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The Relationship Between Türkiye's Available Freshwater Resources and Migration in the Light of Falkenmark and Shiklomanov Indicators

Falkenmark ve Shiklomanov Göstergeleri Işığında Türkiye'nin Kullanılabilir Tatlı Su Kaynakları ve Göç İlişkisi

Erkin Cihangir Karataş[1]

Öz

İklim değişikliğinin dünyayı ve insanları yeniden şekillendirmeye başladığı içinde bulunduğumuz dönemde Türkiye de bu değişiklikten hem iklim hem de toplumsal bakımdan etkilenmektedir. Hem siyasal hem de doğal nedenlerden ötürü Türkiye son yıllarda yoğun bir göçe maruz kalmaktadır. Geçmişte yalnızca geçiş güzergâhı olan ülke bugün göçün nihai varış noktası olmaya başlamıştır. Doğal olarak büyüyen bir nüfus yapısına sahip olan Türkiye'nin nüfusunda göçle gelen ani bir büyüme etkeni daha eklenmiştir. Buna bağlı olarak Türkiye'nin, yaşamı ve iktisadi faaliyeti devam ettirecek doğal kaynakları giderek büyüyen bir baskı altına girmiştir. Bu kaynaklar arasında su kaynakları da bulunmaktadır. Çalışmanın araştırma sorusu "Türkiye'nin kullanılabilir tatlı su kaynakları yoğun göç ile daha da büyüyen nüfus baskısına gelecekte dayanabilir mi?" şeklindedir. Analiz hazır sayısal verilere dayalı olarak nitel yöntemle Falkenmark ve Shiklomanov indileri ışığında yapılmıştır. Türkiye'nin göç ve tatlı su kaynaklarını söz konusu indiler bağlamında ele alması nedeniyle literatürde bir boşluğu doldurması amaçlanmıştır. Sonuç olarak Türkiye'nin kullanılabilir tatlı su kaynakları ilişkisi şimdi olduğu gibi gelecekte baskı altında olmaya devam etse bile ülkenin doğal nüfus büyümesi ülkenin kaynaklarını su kıtlığı sınırının altına itmeyecektir. Fakat nüfusta yoğun göçe bağlı büyük sapmaların ülkenin kaynaklarını gelecekte su kıtlığı sınırının altına iteceği saptanmıştır.

Anahtar Kelimeler: Su Kaynakları, Göç, Sürdürülebilirlik, Falkenmark İndisi, Shiklomanov İndisi

ABSTRACT

In the current period when climate change begins to reshape the world and its people, Türkiye is also affected by this change both in terms of climate and society. Due to both political and natural reasons, Türkiye has been exposed to intense immigration in recent years. The country, which was only a transit route in the past, has now become the final destination of migration. Türkiye, which has a naturally growing population structure, has had another sudden growth factor brought about by immigration. Accordingly, Türkiye's natural resources that will sustain life and economic activity have come under increasing pressure. These resources include water resources. The research question of the study is "Can the available freshwater resources of Türkiye withstand the population pressure that grows with intense migration in the future?" The analysis was carried out using the qualitative method based on available quantitative data and using the Falkenmark and Shiklomanov indicators. It is aimed to fill a gap in the literature by addressing the relationship between Türkiye's migration and freshwater resources in the context of the indicators in question. As a result, even if Türkiye's available freshwater resources continue to be under pressure in the future as they are now, the country's natural population growth will not push the country's resources below the water scarcity limit. However, it was found out that major deviations in population due to intense migration will push the country's resources below the water scarcity limit in the future.

Keywords: Water Resources, Migration, Sustainability, Falkenmark Index, Shiklomanov Index

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INTRODUCTION:

Carbon-based life, the only known life form, is a water-dependent life form. For this reason, efforts to search for life in the observable universe begin by first examining the existence of water. Scientists have determined that life on Earth began in water and that all known life forms are dependent on water. Human beings, just one of these living species, have had to have access to water in order to sustain their biological life throughout their existence. For this reason, the human species has begun to operate in places where access to water is possible. As a natural consequence of this, it would not be wrong to say that human evolution has been shaped by being dependent on water, not only biologically but also sociologically. All branches of activity in the economy, from agriculture to industry, have developed to be dependent on water. However, as with all other natural resources, there is a serious problem with water. That is, water is a finite resource. The constant availability of water resources is of vital importance for humans and the nature in which humans live. However, it is an undeniable fact that human activity puts pressure on water resources in terms of both quantity and quality.

In the face of a finite resource, that is, the limits of its existence, there does not seem to be a limit to the human biological existence and the activities that will meet its needs. The most general definition of economy, "meeting infinite human needs with finite resources", seems like a definition made specifically for water resources. Even if human society does not live in a modern economy, it has tended to grow biologically throughout history. Population growth alone increases human demand for water to meet biological needs. Moreover, human activity is not limited only to meeting biological needs. At this point, economically meeting the growing population and ever-diversifying human needs emerges as a serious problem. Although sustainable resource management is more possible with developing technology, it is not currently possible to meet a sustainable resource consumption process with the current population growth in the world (Rifkin, 2015).

