; Ramos et al., 2021; Wohl, 2010) [14, 26, 36]. These resources might therefore be expected to be further exacerbated by the impacts of climate change in complex and sometimes non-linear ways(Draper & Kundell, 2007; Whitehead et al., 2015) [9, 34]. Climate change is particularly significant to further increase the variability of precipitation, by that means aggravating frequency and intensity of extreme weather events such as floods and droughts. This situation is particularly drastic in drier parts of the world. Additionally, climate change can worsen water quality by reaching higher concentrations of pollutants in rivers as a result of heavy rainfall and possible droughts. (Hosseini et al., 2017; Ponce Oliva et al., 2021) [15, 24] .

Water Potential, Availability and Management Status in the Two Countries

Ethiopia is naturally endowed with water resources that could meet domestic needs, provided sufficient financial resources are allocated for water resources development. Ethiopia's geographical location and favorable climate ensure relatively high rainfall in the country. However, more than 80% of the country's water resources are found only in the four major rivers Blue Nile, Tekeze, Baro Akobo and Omo Gibe (Figure 1), which contain no more than 30 to 40% of Ethiopia's population (Kerebih & Keshari, 2021; Worku Ayalew, 2018) [18, 37].

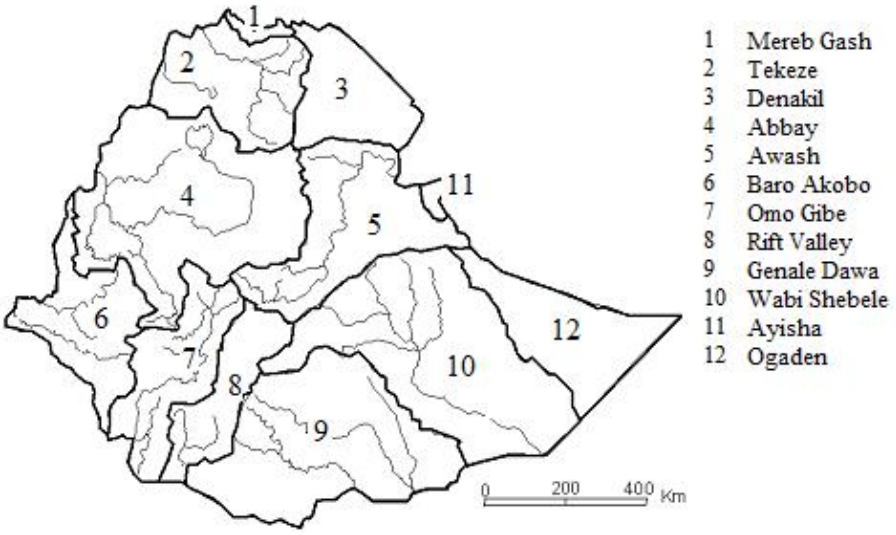

Figure 1: Major basins of Ethiopia (EWNHS, 2018)

In terms of water potential, Ethiopia has relatively more abundant water resources than Turkey. The country has 12 main river basins, 9 salt lakes, 11 lakes, 4 crater lakes, and more than 12 large wetlands (Figure 1). While Ethiopia has relatively adequate water resources, containing approximately 124 billion cubic meters of surface water and 30 billion cubic meters of groundwater (Worku Ayalew, 2018) [37], Turkey has 98 billion cubic meters of surface water and 12 billion cubic meters of groundwater (DSI, 2020). Thus, both countries are considered in the category of water stress countries (Table 1). Especially considering the rapid population growth and inadequate water infrastructure, Ethiopia may soon fall into the water scarcity category. Noticeably, Turkey is a water stress country with an annual water consumption of 1350 m^3 per person (Table 1 & Table 2).

The Falkenmark Index Falkenmark (FLK) (Falkenmark et al., 1989) [1] is one of the most commonly used indicators for determining water resource stress(Rijsberman, 2006), which is defined as the ratio of water availability to total population. The FLK index is a useful tool for classifying (by per capita consumption) water scarcity at the national level (Veettil & Mishra, 2018). Based on the per capita water consumption, the FLK index of a region is categorized as; no stress, stress, scarcity, and absolute scarcity regions (Table 1). Where the index threshold of less than 500 m^3/person/year is considered an absolute water scarcity region and a threshold of more than 1700 m^3/person/year is considered as a no stress region(Falkenmark et al., 1989) [1].

