Investigating the Water Potential and the Relevant Hydrologic Details of the Existing Reservoirs of North Cyprus

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ABSTRACT

This study covers 16 irrigation purposed reservoirs of TRNC. The relevant catchment geomorphologic properties, the Φ index, utilized water volumes, monthly evaporation coefficients, and mean annual sedimentation accumulation rates of these reservoirs were determined. It is found that, between the years 2005 to 2022, from the total active storage volume of 13.756 million cubic meters (MCM) of the studied reservoirs, the estimated total of 2.505 MCM is lost through evaporation, nearly 4.277 MCM was utilized for irrigation and 5.270 MCM volume being the annual average inflow into these reservoirs. Due to the sediment accumulation causes decrease in active volumes so, relevant surface area-storage capacity relationships for each reservoir at various sedimentation volumes were generated. Furthermore, the efficiency of all the reservoirs was approximated to be 31% based on the total utilized volume.

Keywords: Reservoirs of TRNC, Surface Area-Storage Capacity, Evaporation, Φ index, Sedimentation, Catchment Geomorphology.

ÖZ

Bu çalışma, KKTC'de bulunan 16 adet sulama amaçlı göleti kapsamaktadır. Bu göletlerle ilgili havza jeomorfolojik özellikleri, Φ indeksi, kullanılan su hacimleri, aylık buharlaşma katsayıları ve yıllık ortalama sedimantasyon birikimleri belirlenmiştir. 2005-2022 yılları arasında incelenen tüm göletlerin toplam aktif kapasitesi olan 13.756 milyon metreküp'den (MCM), tahmini ortalama yıllık 2.505 MCM'nin buharlaşma yoluyla kaybolduğu, yaklaşık 4.277 MCM'nin ise sulama için kullanıldığı ve 5.270 MCM'nin de akış yoluyla göletleri beslediği belirlenmiştir. Sediman birikimi nedeniyle azalan aktif depolama kapasitesinden dolayı, her gölet için farklı sediman birikimleri baz alınarak uygun hacim-satıh bağıntıları oluşturulmuştur. Ayrıca, tüm rezervuarların verimliliği, toplam kullanılan hacme göre yaklaşık %31 olarak hesaplanmıştır.

Anahtar Kelimeler: KKTC'deki Göletler, Hacim-Satıh, Buharlaşma, Φ İndeksi, Sedimentasyon, Havza Jeomorfolojisi.

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Δ	Gradient of saturation vapor pressure
ΔS	Storage capacity difference for each depth
Δ_{Vs}	Change in water storage within a reservoir
σ	Lummer and Pringsheim constant
Υ	Psychrometer constant
A	Catchment area in square kilometers
A_{mean}	Mean surface area of the reservoir.
D	Possible sunshine hours
DAV	Data Access Viewer
DSI	Devlet Su İşleri
e	Actual vapor pressure of air
E_0	Evaporation from open water surface
E_a	Evaporation due to mass transfer of vapor
$E_{effective}$	Effective evaporation of the region
E_{net}	Net water evaporated from the reservoir
E_{pan}	Pan evaporation obtained from the meteorology office
e_s	Saturated vapor pressure of air
EV	Evaporation from the reservoir surface in a calculated month
t_f	Duration of discharge reaching to zero in hours
K_p	Pan coefficient
L	Length of the main channel in kilometers
MCM	Million cubic meters
n	Actual sunshine hours

NASA	National Aeronautics and Space Administration
Q_n	Net amount of radiation remaining at the free water surface
Q_p	Peak discharge value in $m^3/s/mm$
r	Albedo or Reflection coefficient
R	Volume of direct rainfall
R_A	Angot's value of solar radiation
R_B	Net long wave radiation of the Earth
R_C	Actual short-wave radiation from the sun
S_{Har}	Harmonic slope of main channel
T	Mean monthly temperature
Ta	Monthly average temperature in Kelvin
T_C	Time of concentration in hours
t_p	Time of peak in hours
t_r	Time of rain in hours
TRNC	Turkish Republic of Northern Cyprus
U_2	Wind speed measured at 2 meters height
V_{evap}	Water volume lost through evaporation from the surface area
V_{gin}	Groundwater inflow from the aquifer
V_{inf}	Loss of water through infiltration
V_{pcp}	Volume of rainfall directly entering to the reservoir
V_r	Inflow of runoff volume into the reservoir
V_{sp}	Outflow volume of water from the reservoir
V_{wd}	Withdrawal volume of water for irrigation

Chapter 1

INTRODUCTION

1.1 Brief History of Reservoir Projects in Cyprus

Unfortunately, Cyprus lacks perennial streams (Stefanou & K. Kyrou, 2006). The water flows within the streams mainly during the winter and spring seasons where the rainfall is present. Since there is no permanent supply of water that can be obtained from the streams. That is the main reason why from the beginning of 20th century the Government of Cyprus has attempted to solve this problem through dam projects with the development of modern machinery.

Figure 1.Construction of Kouklia Reservoir embankment (Rider, 1901).

First impoundment projects were done by British government between years 1896-1912 in Köprü (Kouklia), Güvercinlik (Acheritou) and Sınırüstü (Syngrasi) which were located in eastern mesaoria region of the island, and they had a total storage capacity of 5 MCM where the total reserved budget for the construction of these reservoirs were £60 000 (Konteatis, 1974). After the construction of these 3 small dams, more emphasis was given to the improvement of groundwater resources until early 50s because of unfavorable topography of Cyprus the construction of dams makes water stored per unit volume is more costly than the extraction of water from groundwater via pumping wells. The reasons behind the increased demand for dams can be listed as:

- Research conducted after 1960s indicates the saltwater intrusion along the coastal aquifers as a result of overpumping causing limited use (Ergil, 2000).
- Growing demand of water in agriculture, domestic and tourism activities.
- Discovery of suitable sites for the dam projects and with the improvements of relevant construction machinery makes the process to be less costly.

Because of above mentioned reasons, 19 more dams were constructed by the Government of Cyprus between years 1960-1970 and total storage capacity of the reservoirs has increased from 6 to 32 MCM(Konteatis, 1974).

After the declaration of Turkish Republic of Northern Cyprus (TRNC) and separation of the island only 3 of the reservoirs (Gönyeli (Geunyeli), Haspolat (Mia Milea) and Kanlıköy (Kanli Keuy)) have total of 2.340 MCM active storage capacity that were located at the northern part of the island. These reservoirs function during the raining seasons so, there is a need of permanent water storage reservoirs. Hence, of that 18 small rockfill dams were constructed by Devlet Su İşleri (DSİ), Turkey and Water

Works Office (Su İşleri Dairesi), TRNC between the years 1987 to 1994 on the dry rivers for collecting the rainwater from run-off so that, it will also be used for groundwater recharge and agricultural needs.