It is an undeniable fact that the world's population and resources are not evenly distributed. But economic prosperity has certain addresses. This triggers migration towards these regions. For this reason, Türkiye has become the final and indirect destination of migration due to its geographical location. Accordingly, both the country's increasing natural population structure and its exposure to intense migration have raised problems regarding the sustainability of the use of resources. The research question of this study, which was conducted in line with the problem in question, is "Can Türkiye's available fresh water resources withstand the growing population pressure due to intense migration in the future?" For this purpose, an analysis will be made with numerical data on the current population size and population projections in the light of Shiklomanov and Falkenmark indicators, keeping Türkiye's water resources constant. The analysis to be made will be entirely in a volumetric (quantity) context, excluding the pressure that the resources are under and will be under in terms of quality. In the first part, the general structure of Türkiye's water resources will be emphasized, and then the Shiklomanov and Falkenmark indicators will be defined. In the second part, the current population structure will be evaluated through these two indicators and the status of Türkiye's water resources will be examined. In the last section, Türkiye's available water resources will be evaluated in the light of Falkenmark and Shikolmanov indicators, based on ready-made population projections for the future. Based on the results, it will be tried to determine what can be done to use Türkiye's water resources sustainably.

1. Türkiye's Current Freshwater Availability and Falkenmark/Shiklomanov Indicators

In nature, water takes part in a process called the natural cycle. This cycle includes the steps of precipitation, evaporation, surface runoff, infiltration into underground sources and discharge into the final source. During this process, all natural life meets its water needs. The amount of water in this cycle may vary depending on geography. For example, while Central America has limited natural water resources, the north of the continent is very rich. However, in a world divided by political borders, regions with rich resources and regions with scarce resources can exist simultaneously within the borders of a country. Türkiye's Central Anatolia Region, which has scarce water resources in the natural cycle, and the Black Sea Region, which has rich resources, are good examples of this situation. Water from other countries can also come within the political borders of countries and join the total water resources. The sum of the total water in the natural cycle and the water from transboundary sources constitutes the country's gross water availability.

Not all of a country's total water resources are suitable for use. The reason for this is that a certain part of the water must be left in the source in order for the natural water cycle to continue and the ecosystem to survive without damage. The remaining part of the water that must be left at the source is called available water resources. Available water resources, just like gross resources, are divided into two: surface water and groundwater. The availability rates for these two resources may vary.

Table 1 Türkiye's Freshwater Availability

Source Type	Volume (km^3)
Annual Rainfall	450
Surface Water	
Annual surface flow	186
Annual available surface water	94
Ground-water	
Underground Infiltration	41
Annual drawable groundwater	18
Annual Total Available Water	**112**

Source: DSİ - Soil Water Resources, https://dsi.gov.tr/Sayfa/Detay/754 04/04/2024

Türkiye mostly depends on surface water as available water resources. Approximately 84% of the total available water volume of 112 km^3 is surface water. The total groundwater availability is 18 km^3. Only about 50% of Türkiye's gross water resources are available. In other words, the volumetric availability of water resources in Türkiye is almost 1/2.

It is partly a relative matter how rich a country is in available water resources within its political boundaries. The same situation is valid for the water availability of an entire drainage basin, regardless of political borders. For example, the Great Sahara in northern Africa is absolutely water scarce. However, water scarcity can also occur in regions where absolute water scarcity does not exist. This type of water scarcity is called economic water scarcity, not physical water scarcity. What matters at this point is how much pressure the water availability within a certain limit is under. This pressure in question is of two types: quality and quantity. A given body of water may suffer from both types of pressure or may be stressed by only one. For example, India's Ganges River is heavily polluted by human and industrial waste. Studies conducted on the Ganges River have revealed that the river water is highly contaminated with carcinogenic elements such as plastic(Nelms et al, 2021), mercury(Pal et al, 2021) and other metals (Haque, 2020, p.1). The picture that emerges here shows that the water body is under pressure in terms of quality. It should be noted at this point is that it is very difficult to determine the limits of the resulting pressure in terms of quality. The reason for this is that water and water resources management has an integrated structure. Since water is an input in almost every field, it needs to be handled with an integrated management. Therefore, quality pressure involves intense externalities.

Water resources may also be under pressure in terms of volume (quantity). Extracting so much water from a particular water body for irrigation or any other purpose that disrupts the natural cycle of water can put the resource under volumetric pressure. An example of this is Manila in the Philippines. It has been stated that the water table is falling by 6 to 12 meters per year as a result of excessive extraction from underground water resources for industrial use(Ebariva et al, 1997) . Similarly, due to population growth, excessive water withdrawal from the Yellow River in China for use in industry and agriculture has caused the river to dry out (Changming & Shifeng, 2022). In addition, the drying out of the Aral Sea was caused by the over-exploitation of the resources that feed the water body for agricultural irrigation purposes(NASA, 2024; Esa, 2024). It is important to remember that global warming, as well as excessive water withdrawal, has an impact on the volumetric pressure on resources.

Several methods have been developed to measure the adequacy of water resources in terms of volume. One of these methods is the calculation of the water availability in a certain region as the amount of water per person. The results obtained from the calculation of water availability per capita are evaluated through two reliable indicators, Falkenmark and Shiklomanov water pressure indicators. Falkenmark links the population of a country with its water resources and reveals the pressure of the population on water resources, taking into account the needs of natural systems (Aydın et al., 2017).The indicator is one of the most widely used indicators to indicate the pressure on water resources(Lallana & Marcuello, 2004, p.4).