Water (m^3/person/year)	Classification
1700 & above	No water stress
1000-1700	Water stress
500-1000	Water scarcity
500 & below	Absolute water scarcity

T**able 1:** Classification of water availability according to the Falkenmark index (Falkenmark et al., 1989) [1]

Turkey's per Capita Water Potential

According to DSI (DSI, 2020) [10], the water potential that can be used for various purposes has been determined to be 110 billion m^3 per year on average under current technical and economic conditions, of which 98 billion m^3 is surface water and 12 billion m^3 is groundwater. The technically and economically usable water volume is estimated at 112 billion m^3/year. According to projections of Turkish Statistical Institute, the population of Turkey will reach almost 94 million in 2030 (TUIK, 2018) [31] and the water potential will decrease to 1,190 m3 per capita per year. Based on the Falkenmark index rule, Turkey's water availability per capi-

ta is given in the following table (Table 2).

Year	Population (million) (TUIK, 2018)	Water potential (m^3/person/year) (DSI, 2020)
1960	27	4148
1970	35	3200
1980	44	2545
1990	55	2036
2000	66	1697
2010	72	1555
2020	83	1350
2030	94	1190

Table 2: Turkey's per capita water quantity between 1960-2030

Ethiopia's per Capita Water Potential

While East Africa is the water tower, Ethiopia is not particularly notable for its water resource use and per capita water use. This is due to rapid population growth and poor management of the country's water resources. The technically and economically accessible water quantity in the country is about 154 billion m^3/year. According to World Bank projections, Ethiopia's population will exceed 135 million in 2030 (World Bank, 2019) [38], and its water potential will decrease to 1,100 m^3 per capita per year. Ethiopia's water availability relative to its total population, taking into account the Falkenmark index, is shown in (Table 3).

Year	Population (million) (World Bank, 2019)	Water potential (m^3/person/year)
1960	22	7000
1970	28	5500
1980	35	4400
1990	48	3208
2000	66	2333
2010	85	1812
2020	110	1400
2030	140	1100

Table 3: Ethiopia's per capita water potential between 1960-2030

According to Falkenmark index, per capita water potential should be 17000 or more m^3/year for a country to be considered as a country without water stress. As can be seen from the above table (Table 2 and Table 3), both countries are classified as a water stress country in terms of per capita water potential. While the population of Turkey and Ethiopia was almost the same in 2000 (66 million), the population of the two countries reaches 83 and 110 million, respectively, in 2020 (TUIK, 2018; World Bank, 2019) [31, 38]. With such rapid population growth, it seems likely that both countries will be among the countries with absolute water scarcity in the coming years.

Similarity of the Two Countries in Transboundary Water Issues

One of the challenges facing the world today is how to manage and use natural resources, especially international freshwater resources, and how to share them sustainably with various socio-economic sectors (Judith Rees, 2019) [17].

Transboundary waters are water resources used jointly by two or more independent countries, and these resources include international freshwater and groundwater, aquifers and international marine ecosystems (Speed, 2013) [29]. Lakes, rivers and aquifer systems do not simply follow national boundaries and their use requires international cooperation (Dinar et al., 1997) [8]. Although there are a total of 153 countries in the world that use transboundary lakes, rivers and aquifers jointly, only 17 of these countries have regulated all their common waters through transboundary agreements. The two countries have similar problems with their transboundary water resources as they both struggle over how to share them with neighboring riparian countries. Just as the problem of the Nile River is coming to a head between Ethiopia, Egypt and Sudan, the issue of the Euphrates and Tigris Rivers is also causing tension between Turkey, Syria and Iraq (Williams, 2011) [35].