Table 1. List of reservoir projects constructed after the declaration of TRNC.

Name of the Reservoir	Location	Construction Year	Capacity (m^3)
Akdeniz (Agia Irini)	Güzelyurt (Morphou)	1994	1468157
Arapköy- Ayanidere (Klepini-Agios Epiktitos)	Girne (Kyrenia)	1990	608881
Arapköy-Uzundere (Klepini-Kipia)	Girne (Kyrenia)	1990	444150
Beşparmak-Çiftlikdere (Alagadi)	Girne (Kyrenia)	1993	774575
Dağyolu-Üçparmakdere (Fota-Ovgos)	Girne (Kyrenia)	1994	392250
Değirmenlik-Çataldere (Kythrea)	Lefkoşa (Nicosia)	1990	296814
Ergazi-Sayadere (Ovgoros-Fragkolakkos)	Yeni Iskele (Trikomo)	1989	405025
Geçitkale-Eğridere (Lefkoniko-Gerokolympos)	Gazimağusa (Famagusta)	1989	1360510
Geçitköy-Dağdere (Panagra-Palaiomylos)	Girne (Kyrenia)	1989	1820150
Gemikonağı-Madendere (Xeros)	Lefke (Lefka)	1995	4121205
Gönendere-Korderesi (Knodara-Peristeria)	Gazimağusa (Famagusta)	1987	938666
Hamitköy-Baştanlıkdere (Mandres)	Lefkoşa (Nicosia)	1992	529125
Karşıyaka-Karşıyakadere (Vasilia)	Girne (Kyrenia)	1989	25000
Mersinlik-Azganlıdere (Flamoudi)	Yeni Iskele (Trikomo)	1989	1145065
Serdarlı-Ağılıdere (Chatos-Agli)	Gazimağusa (Famagusta)	1992	391880
Şirinevler-Polatdere (Ayos Ermolaos-Ovgos)	Girne (Kyrenia)	1994	517167
Tatlısu-Portakallıdere (Akanthou)	Gazimağusa (Famagusta)	1990	156000
Zeytinlik-Köprüdere (Templos-Keupru)	Girne (Kyrenia)	1989	50000

Total storage capacity of reservoirs constructed after the estabilishment of TRNC is 15.445 MCM. Gemikonağı-Madendere Reservoir is the largest one having 4.121 MCM storage capacity and the smallest one is the Karşıyaka/Karşıyakadere Reservoir with a storage capacity of only 25000 cubic meters. The purpose of usage of these reservoirs are for irrigation except Zeytinlik-Köprüdere and Karşıyaka-Karşıyakadere which were constructed for groundwater recharge. Additionally, Geçitköy-Dağdere Reservoir had 1.820 MCM originally but later on, its storage capacity was increased to 26.5 MCM for the water supply project from Alaköprü Dam in Mersin to Geçitköy-Dağdere Reservoir at TRNC

1.2 Research Aims & Objectives

The main objective of this research is to find catchment characteristics and utilized, evaporated and runoff volumes for the 16 studied reservoirs to analyze the contribution and role of water reservoirs to the water potential of Turkish Republic of Northern Cyprus. In addition to the water budget calculations, possible live active storage of each studied reservoir at different sedimentation levels were determined. The aim of this study is to provide valuable insights for making effective decisions about managing water resources of the region.

1.3 Research Limitations

Similar to most researches conducted without budget and limited time this research had some limitations. The biggest limitation of this research was the lack of monthly volume measurements. Lack of volume data was generally measured three or maximum four times a year for each reservoir and during 2020, due to Covid-19 pandemic no measurements were taken at all. missing data was filled by using weighted average method considering effective evaporation and precipitation as it is mentioned in Chapter 5.

Volume readings for the Mersinlik-Azganlıdere Reservoir are unavailable beyond the year 2013 due to the presence of extensive vegetation surrounding the reservoir. Consequently, data calculations for the Mersinlik-Azganlıdere reservoir only encompass the period from 2005 to 2014. Similarly, for the Arapköy-Uzundere Reservoir, volume readings were not obtainable beyond the year 2020.

Figure 2. Strong vegetation covering Mersinlik-Azganlıdere Reservoir.

Another challenge encountered during this research pertained to identifying suitable meteorological stations for the Şirinevler-Polatdere and Dağyolu-Üçparmakdere reservoirs. These reservoirs are situated between the Boğazköy and Kozan districts, making the selection of appropriate meteorological data stations complex. As a resolution, the averages from both nearby stations were employed to estimate the runoff volumes for these reservoirs.

Moreover, the findings concerning the Gönendere Reservoir have been omitted due to the unavailability of surface area-storage capacity details of the reservoir.

1.4 Structural Outline of the Study

6 pillars of this research include chapters below:

- In Literature Review three of the previous studies related with this research were discussed and their significance in this study was highlighted,
- For the Theory section, the scientific explanation of methods used for this study were discussed in detail with relevant formulas with procedures of calculations,
- In Study Area chapter, the geographical and meteorological information about TRNC was given and basic details about the studied reservoirs were mentioned,
- Under Methodology chapter, calculations were discussed in detail by giving relevant examples for each calculation type,
- In the Results & Discussion chapter, obtained results for this research were discussed in detail, by providing relevant tables and comments about the findings.
- The Conclusion & Recommendations chapter highlights the conclusions and suggests several relevant recommendations.

Chapter 2

LITERATURE REVIEW

One of the seminal works in the field of reservoir studies in Cyprus is the publication authored by Konteatis (1974), titled "Dams of Cyprus." This notable study provides an extensive examination of various aspects related to reservoirs on the island. The book delves into intricate details regarding the construction of these reservoirs, encompassing essential parameters such as reservoir capacity, catchment dimensions, and stream flow rates. Furthermore, it details valuable insights into the water quality for each reservoir and shedding light on the composition and characteristics of the stored water. Another noteworthy feature of "Dams of Cyprus" is its comprehensive coverage of the hydrological history of the region. By tracing the hydrological developments and variations over time, the study contributes to a deeper understanding of the intricate relationship between water resources and environmental conditions in Cyprus. Through meticulous documentation and analysis, Konteatis's work serves as a pivotal resource for researchers, hydrologists, and environmental scientists that are seeking to explore the hydrological dynamics of the island. In an academic context, this seminal publication facilitates the comprehension of Cyprus's hydrological landscape, providing a foundation for subsequent studies and research endeavors. The multifaceted insights offered by "Dams of Cyprus" transcend mere construction details, extending to encompass broader considerations of water resource management, ecological implications, and the broader socio-environmental implications of reservoir development. As such, the book remains an essential reference for anyone engaged in the exploration of water resource management, hydrology, and environmental studies within the context of Cyprus.