Table 2 Falkenmark Index

Category/Condition	Water Availability (m^3/capita/year)
No Water Stress	>1700
Water Stress	1700-1000
Water Scarcity	1000-500
Absolute Scarcity	<500

Source: M. Falkenmark, The massive water scarcity threatening Africa-why isn't it being addressed", Ambio 18(2), pp (112–118), Berlin, Springer, u.p.

Table 2 shows how Falkenmark classifies the severity of water stress according to annual water availability per capita. Accordingly, no water pressure is defined for areas above 1700 m^3. While the presence of water below this threshold means the beginning of water pressure, the 1000 m^3 limit is defined as the threshold at which intense water pressure begins, in other words, the water scarcity threshold. 500 m^3 is accepted as the limit where absolute water scarcity begins(Falkenmark, 1989). A similar water pressure indicator for the same purpose was developed by Shiklomanov. However, the Shiklomanov indicator was prepared with higher values than the other indicator.

Table 3 Shiklomanov Index

Category/Condition	Water Availability (m^3/capita/year)
Catastrophically Low	<1000
Very Low	1000 - 2000
Low	2000 - 5000
Average	5000 - 10000
High	10000 - 20000
Very High	>20000

Source: C. Lallana & C. Marcuello, 2004.

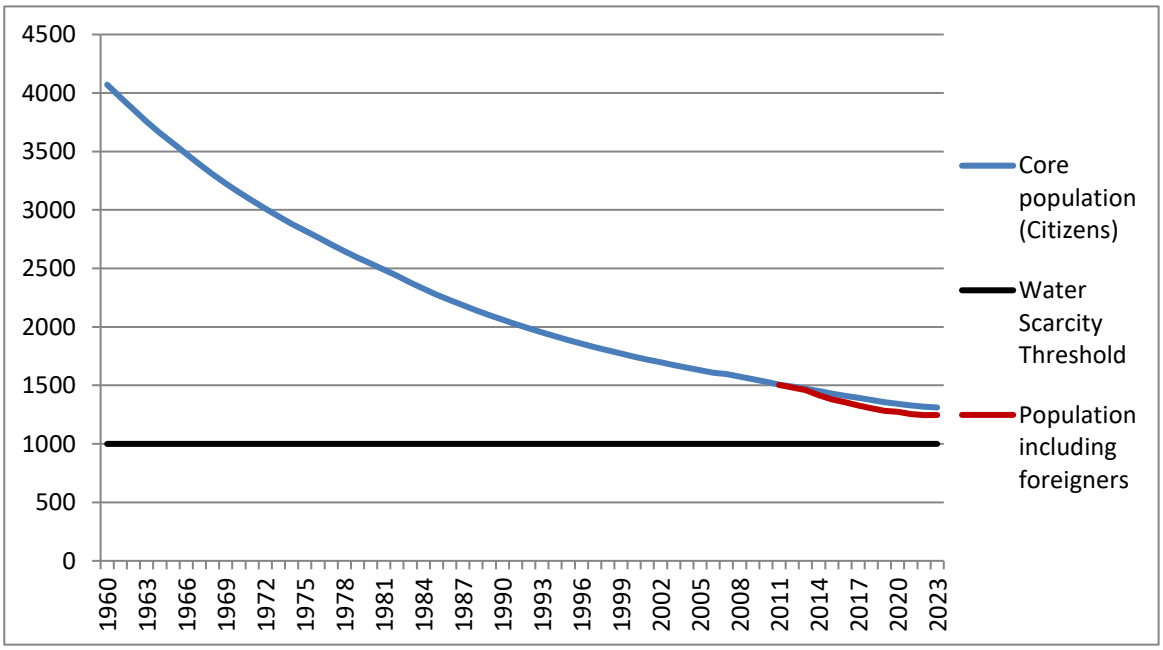
When the Shiklomanov indicator in Table 3 is examined, it can be seen that 2000 m3 is classified as "Low". In addition, it has determined the annual water volume of 1000 m3 as the limit of the sections

classified as "Very low" and " Catastrophically Low " (Lallana & Marcuello, 2004, p.4). For Shiklomanov, just like Falkenmark, this limit was the threshold at which available water resources came under serious pressure.

2. Current Pressure on Türkiye's Water Resources

In order to determine the pressure on Türkiye's water resources in the context of the Shiklomanov and Falkenmark indicators, which are indicators used to determine the severity of pressure on available water resources, it is first necessary to determine the population. For this purpose, data covering the years 1960-2023 produced by TUIK were used. Using time-spanning data series is important to monitor how the pressure on water resources grows over time. It is seen that the population of Türkiye, which was just over 27.5 million in 1960, is constantly increasing and will exceed 85.3 million by 2023. Accordingly, the quantity pressure on water resources has grown steadily over the years. Chart 1 shows the change in Türkiye's annual average available water per capita.

Chart 1 Türkiye's Available Water (m^3/capita/year)



Source: It is prepared by the author using DSİ, TUIK and T.C. Göç İdaresi data.