The UN General Assembly approved the resolution on the non-navigational use of international waterways on 8 July 1997. However, not all countries involved in disputes over transboundary waterways have signed the agreement yet. So it has some marginal implications for resolving current and future water disputes (Schelwald-van der Kley, 2009) [28]. Although Sudan was in favor of the agreement among the countries using the Nile rivers jointly, Egypt and Ethiopia abstained, and Burundi opposed this agreement. When it comes to the Euphrates-Tigris rivers, Syria was in favor, Turkey was against and Iraq did not attend the meeting (Özlem Tür & Raymond Hinnebusch, 2013) [23]. This indicates that both upstream and downstream countries are less likely to sign the convention and are reluctant to settle disputes over transboundary water issues.

Turkey, considered as a hegemon in the neighborhood of the littoral states (Kibaroglu, 2015) [19]. Accordingly, it is helpful to take a closer look at the factors that led to Turkey's rejection of the Convention in 1997 and practice of Turkey's transboundary water policy have evolved dramatically since then. On the other hand, Ethiopia's attitude towards the 1997 Convention UN on the Law of Non-Navigational Uses of International Waters remains unclear as it abstained from the Convention. At the same time, the Nile Convention signed in 1959 unjustly deprived the country of the planning and use of its own waters. Also, Ethiopia's stance on the use of the Nile in recent years and Egypt's approach to sharing the river may complicate existing tensions over its use.

With the start of construction of mega irrigation projects (GAP) on the Euphrates and Tigris rivers, tensions have arisen between Turkey and the riparian states. The Euphrates and Tigris Rivers both originate in the mountains of Eastern Turkey (Cavus et al., 2022; Kibaroglu, 2015) [5, 19]. They flow into Syria and Iraq empty into the sea at the tip of Arabian-Persian Gulf. Given this background, Turkey considers itself as an upstream state with respect to the Euphrates and Tigris rivers. Turkey has 28% and 12% of the Euphrates and Tigris rivers, respectively. It is estimated that Turkey contributes 88% of the annual flow of the Euphrates, while Syria contributes 12% (Beaumont, 1998) [4]. However, these figures are controversial. Some authors estimate that Turkey contributes 98.6% of the runoff (Eklund & Thompson, 2017) [11]. It is also estimated that Turkey contributes 51% and Iraq 39% of the Tigris outflow (Rahi & Halihan, 2021) [25].

Recently, Ethiopia has initiated a new hydraulic megaproject called Grand Ethiopian Renaissance Dam Project (GERD) on the Nile River, which was previously used only by neighboring riparian countries to meet its energy needs. In 2011, the country took significant measures to meet this demand. When this project is completed, it is expected to reverse the previous status and volume of the Nile River shared only between Egypt and Sudan (85% and 12% respectively) [27]. Turkey is still working on the GAP /Great Anatolia project, which has already reduced the amount of water received by downstream states, increasing tensions between these three countries.

The Euphrates and the Tigris rivers

The Euphrates and Tigris rivers (Figure 2) rise in Turkey, cross Syria and Iraq, and flow into the Persian Gulf. These two rivers are Turkey's largest source of water (Mabon et al., 2021) [21] and, along with other water sources, make Turkey the most water-rich country in the Middle East (Abdel-Samad & Khoury, 2006) [1]. Turkey considers water as a valuable resource that could be sold to its neighbours in need and provide it with much needed revenue (Konuralp Pamukcu, 2003) [20]. To achieve this goal, Turkey is attempting to build a series of dams to extract more water from the Euphrates River as part of the Great Anatolia Project. The Project would not only secure a large amount of water that could be sold to the neighbouring countries, but would also increase Turkey's hydropower production and expand irrigated land (Daniel P. Loucks, 2017) [6].