Another notable study about reservoirs in Cyprus was done by Hrissanthou (2006) titled "Comparative application of two mathematical models to predict sedimentation in Yermasoyia Reservoir, Cyprus". The study focuses on estimating the mean annual deposition of sediment in the Yermasoyia Reservoir located northeast of Limassol, Cyprus, by using two mathematical models. The reservoir has a storage capacity of 13.6 million cubic meters and is fed by the Yermasoyia River's basin with an area of 122.5 square kilometers. The research aims to estimate the sediment inflow originating from the basin into the reservoir. Two models are employed for this estimation, each consisting of three sub-models:

- Rainfall-runoff,
- Soil erosion, and
- Sediment transport.

In the first model, potential evapotranspiration is used in the rainfall-runoff sub-model, along with the soil erosion sub-model by Schmidt and the sediment transport sub-model by Yang. In the second model, actual evapotranspiration is utilized in the rainfall-runoff sub-model, along with the soil erosion sub-model by Poesen and the sediment transport sub-model by Van Rijn. To calculate the deposition amount in the reservoir, the Brune diagram is employed, providing trap efficiency information for the reservoir. The study makes use of daily data from three rainfall stations and meteorological station data including air temperature, relative humidity, and sunlight hours over a four-year period (1986-1989). The research compares the computed annual runoff volumes and mean annual soil erosion rates obtained from the models with actual measurement data. This academic investigation contributes to understanding the sediment deposition processes in the Yermasoyia Reservoir's basin and provides insights into the accuracy of the employed mathematical models for predicting sediment inflow (Hrissanthou, 2006).

The master's thesis authored by Zehra Güliz Şener in 1997, titled "An Investigation on Evaporation from Small Reservoirs of Northern Cyprus," stands as a notable and pioneering research effort concerning reservoirs in the region following the establishment of the Turkish Republic of Northern Cyprus (TRNC). The thesis is particularly significant due to its comprehensive examination of various aspects related to the small reservoirs constructed in Northern Cyprus during the late 1980s and early 1990s.The central focus of the study is the meticulous exploration of evaporation phenomena in the context of these reservoirs. Of notable importance is the thesis's emphasis on quantitative analysis, specifically regarding evaporation volume calculations. This analytical study involves the application of scientific methodologies to assess the extent of evaporation losses from specific reservoirs. The author undertakes the challenging task of determining the evaporation heights of the Famagusta, Kyrenia, and Nicosia regions where the pilot reservoirs under investigation are situated by using Penman, Pan and Water Budget Methods. These evaporation height (depth) determinations are subsequently utilized to calculate the evaporation volumes for notable reservoirs such as Ergazi-Sayadere, Hamitköy-Baştanlıkdere, Değirmenlik-Çataldere, Alagadi/Çiftlikdere and Gönyeli Reservoirs.

Chapter 3

THEORY

3.1 Reservoirs

Any structure erected across a river or stream to keep water from flowing downstream and eventually may be discharges into the sea is used to store water. Behind this manmade structures, artificial lakes called reservoirs are formed. These reservoirs can be used to store water for agriculture, industry, and household use. They may also be used for fishing, boating, and other leisure activities (National Geographic Society, 2022). The only usages of small reservoirs in TRNC is for irrigation, groundwater recharge and flood risk minimalization. However, it is possible to utilize the reservoirs of TRNC for domestic use with the proper management of water resources.

The total capacity of the operational reservoirs in TRNC is close to 16 MCM. This is extremely low compared to Southern part of the island, despite having just 1.8 times the size of the northern section of the island, having a total reservoir capacity of almost 304 MCM. The main reasons behind this is the presence of less mountainous areas in the northern part which are suitable to the construction of water storage facilities and also due to less precipitation compared with the southern side of the island (Tarım Master planı, 2017). In addition, There is a sharp reduction in water levels in West-Mesoarial reservoirs of TRNC due to construction of other dams over their catchments at the foothills of Troodos mountains where they receive high run-off due to heavy rainfalls.

The storage capacity of a reservoir is allocated to three primary purposes. Firstly, a portion of the capacity serves as an active storage (volume), fulfilling roles such as regulating downstream flow, supplying water, supporting recreational activities, and facilitating hydropower generation if exists. Secondly, the remaining segment is designated as dead storage, primarily intended for collecting sediment. Lastly, a specific capacity is reserved as flood storage, aimed at mitigating potential flood-related damages at downstream by temporarily holding excess water during flood events (Loucks & van Beek, 2017).

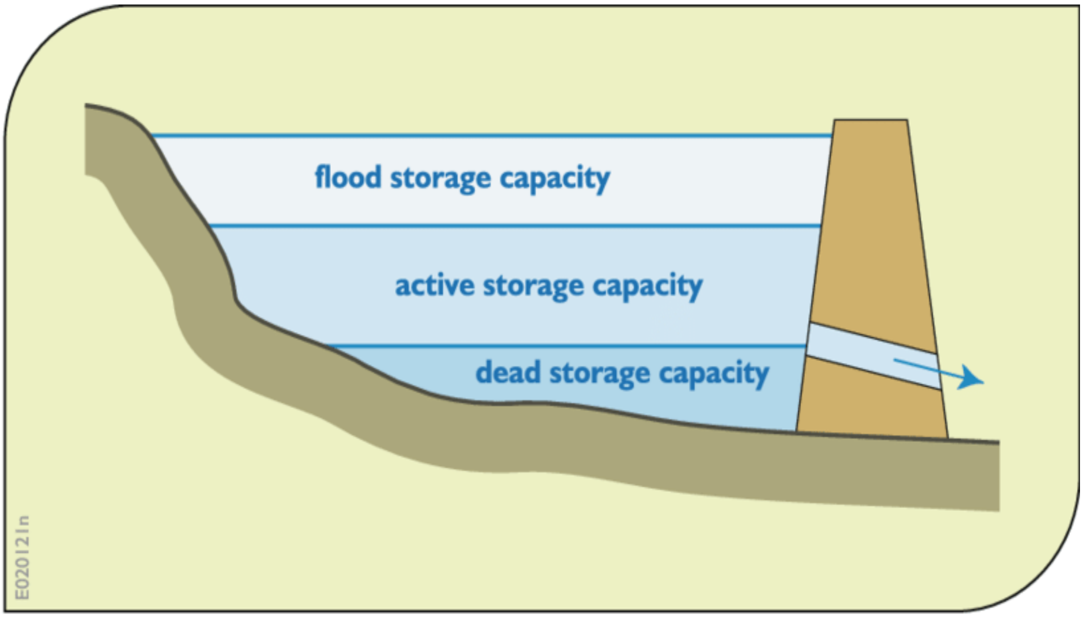

Figure 3. Parts of storage capacity in a reservoir (Loucks & van Beek, 2017).