While the water volume per capita was 4071 m^3 in 1960, it continuously decreased over time, decreasing to 2024 m^3 in 1991 and to 1989 m^3 in 1992. This shows that Türkiye's water availability decreased from "low" to "very low" more than 30 years ago, according to the Shiklomanov indicator. Looking at the Falkenmark indicator, per capita water availability decreased to 1721 m^3 in 2001 and 1697 m^3 in 2002. According to Falkenmark, the 1700 m^3 "water pressure" limit was crossed in a negative direction more than 20 years ago. In other words, Türkiye has been living under water pressure for more than twenty years. Since these years, the pressure on water resources has been continuously increasing as before, and by 2023, the water availability has decreased to 1311 m3. In both water pressure indicators used, an annual volume of 1000 m^3 per capita was determined as the limit at which water scarcity begins. In order to better understand this limit, it is useful to give examples of countries where water availability is below this limit. Examples of these are Saudi Arabia, Afghanistan, Iran, Iraq, Syria, Egypt, Algeria, Morocco, Tunisia and Libya. So much so that none of these countries fell below Falkenmark's "absolute water scarcity" limit of 500 m^3 (Leao et al, 2013; Ruess, 2015).

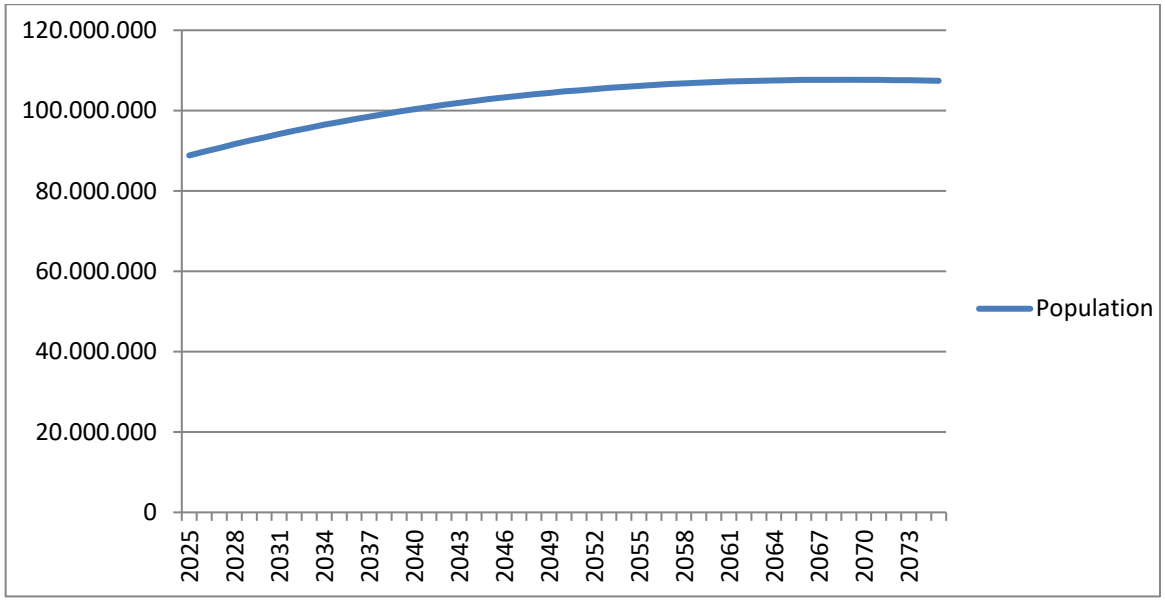
Available population and water volume data show that Türkiye is getting closer to the water scarcity limit every day. But the point to remember here is that so far the analysis has only been made for Türkiye's own population. When it comes to water, which is a basic human need and an input to every sector, the population permanently residing in the country should also be included in the analysis. There has been a major deviation in the natural course of the population as the country has been subjected to an intense influx of refugees since 2011. For this purpose, it would be useful to include the foreign population in the country in the analysis in order to more accurately determine the pressure on natural water resources.

Chart 1 shows the impact of the deviation from the natural course of population caused by migration on water pressure for the period after 2011. The part shown with a red line is the change in annual water volume per capita due to migration. Only the foreign population arriving after 2011 and in the data published by the Republic of Türkiye Ministry of Interior - Presidency of Migration Management (PMM) has been added here. The only items that make up the data set are foreigners with permanent residence permits(Göç İdaresi – İkamet İzinleri, 2024) and Syrian refugees(Göç İdaresi – Geçici Koruma, 2024) whose legal status is "benefiting from temporary protection"(Büyükayhan, 2021). PMM data used in the analysis for Syrian refugees was lower than the World Bank data for each year(World Bank DataBase, 2024). Although PMM states that the total number of foreigners residing in Türkiye is more than 5 million(Göç İdaresi – Hakkımızda, 2024), the totals in the analysis have not reached this level for any year. Under these conditions, Türkiye's annual water availability per capita has fallen to 1248 m^3 by 2023, approaching the water scarcity limit. Up to this point, if both the core population and foreign population data are accepted as accurate, water scarcity has not occurred in Türkiye, although there is an increasing pressure on available water resources.