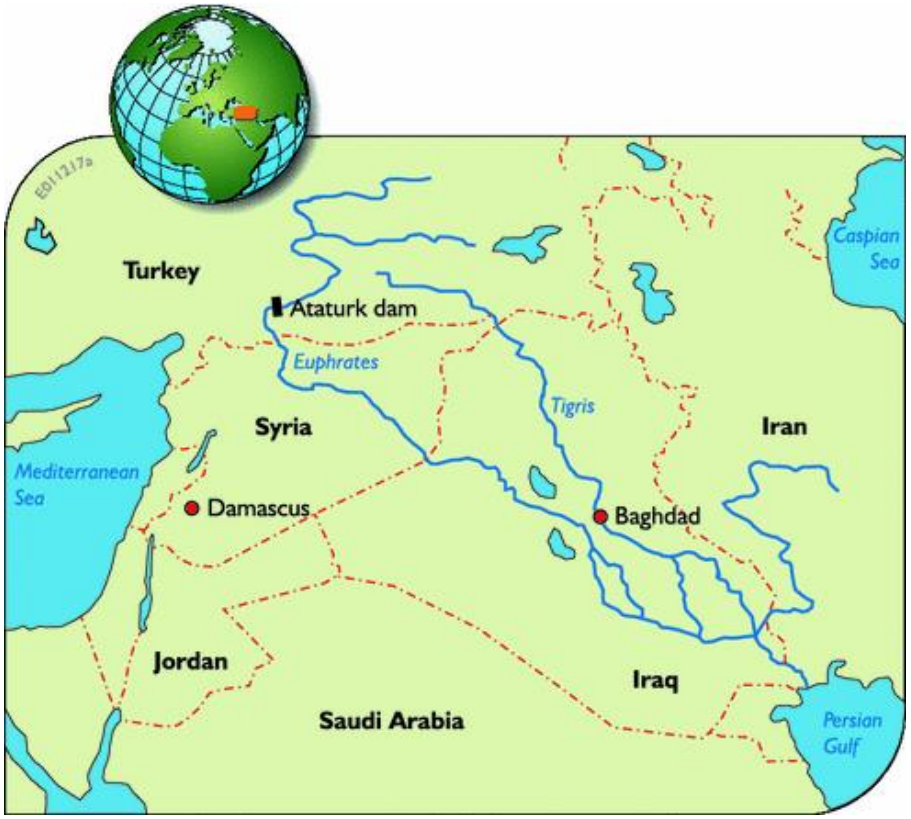

Figure 2: The Eurphrates and Tigris rivers (Jongerden, 2010) [16]

The Nile River

The Nile is one of the most notable and frequently studied rivers in the world. In particular, researches are carried out about where the river is and what features it contains. The river is remarkable in terms of settlement, tourism and archeology, as well as encompassing vast fertile agricultural areas. The Nile basin has a drainage area of 2.9 million km^2 and is a basin that constitutes 10% of the African continent, and this basin is shared by the countries of Egypt, Ethiopia, Burundi, Tanzania, Kenya, Rwanda, Zaireve, Sudan and Uganda. The Nile Basin takes its name from the main river of the basin, the Nile. The Nile river is the longest river in the world, with a length of 6825 km (Figure 3)(Rahi & Halihan, 2021) [25]. As the Nile river flows from South to North, it gets most of its source from Lake Tana in Ethiopia. The annual amount of water supplied to the Nile from this lake is approximately 72 billion m^3, which constitutes almost 72% of the total flow feeding the river.

Figure 3: The Nile River (Daniel P. Loucks, 2017) [6]

Water both as a Source of Conflict and Cooperation in Turkey and Ethiopia?

Water also unites and divides different nations and regions. Water is an integral part of the relations between nations, states and communities, law and society. In addition, there are increasingly complex legal and policy issues associated with its use, as water is an increasingly basic and essential need and a less accessible resource. One of the problems that has been going on since ancient times is to which country or region a water body belongs, who has the right to manage and use the water body, or how to share the water. Tensions between countries with relatively water-rich upstream countries (Turkey and Ethiopia) and those downstream countries that are highly dependent on water from upstream countries, such as Egypt, Sudan, Syria and Iraq, are increasingly becoming conflicts between them (Kibaroglu, 2015) [19].

Egypt, which contributes nothing to the Nile, blames Ethiopia for the fulfillment of the Nile dam, fearing that this will lead to serious water shortages. Similarly, to regulate the Nile water, Egypt has already built the Asuwan Dam, which has been of vital importance to itself throughout history. In this sense, the future sharing of transboundary water will be further challenged unless a legitimate and comprehensive mutual agreement is reached to properly regulate water allocation between different regions and rival users. It should be recalled that 72 percent of the Nile River comes from the highlands of Ethiopia, while Egypt and Sudan always contribute the least to the river. For this reason, Ethiopia should establish a legal framework to achieve its national targets regarding transboundary water use.