3.2 Hydrological Cycle

The hydrologic cycle, also known as the water cycle, is a cycle in which water circulates continuously in the Earth-atmosphere system. The most significant processes in the water cycle are evaporation, condensation, precipitation, infiltration, transpiration, and runoff.

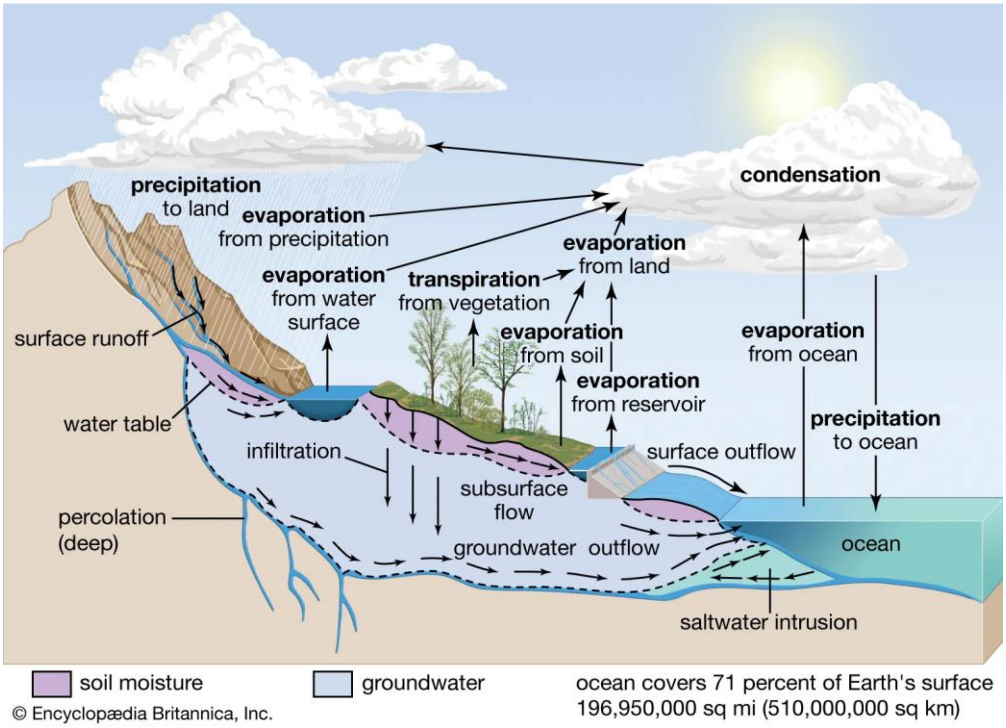

Figure 4. Hydrological Cycle (Britannica, 2023).

- Runoff: When there is more water than the land can absorb, runoff occurs. Water runs across the land's surface and into surrounding creeks, streams, and eventually into the sea or ocean if there is no dam structure somewhere over the stream or river.
- Evaporation: Evaporation is the conversion of liquid state of water to gaseous state of water. (Water vapor). Evaporation transports water from the Earth's surface to the atmosphere.

- Transpiration: Process that involves the evaporation of moisture from the plants.
- Condensation: It is the reverse process of evaporation where water gradually turns from gaseous state to liquid state.
- Infiltration: Water entering the soil by filling its voids due to gravity is known as infiltration.
- Precipitation: Any liquid or frozen water that condenses in the atmosphere and falls to the ground is referred to as precipitation. Rain, sleet, and snow are only a few of its various.

Water level inside the reservoir can be increased by runoff and precipitation. On the other hand, stored water inside the reservoir can be lost by evaporation and infiltration processes of hydrological cycle. So, for estimating the water budget within the reservoir it is important to know the amount of each component within the hydrological cycle. Furthermore, recent rainfall studies in Southern Cyprus reveals that, there is currently 14% less rainfall than at the turn of the century. It has also been shown that only 20% of the current rainfall contributes to the water budget (Elkiran & Ergil, 2006).

3.3 Water Budget of a Reservoir

The water budget of a reservoir refers to the mass (volume) balance between the inflows and outflows of water within the reservoir system. It involves tracking the various sources of water that enter the reservoir, such as precipitation, runoff, and tributary flows by comparing them with various ways like how water is utilized or discharged, including evaporation, downstream releases, and any other losses like infiltration.

The objective of any water budget analysis is to understand how changes in these components impact the reservoir's water levels, its storage capacity, and overall, its water volume availability. The equation describing the change in water storage within a reservoir (ΔV_s) over a specific time can be expressed as follows:

$$\Delta V_s = V_r + V_{pcp} + V_{Gin} + V_{sp} - V_{evap} - V_{inf} - V_{wd} \quad (3.1)$$

where the term V_r represents the inflow of runoff into the reservoir (m^3), while V_{Gin} accounts for groundwater inflow from the aquifer (m^3). On the other hand, V_{sp} refers to the outflow of water from the reservoir due to its spills (m^3), and V_{wd} encompasses water withdrawals for irrigation, livestock, and household needs (m^3). Additionally, V_{pcp} signifies the volume of rainfall directly entering through the reservoir's surface (m^3), and V_{evap} represents the water volume lost through evaporation from the reservoir's surface area (m^3). Lastly, V_{inf} considers the loss of water through infiltration from the reservoir mainly due to the soil texture of its bed (m^3). This equation systematically outlines the factors contributing to the change in water storage within the reservoir and underscores the dynamic interplay between these components over time (Fowe et al., 2015).