3. Projected Future Situation of the Pressure on Türkiye's Water Resources

One of the basic conditions for creating a sustainable economy and development is the sustainable use of existing depletable natural resources without overexploitation. It was stated above that water is one of these natural resources, and that it has extra importance because it is an input in every sector of the economy and all natural life. Starting from this point, the water pressure indicators defined in the first section will be used to evaluate a sustainable economy and development for Türkiye from the perspective of available water resources. The evaluation will be made using fixed water availability and ready-made population estimates for Türkiye. According to TÜİK's projections for the future situation of Türkiye's population, the country's population tends to grow for the near and medium-term future.

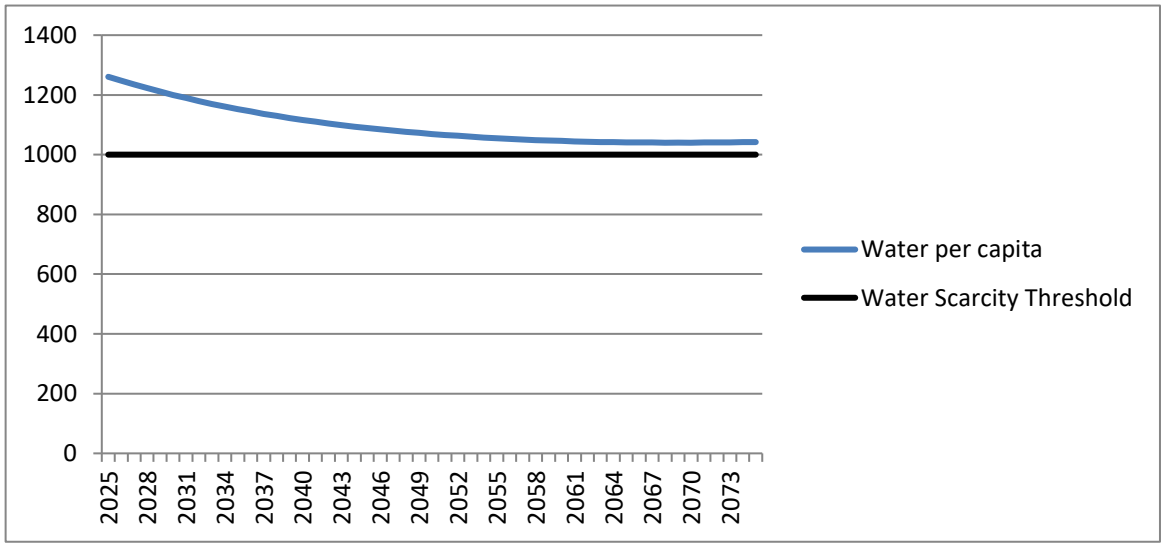
Chart 2 Population Forecast for Türkiye (2025-2075)



Source: TUIK - https://data.tuik.gov.tr/Bulten/Index?p=Nufus-Projeksiyonlari-2023-2100-53699

Chart 2 shows the main scenario of the population projections made by TÜİK for Türkiye. Accordingly, the population of Türkiye is expected to increase continuously and reach its highest level of 107.65 million in 2070. After this date it is expected that the population growth trend will stop and the population will remain at around this level for a long time. Based on this prediction, if we look at Türkiye's water resources in terms of per capita amount, we see the picture in Chart 3. Accordingly, it is seen that water availability per capita will gradually decrease until 2070, when the population reaches its highest level, decreasing to 1040.3 m^3. This value will approximately be maintained for a long time in parallel with the change in population.

Chart 3 Türkiye's Available Water Forecast for the Years 2025-2075 (m^3/capita/year)

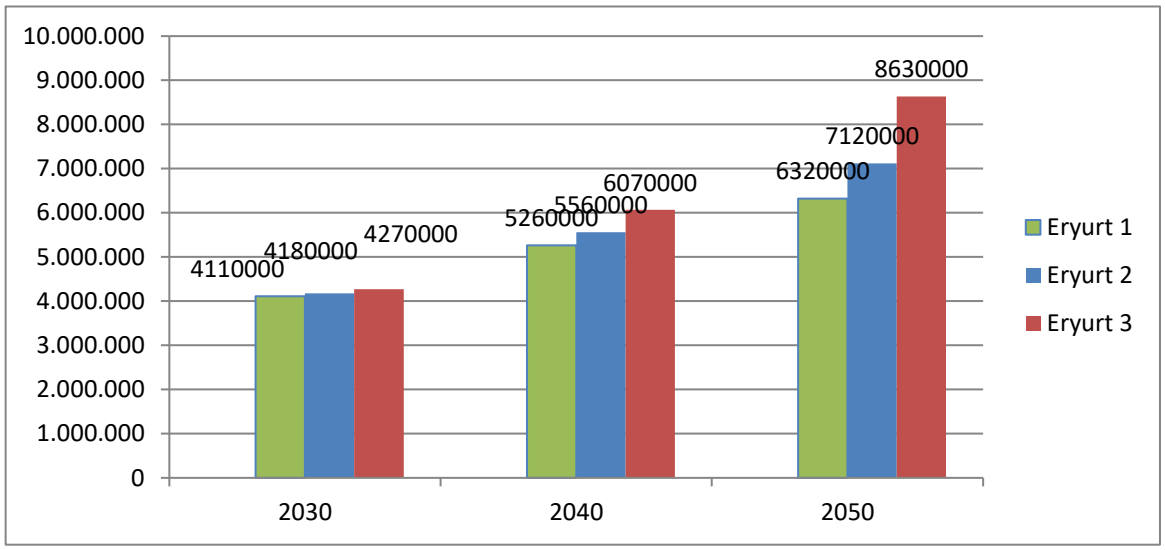


Source: It is created by the author using TUIK and DSI data.