Considering that common interests of states can be achieved through mutual cooperation rather than dispute, comprehensive transboundary water cooperation between upstream and downstream states is of utmost importance. Moreover, diplomatic engagement for transboundary water cooperation and promotion of sustainable water management is essential for promoting peace and stability. To ensure this, the development of science-based strategies between these competing users is essential. Regarding the water management challenges and problems in Ethiopia and Turkey, the critical issues are highlighted below. The general current problems of water management in Turkey can be briefly summarized as follows: -

- Lack of inter-governmental and inter-institutional coordination in water management.
- Limitation and dependence of water management on administrative bodies or institutions.
- Approaches focused on post pollution disposal
- Operational problems of the institutions
- Water is not used efficiently and effectively
- Inadequacies in monitoring capacity and infrastructure
- Pressures on water resources (climate change, population, industrialization, etc.)
- Recycling cost not adequately ensured

On the other hand, the main water management problems in Ethiopia can be briefly summarized as follows:-

- Hydropolitical and security problems (due to growing Bereacracy, mismanagement of the country's resources, tension over transboundary waters between riparian states and regrettably ethnic based disputes, the country is facing deep unrest within and outside the arena).
- Techno-economic problems (the total exploitable water resource potential is not yet clearly known and only a portion of the waters have been exploited so far)
- Natural problems (vulnerability of the country to severe droughts and floods at different times due to hydrological variability)
- Transboundary nature of most of the country's water resources (About 80% of the major catchments are transboundary, with 97% of the runoff flowing to neighboring countries. The annual volume of water supplied to the Nile from Ethiopia alone is 72 billion m^3, which constitutes approximately 72% of the total river flow.)
- Traditional irrigation practices resulting in high water consumption (86% of total water withdrawals used for agricultural

purpose)

Conclusions and Future Perspective

Ethiopia has a significant deficit in the use and management of its water resources and in addressing the difficulties related to transboundary water issues. For this reason, countries need an integrated water management and good enforcement of laws in order to successfully manage their existing water resources. It is unconditionally important to establish water commissions that fully manage water resources (surface waters, groundwater and wetlands) at both the national and state level, in line with new technologies, international platforms and guidelines. In both Turkey and Ethiopia, very effective water use notable water conservations are needed to meet the water needs of today's society on the one hand and to ensure the availability of water for the needs of future generations on the other. However, in order to achieve good water resources management in both countries, cooperation with the sector and an integrated management with stakeholder participation should be developed. Radical changes in the country's water policies are necessary to solve the existing water problems and to face a possible absolute water scarcity crisis that may occur in the future.

As far as the use of potentially available water resources is concerned, there is a wide gap between Ethiopia and Turkey. Turkey has a remarkable utilization of both its domestic and transboundary waters. Natural resources in Ethiopia, especially water resources, are poorly protected and managed, and most of the resources are still unused. To change this, the government should pay attention and conduct detailed studies. Both Turkey and Ethiopia should adopt an inclusive water policy on how water must be shared through inter-basin transfers or between different neighboring countries and allocated in a way that supports and promotes the socio-economic development of each country. Preferably, each country's water management approach should be coordinated with that of its neighbours if peace and prosperity are to be sustained and conflict precluded in the region.

Declarations

Conflict of Interest

The authors declare that they have no known competing fnancial interests or personal relationships that could have appeared to infuence the work reported in this paper. The founding sponsors had no role in the design of the study; in writing the manuscript; nor in the decision to submit the article for publication.

Ethical Approval

Not applicable.

Consent to Participate

All authors whose names appear on the submission.

1) made substantial contributions to the conception or design of the work; the acquisition, analysis, or interpretation of data; or the creation of new software used in the work;

2) drafted the work or revised it critically for important intellectual content;

3) approved the version to be published; and.

4) agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Consent to Publish

All authors whose names appear on the submission give their consent to publish this paper in case it is accepted.

Competing Interests

The authors have no competing interests to declare that are relevant to the content of this article.

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