3.4 Estimating Evaporation Amount from Small Lakes

Due to its inherent characteristics, the direct measurement of evaporation from water surfaces is infrequently undertaken, especially when considering larger spatial and temporal scales. Instead, evaporation from water bodies is predominantly derived through indirect computational approaches. These encompass a range of techniques, such as:

- Utilization of pan coefficients in conjunction with measured pan evaporation, application of water balance assessments
- Implementation of energy balance considerations,

- Incorporation of mass transfer methodologies, and
- Integration of combined techniques. The optimal selection of a specific technique for evaporation estimation is primarily contingent upon factors including the availability of relevant data, the dimensions or nature of the water body in question, and the requisite level of precision necessary for the accuracy of the resultant evaporation estimates (Jensen, 2010).

3.4.1 Penman Combination Method

The Penman (Combination) method is widely used to estimate potential evaporation, which represents the amount of water that could potentially evaporate and transpire from a specific surface under ideal conditions. The Penman equation incorporates meteorological variables such as solar radiation, air temperature, humidity, wind speed, and atmospheric pressure. It calculates the rate of evapotranspiration by considering both the energy available for evaporation and the aerodynamic resistance to moisture transfer(Usul, 2001). Even through Penman equation requires complex meteorological data, it gives more accurate results and can be applicable to use these results as an actual evaporated value instead of measuring evaporation with the proper equipment(Valiantzas, 2006). One disadvantage of using the Penman method to predict evaporation value is the calculation's complexity since each of these parameters can be stated in a variety of units. The use of all these parameters may cause confusion during the calculation steps resulting in severe inaccuracies if the appearing parameters are not expressed in their appropriate units (Valiantzas, 2006).

An equation derived by Howard Penman in 1948 to estimate evaporation is shown below:

$$E_0 = \frac{\frac{\Delta}{\gamma}\times Q_n + E_a}{\frac{\Delta}{\gamma}+1} \tag{3.2}$$

where,

E_0: Evaporation from open water surface (mm/day).

Q_n: Net amount of radiation remaining at the free water surface (it is found as g.cal/cm^2/day and converted into mm/day by dividing it by 59 to be used in Penman equation).

E_a: Evaporation due to mass transfer of vapor (mm/day).

Δ: Gradient of saturation vapor pressure (Determined by interpolation from Table 2 as Δ/γ).

γ: Psychrometer constant (equals to 0.66 mb/°C or 0.49 mm Hg/°C).

Ratio between gradient of saturation vapor pressure and psychrometer constant (Δ/γ) can be determined by interpolation from the given table below:

Table 2.Values of Δ/γ varying with monthly average temperatures (Şener, 1997).

Temperatures (°C)	Δ/ϒ
0	0.67
5	0.92
10	1.23
15	1.64
20	2.14
25	2.78
30	3.57
35	4.53
40	5.70
45	7.10
50	8.77

Values of Q_n and E_a are determined from the equations below:

$$Q_n = R_c\,(1 - r) - R_B \quad (3.3)$$

$$R_c = R_A \times \left(0.20 + 0.48 \times \left(\frac{n}{D}\right)\right) \quad (3.\ 4)$$

$$R_B = \sigma \times Ta^4 \times (0.47 + 0.077 \times \sqrt{e}\,) \times \left(0.20 + 0.80 \times \frac{n}{D}\right) \quad (3.\ 5)$$

$$E_a = 0.35 \times (e_s - e) \times (0.5 + 0.54 \times U_2\,) \quad (3.\ 6)$$

The definitions of the parameters in the equations written above are as follows:

R_B: Net long wave radiation of the Earth.

R_C: Actual short-wave radiation from the sun and atmosphere, at the Earth's surface.

R_A: Angot's value of solar radiation arriving at the outer limit of the atmosphere in g.cal/cm^2/day.it can be found by the interpolation of latitudes from Table 3. For Gazimağusa region latitude selected as 35.3728, for Lefkoşa region it is selected as 35.15, for Girne region selected as 35.32 and lastly, for Güzelyurt region latitude selected as 35.20.

r: Albedo or Reflection coefficient which is accepted as 0.06 for free water surfaces such as reservoirs.

n/D: It is the ratio of actual sunshine hours to possible sunshine hours. Possible sunshine hours, D, can be determined by interpolation from Table 4 for the latitude of the region and time of the year. Actual sunshine hours, n, obtained from meteorology office from Gazimağusa, Lefkoşa, Girne and Güzelyurt stations.

σ: Lummer and Pringsheim constant, equals to 117.74×10^{-9} $gr.cal/cm^2/day$.

T_a: Monthly average temperature in Kelvin (°C+273).

e: Actual vapor pressure of air in mm Hg. Determined by multiplying relative humidity (%) with the saturated vapor pressure of air (e_s).

e_s: Saturated vapor pressure of air in mm Hg. Obtained by interpolation through Table 5.

U_2: Wind speed measured at 2 meters height in m/s obtained from meteorology office from Gazimağusa, Lefkoşa, Girne and Güzelyurt stations.

Table 3. Angot's values (RA) for different latitudes (Usul, 2001).

Latitude	Months											
(°N)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
90	0	0	55	518	903	1077	944	605	136	0	0	0
80	0	3	143	518	875	1060	930	600	219	17	0	0
60	86	234	424	687	866	983	892	714	494	258	113	55
40	358	538	663	847	930	1001	941	843	719	528	397	318
20	631	795	821	914	912	947	912	887	856	740	666	599

Table 4. Possible hours of sunshine (D) for different latitudes in (Usul, 2001).

Latitude	Months											
(°N)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
10	11.6	11.8	12.1	12.4	12.6	12.7	12.6	12.4	12.9	11.9	11.7	11.5
20	11.1	11.5	12	12.6	13.1	13.3	13.2	12.8	12.3	11.7	11.2	10.9
30	10.4	11.1	12	12.9	13.7	14.1	13.9	13.2	12.4	11.5	10.6	10.2
40	9.6	10.7	11.9	13.2	14.4	15	14.7	13.8	12.5	11.2	10	9.4
50	8.6	10.1	11.8	13.8	15.4	16.4	16	14.5	12.7	10.8	9.1	8.1

Table 5. Values of Saturated vapor pressure of air (e_s) (Şener, 1997).