It would be misleading to predict the possible pressure on water resources without adding the current foreign population to Türkiye's future population projections. However, it is very difficult to predict the future number of foreigners in the country. Therefore, the number of foreigners with residence permits will not be added to the future population of Türkiye. On the other hand, Syrian

refugees are likely to stay in Türkiye for a certain period of time. Therefore, it would be reasonable to add the population of Syrian refugees to the Turkish population projection. However, since there is no official projection for future numbers of refugees, the population projections made by Eryurt (Eryurt, 2023; Erdoğan, 2022) based on official data will be used and added to the projections made for the main population of Türkiye.

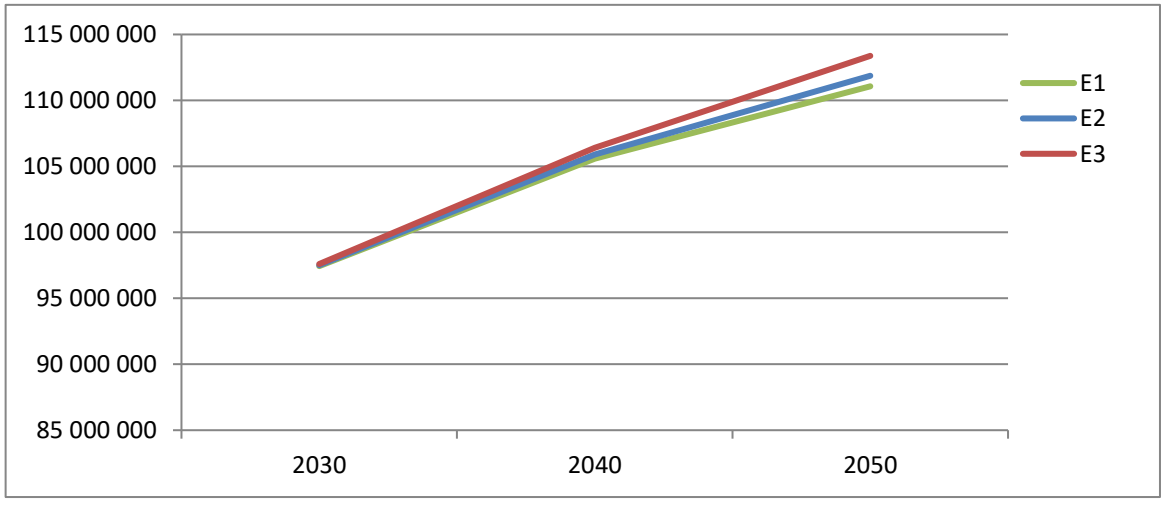
Chart 4 Syrian Refugee Population Projection in Türkiye



Source: M. A. Eryurt

In Chart 4, the projection for the Syrian refugee population is shown in three scenarios. All scenarios show an increase over the years. Data from these scenarios were added to the population projection for Türkiye. The results obtained are shown in Chart 5, including Eryurt's scenarios separately. It can be seen that Türkiye's total population will reach 111 million in 2050 for the first scenario (E1), 111.8 million for the second scenario (E2) and 113.3 million for the third scenario (E3).

Chart 5 Population Projection for Türkiye Including Refugees

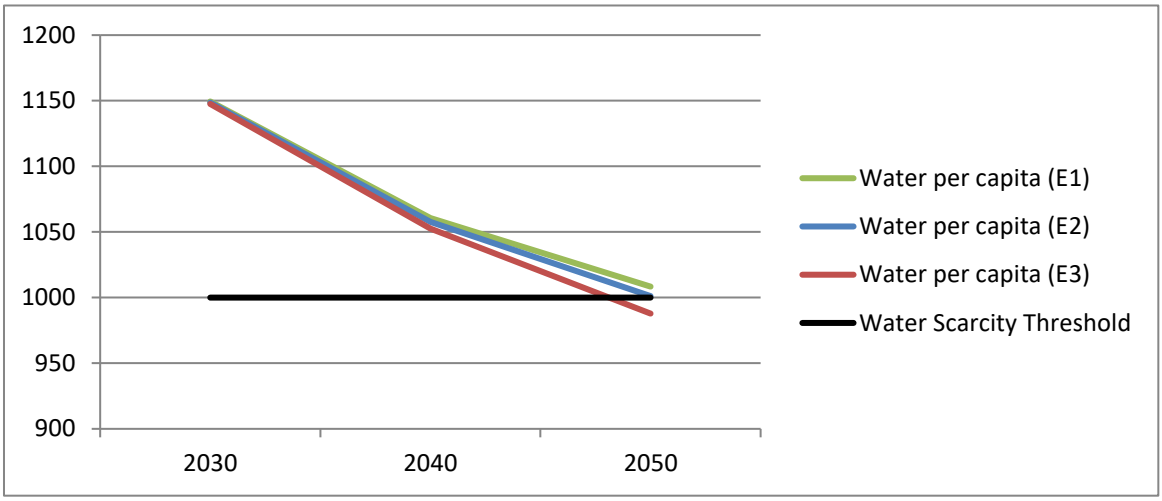


Source: Prepared by the author using M. A. Eryurt and TÜİK data.

Adhering to these scenarios and considering Türkiye's water availability per capita in the light of the total population forecast for Türkiye, the resulting situation can be seen in Chart 6. Accordingly, with the increasing population, the amount of water per capita constantly decreases and by 2050, it will

be 1008.3 m^3 for the E1 scenario, 1001.1 m^3 for the E2 scenario, and 987.8 m^3 for the E3 scenario. These values show that the water scarcity limit is very close to the first scenario if the Falkenmark and Shiklomanov indicators are accepted as determinants. For the second scenario, it shows that the water scarcity limit has almost been reached, while for the third scenario, the water scarcity limit has been seriously exceeded.

Chart 6 Türkiye's Water Amount Forecast (m^3/capita/year)



Source: Created by the author using data from DSI, TÜİK and M. A. Eryurt.

According to the integrated population forecast made until 2050, it is seen that only the most optimistic scenario does not reach the water scarcity limit. However, if we consider that Türkiye's own population will increase until 2070 and the water scarcity limit will be very close, even considering Eryurt's most optimistic scenario, it seems certain that the pressure on Türkiye's available water resources will push Türkiye below the water scarcity limit by 2070. Even if the level of the population in the optimistic scenario coded E1 in 2050 is added to the population of Türkiye in 2070 without any increase, the amount of available water per capita will decrease to approximately 982.6 m^3, well below the water scarcity limit. Moreover, the foreign population with long-term residence has not been added to the future scenarios regarding population projections, as is done today when calculating the amount of water per capita.

Türkiye's previously mentioned population size of 210 million (Yumaklı, 2024) expected for 2050 is on a scale that does not even need to be calculated in terms of the pressure it will create on water resources. It is unlikely that the guest population in question is due to tourism. Because the average length of stay of tourists in the country has not exceeded 12.3 overnight stays in any year in the last 12 years (TÜİK - Turizm İstatistikleri, 2024). This can only be an external factor that is used to calculate the pressure on water resources. At this point, it should be noted that the indirect effects of climate change include intense migrations and epidemics (UN Water, 2024; Watkiss et al, 2005). It seems possible for Türkiye to encounter such a large population flow only if it is exposed to such mass migrations.

CONCLUSION:

If we evaluate the amount of fresh water available per capita in Türkiye using these indicators, we can see that water resources have come under increasing pressure as the country's population has grown over the years. By 2023, Türkiye's per capita water volume has decreased to 1311 m3. This volume shows that the country is under "water stress," according to Falkenmark. Shiklomanov rated

the presence of water in this volume as "very low". In other words, contrary to popular belief, it was found that Türkiye, far from being a water-rich country, is a country whose water resources are under pressure. However, the calculation was made on the basis of the population of Türkiye. This situation will lead to misleading results, especially for a country with a dense foreign population since 2011. Therefore, using official records, adding Syrian refugees and foreigners with long-term residence permits to the population, and looking at the stage of water pressure will produce relatively more accurate results. In this case, adding these figures to the population yields a per capita water volume of 1248 m3. This shows that the pressure on water resources is still increasing. It is worth remembering that the calculation at this point is made by including only registered foreigners.

Currently, analyses based on official figures show that although Türkiye's water resources are under pressure, it has not yet reached the water scarcity limit. However, considering Türkiye's increasing population structure, making a prediction about what the future situation may be is of great importance for the sustainable use of water resources. For this reason, the projections made by TÜİK for the population of Türkiye were taken as data and the situation of water pressure in Türkiye was examined. The result is that the water shortage limit will not be exceeded in any period, provided that TÜİK's prediction that the population of Turkey will continue to grow until 2070 is accepted. The annual amount of available water per capita in Türkiye will reach its lowest limit with 1040.3 m^3 in 2070. This volume shows that the water pressure is very high but will still remain above the water scarcity limit.

However, Syrian refugees and other foreigners with long-term residence permits were not included in the population estimate made by TÜİK. It is not possible to find data on how many foreigners will obtain residence permits and maintain long-term residence in Türkiye in the future. But it is possible to make population projections for the coming years using official data for the Syrian refugee population. Based on this, the population estimates made by Eryurt based on official data were added to Türkiye's estimated future population. The obtained numbers were accepted as data and the pressure on Türkiye's water resources was evaluated. At this point, since Eryurt developed three different scenarios, all three scenarios were added to the population of Türkiye and the annual available water volume per capita was calculated. Since the Syrian refugee population in Türkiye tends to grow like Türkiye's own population, an increase in the pressure on water resources has been observed. The result shows that Türkiye's water availability, in the light of the Falkenmark and Shiklomanov indicators, is below the water scarcity limit in the E3-coded scenario for 2050, just at the water scarcity limit in the E2-coded scenario, and above the water scarcity limit in the E1-coded scenario. However, even if the refugee population does not increase after 2050, it is seen that the water availability has dropped below the water scarcity limit for all three scenarios in 2070 and the hypothesis is confirmed. This means that the pressure on Türkiye's water resources will lead to unsustainable resource use.