Temperatures (°C)	e_s (mm Hg)
0	4.59
5	6.56
10	9.23
15	12.81
20	17.57
25	23.81
30	31.9
35	42.28
40	55.47
45	72.07
50	92.68

3.4.2 Pan Evaporation Method

The most common way for finding evaporation in a small body of water, such as shallow lakes, is to multiply monthly coefficients by recorded pan evaporation. The pan evaporation method is a widely used technique to estimate evaporation rates from open water surfaces, typically using a standardized instrument known as an evaporation pan. This method is particularly useful when direct measurements of evaporation from natural water bodies are not available or are difficult to obtain. This method provides a practical and accessible way to assess the potential water loss due to evaporation.

The precision of this procedure is dependent on the surroundings around the pan. Evaporation from a natural body of water is normally at a lower rate because the body of water does not have metal sides that absorb heat from the sunlight, and light penetration in a pan is essentially uniform whereas, light penetration in natural bodies of water decreases as depth increases. To compensate this, it is recommended to multiply the pan evaporation by 0.75 (Jensen, 2010).

The amount of evaporation can be measured using a variety of instruments, but the results from one tool are typically not comparable to those from another. The Class-A pan is a common evaporation pan that the National Weather Service of US uses to detect evaporation and it is widely used in other parts of the world. A Class-A pan is a cylinder with a diameter of 120.7 cm and a depth of 25.4 cm, and it is raised around 15 cm from the ground by using wooden stand (Ertek, 2011).

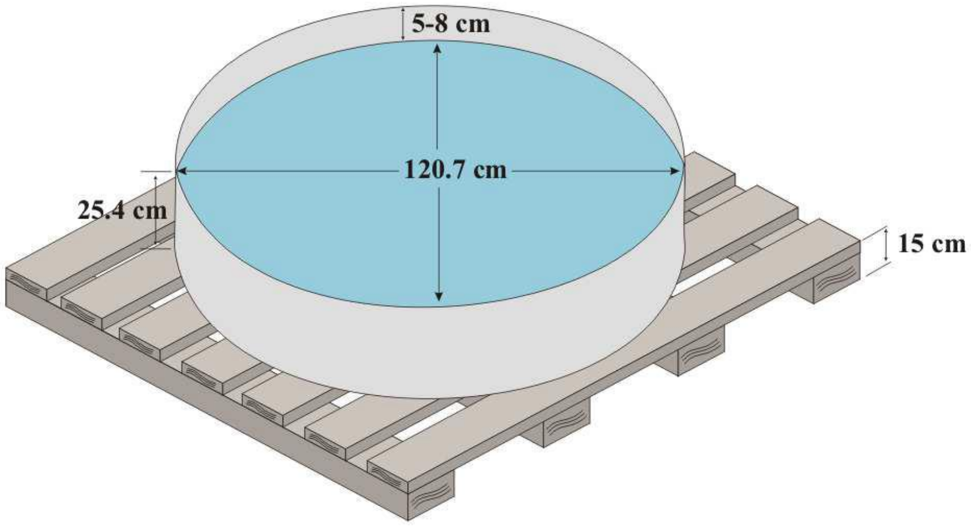

Figure 5. Typical Class-A pan with dimensions (Ertek, 2011).

3.4.3 Estimating Net Evaporation from the Reservoir

Since the evaporation of water from the pan and from the soil is different due to their latent heat capacity absorptions different coefficients must be developed to compensate this difference.

Hence, evaporation from the small reservoirs can estimated by using the equations below:

$$E_{effective} = K_p \times E_{pan} \quad (3.7)$$

$$EV = \frac{E_{effective} \times A_{mean}}{1000} \quad (3.8)$$

$$E_{net} = EV - R \quad (3.9)$$

where,

$E_{Effective}$: Effective evaporation of the region in mm/month.

K_p: Pan coefficient which is a correction factor to find effective evaporation.

E_{pan}: Pan evaporation obtained from the meteorology office in mm/day. Converted to mm/month by multiplying with the number of days in a particular month.

EV: It is the evaporation from the reservoir surface in a calculated month (m^3/month).

A_{mean}: Mean surface area of the reservoir during calculated month and the previous month in m^2. Obtained by reading Surface Area-Storage Capacity curves taken from the Water Works Office TRNC.

E_{net}: It is the net water evaporated from the reservoir in the studied month (m^3/month).

R: is the volume of direct rainfall on top of reservoir in (m^3/month) it should be subtracted from the evaporated volume to determine net evaporation from the reservoir surface area.

3.5 Φ Index of a Catchment

The Φ index, within the context of hydrology and catchment analysis, represents a significant parameter that characterizes the hydrological response of a catchment area to a given amount of rainfall. Specifically, it is defined as the constant infiltration capacity that, if applied uniformly across the catchment, would produce the observed total runoff corresponding to the given rainfall input (Chin, 2018).

3.6 Decreased Active Reservoir Volume due to Sediment Accumulation

Over time, reservoirs are experiencing a gradual decline in their storage capacity due to the ongoing accumulation of sediment carried by rivers. This sediment deposition is primarily attributed to the diminishing velocity within the conduit linking rivers or streams and the reservoir. The weakened force within this connection inhibits the movement of sediment particles, leading to their settling and accumulating within the reservoir. Moreover, sedimentation rates exhibit significant variation among different reservoirs due to several influencing factors. These factors encompass soil characteristics, land cover patterns, occurrences of land disturbances (including events like landslides and wildfires), the extent of the contributing catchment area, and the prevailing hydroclimate conditions. Each of these elements contributes uniquely to the rate at which sediment accumulates within reservoirs.

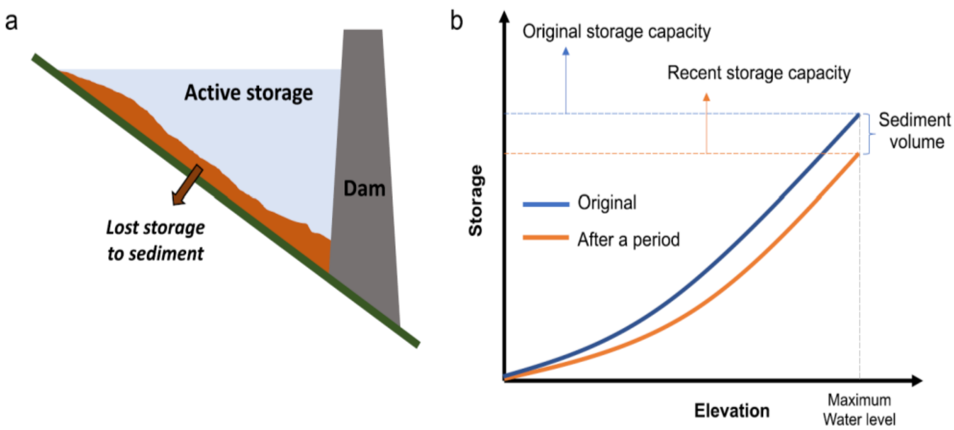

Figure 6. Sedimentation and loss of storage capacity (Yao et al., 2023).

3.7 SCS Mockus Synthetic Unit Hydrograph

The SCS Unit Hydrograph is a simplified method used to estimate streamflow in response to rainfall events. It was developed by Victor Mockus and was derived based on many unit hydrographs from basins that varied in characteristics such as size and geographic location. The Soil Conservation Service (SCS) dimensionless unit hydrograph procedure is one of the most well-known methods for deriving synthetic unit hydrographs in use today. Synthetic mockus hydrograph can be drawn in curvilinear and triangular methods.

3.7.1 Triangular Synthetic Unit Hydrograph

Triangular Synthetic unit hydrograph is applicable for the catchment areas bigger than 1 square kilometer and smaller than 10 square kilometers and can be obtained from the equations below:

$$T_C = 0.00032 \times \frac{L^{0.77}}{S_{Har}{}^{0.384}} \quad (3.10)$$

$$t_p = (0.5 \times t_r) + (0.6 \times T_C) \quad (3.11)$$

$$t_f = 1.67 \times t_p \quad (3.12)$$

$$t_b = t_p + t_f \quad (3.13)$$

$$Q_p = \frac{0.208 \times A}{t_p} \quad (3.14)$$

where,

T_C: Time of concentration in hours.

L: Length of the main channel in km.

S_{Har}: harmonic slope of main channel obtained by dividing main channel to 10 equal points.

t_p: Time of peak in hours.

t_r: Time of rain in hours. for practical purposes, it is recommended to select:

- tr = 0.5 hr $0 < Tc \leq 3$ hr,

- tr = 1.0 hr 3 < Tc ≤ 6 hr
- tr = 1.5 hr 6 < Tc ≤ 9 hr
- tr = 2.0 hr 9 < Tc ≤ 15 hr
- tr = 2.5 hr 15 < Tc ≤ 22.5 hr
- tr = 3.0 hr 22.5 < Tc ≤ 30 hr.

t_f: Duration of discharge reaching to zero after time of peak in hours.

Q_p: Peak discharge value in m^3/s/mm.

A: Catchment area in square km.

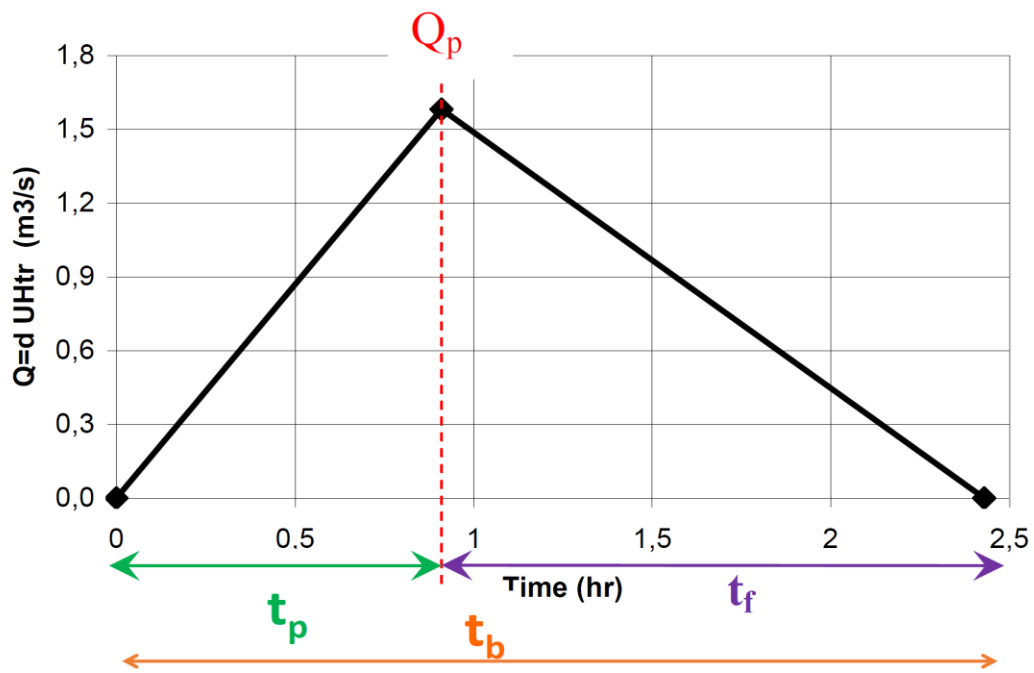

Figure 7. A sample Triangular Mockus Unit Hydrograph.

3.7.2 Curvilinear Synthetic Unit Hydrograph

Similar equations with the Triangular Synthetic Unit Hydrograph were used to obtain Q_p and t_p values for the Curvilinear Synthetic Unit Hydrograph. While determining ordinates, t_p value obtained should be multiplied by representative time ordinates and Q_p value, should be multiplied by the representative discharge ordinates derived by

Victor Mockus. Curvilinear Mockus Unit Hydrograph can only be drawn for catchments bigger than 10 square kilometers and smaller than 1000 square kilometers unlike triangular method where the catchment area should be smaller than 10 square kilometers and bigger than 1 square kilometers.

Table 6. Representative time and discharge values determined by Victor Mockus.

t (hr)	**Q (m^3/s)**
0	0
0.1	0.03
0.2	0.1
0.3	0.19
0.4	0.31
0.5	0.47
0.6	0.66
0.7	0.82
0.8	0.93
0.9	0.99
1	1
1.1	0.99
1.2	0.93
1.3	0.86
1.4	0.78
1.5	0.68
1.6	0.56
1.7	0.46
1.8	0.39
1.9	0.33
2	0.28
2.2	0.207
2.4	0.147
2.6	0.107
2.8	0.077
3	0.055
3.2	0.04
3.4	0.029
3.6	0.021
3.8	0.015
4	0.011
4.5	0.005
5	0

Chapter 4

STUDY AREA

4.1 Definition of the Study Area

Cyprus is an island located in the Eastern Mediterranean, situated south of Turkey, west of Syria, and north of Egypt. The total land area of Cyprus is approximately 9251 square kilometers (3572 square miles), making it the third-largest island in the Mediterranean Sea. From 9251 square kilometers, 3355 square kilometers belongs to the TRNC that spans from the northeastern tip of the Karpaz Peninsula to the westernmost point, the Erenköy exclave, encompassing Morphou Bay and Cape Koruçam. Its southernmost boundary is marked by the village of Akıncılar.