There are many scientific studies in the literature about Türkiye's growing population structure due to migration and the fact that climate change caused by global warming creates various pressures on water resources. Negativities that will arise due to climate change include floods due to excessive sudden rainfall and droughts due to the increase in average temperatures. In all cases, the direct negative effects of climate change on Türkiye's water resources should also be taken into account. It follows from all these data that Türkiye's available water resources will not be able to handle the population pressure that will grow with migration in the medium and long-term future. In the medium and long term, Türkiye must protect its own population from unsustainable growth brought about by migration, which will lead to a catastrophic shortage of available fresh water resources.

Etik Standart ile Uyumluluk

Etik Kurul İzni: *Bu makalede etik kurul iznine gerek yoktur, buna ilişkin ıslak imzalı etik kurul kararı gerekmediğine ilişkin onam formu sistem üzerindeki makale süreci dosyalarına eklenmiştir*

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[EN] The author(s) declare that they do not have a conflict of interest with themselves and/or other third parties and institutions, or if so, how this conflict of interest arose and will be resolved, and author contribution declaration forms are added to the article process files with wet signatures.

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EXTENDED SUMMARY

Research Problem:

The aim of this study is to evaluate the current and future status of Türkiye's freshwater resources in the light of Falkenmark and Shiklomanov indexes.

Research Questions:

What is the status of Türkiye's fresh water resources in terms of water volume per capita? What will Türkiye's fresh water resources be like in the future, in terms of the amount of water per capita as a result of population growth? Can Türkiye's available freshwater resources withstand the increasing population pressure caused by intense migration in the future?

Literature Review:

In the literature review on the subject, there are studies that evaluate Turkey's freshwater resources in the context of Falkenmark and Shiklomanov indicators (Veettil & Mishra 2018; Zhong et al, 2023; Nabavi & Mostafazadeh, 2021; Doeffinger & Hall, 2020; McNally et al, 2019; Koç et al, 2022; Altinbilek & Hatipoglu Birpınar & Tuğaç, 2018; Aydın et al, 2017). However, these were not created to monitor the long-term continuous change course for the future. In addition, these studies were created only in the context of the country's natural population flow. Since the effect of intense migration flow on natural population growth has been left out, these studies are not sufficient to measure the real impact. The aim of this study is to fill this gap in the literature.

Methodology:

The data used for the study was obtained from studies previously conducted by official institutions and universities. While water resources and population data were obtained from Türkiye's official institutions, predictions about the future structure of the foreign population were obtained from academic studies and reports. The study was carried out by analyzing these data, which represent numerical quantities, in a qualitative context.

Results and Conclusions:

In the study, it was seen that Türkiye's fresh water resources are stable. By evaluating this fixed asset on the scale of water volume per capita, it has been seen that Türkiye's fresh water resources have been under pressure for a long time. This pressure has been seen since 2002, with the volume of fresh water per capita falling below 1700 m^3 per year. Shiklomanov defined this value as "very low" and Falkenmark as "water stress". By 2023, the volume of fresh water per capita decreased to 1311 m^3, indicating that the pressure became even

more severe. In order to obtain a better result, the rate was recalculated by adding foreigners living in the country to the population. Accordingly, it was revealed that the value decreased to 1248 m^3 in 2023. Although the values have shown that the foreign population living in the country creates serious additional pressure on water resources, the water scarcity limit of 1000 m^3 has not been reached. From this point on, the population estimates made for Türkiye and Syrians until 2050 were added to the study and the results obtained were evaluated according to the mentioned indexes. The results show that as the population of Türkiye and Syrians increases until 2050, the pressure on the country's water resources will gradually increase. Accordingly, water pressure will not reach the water scarcity limit only in 2050 and 2070 for Türkiye. Even if it does, it will be down to a limit very close to water scarcity. These values were determined as 1069 and 1040 m^3, respectively. Water pressure values were calculated for 2050 by adding the increasing foreign population to Türkiye's own population. Accordingly, with three different scenarios, the annual freshwater volume per capita by 2050 is 1008.3 m^3 for the E1 scenario, 1001.1 m^3 for the E2 scenario, and 987.8 m3 for the E3 scenario. The first of these scenarios is not below the water scarcity line. While the second scenario is right at the water scarcity limit, the third scenario is well below the water scarcity limit. However, when it is remembered that the population of Türkiye will increase until 2070, it is seen that even if the foreign population in the E1 scenario, which is the most optimistic scenario, will remain unchanged, the pressure on Türkiye's water resources will be well below the water scarcity limit with 982.6 m^3. Based on these results, it was concluded that the permanent foreign population in Türkiye will create an unsustainable pressure on the country's water resources in the future. For this reason, the general opinion has been reached that Türkiye has to maintain a sustainable migration policy.