TRNC has 5 distinct landforms:

1. Kyrenia Plain/Coast: It extends from Panagra delta all the way up to the northern part of Kantara mountains with a distance of 75 kilometers in length.
2. Beşparmak Mountains: These are the mountains between Kyrenia Coast in the north and Mesaria Plain. All the reservoirs in TRNC are fed by the rainwater coming from Beşparmak Mountains except Gemikonağı/Lefke Reservoir which is fed by runoffs coming from Troodos hills at the southern part of the island.
3. Dipkarpaz Peninsula: This long and narrow wedge-shaped peninsula is located at the northeastern end of TRNC.
4. Güzelyurt Plain: It is located in the western part of TRNC, lying between the Troodos Mountains at the south and the Beşparmak Mountains at the north.

The agricultural productivity of the Morphou Plain is supported by water resources, including rivers and underground aquifers.

5. Mesaoria Plain: This is a vast, flat plain situated between the Kyrenia Range at the north and the Troodos Mountains at the south. The plain is known with its agricultural significance and fertile soils, hence making it essential area for farming in TRNC.

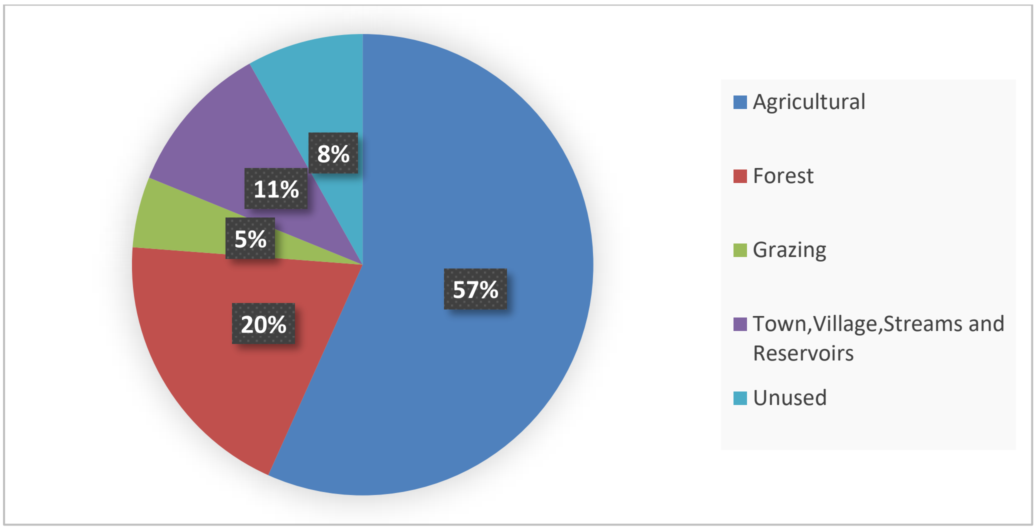

Figure 8. Land distribution of TRNC (Tarım Master Planı, 2017).

The whole studied area covers different regions of TRNC, and these regions have different meteorological, topographical and hydrological properties. The island faces water scarcity, recurrent droughts, with a Mediterranean climate of irregular rainfall patterns by making the dams and reservoirs crucial for water storage, management, and supply. The monthly average rainfall (mm), monthly average temperatures (°C), monthly average relative humidity (%) values of TRNC are provided in the tables below:

Table 7. Average Monthly Rainfall Data of TRNC (Meteorology Office).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
2004	217.6	84.4	1.4	11.4	6.0	4.4	0.0	0.0	0.0	18.6	59.2	86.4	489.4
2005	57.1	30.4	22.6	24.8	11.7	33.7	0.0	1.0	10.5	12.5	105.1	9.5	347.9
2006	106.1	38.6	38.4	12.9	5.1	1.9	12.8	0.0	6.8	70.8	39.6	12.9	345.7
2007	31.8	127.4	35.9	19.1	70.7	0.4	0.6	1.6	0.3	6.7	27.3	55.0	376.8
2008	23.1	31.5	9.6	7.6	15.9	0.2	0.0	3.2	7.6	20.5	16.8	78.5	214.5
2009	62.2	75.7	54.5	15.7	14.3	0.1	0.9	4.6	27.4	35.5	41.9	154.5	487.3
2010	118.1	158.1	7.7	12.8	14.4	8.4	1.7	0.4	1.7	12.1	0.6	51.9	381.6
2011	101.5	44.4	37.1	48.4	32.7	18.8	0.0	0.1	14.2	10.8	103.6	64.9	476.5
2012	164.7	62.1	23.0	14.2	50.6	3.0	1.6	1.4	0.0	67.5	86.0	107.3	581.4
2013	61.9	33.3	11.2	38.3	43.0	0.0	0.0	0.2	2.0	4.3	12.1	57.7	476.5
2014	16.7	17.9	28.7	12.5	48.6	11.4	0.6	0.4	12.5	53.6	37.0	80.9	320.8
2015	75.0	77.0	54.8	24.7	25.6	5.7	0.8	0.5	10.5	37.1	11.0	51.9	374.6
2016	44.0	17.3	38.1	17.3	22.8	1.0	0.0	0.0	8.2	5.6	37.7	174.2	366.2
2017	37.8	3.2	31.5	21.2	12.2	3.0	0.0	1.3	1.6	15.7	53.8	15.0	196.3
2018	90.4	26.6	16.1	11.3	33.1	22.7	0.5	1.2	13.9	40.5	64.5	131.7	452.5
2019	95.0	130.8	67.6	34.5	0.6	19.2	0.3	5.4	10.7	55.0	16.8	118.4	554.3

Analyzing the data, several trends and patterns can be observed. Over the years, it is evident that Northern Cyprus experiences a distinct rainy season, which is typically concentrated within December and January. During this period, particularly in 2004, 2010, and 2012, the rainfall is notably higher than in other months. The highest yearly total was recorded in 2012, reaching 581.4 mm, indicating an exceptionally wet year. On the other hand, the summer months, July and August, tend to be extremely dry, with rainfall close to zero in many years, such as 2004, 2005, 2006, and others. This suggests a pronounced dry season in TRNC during these months. Furthermore, the data shows considerable year-to-year variability in yearly total rainfall, ranging from a low of 196.3 mm in 2017 to a high of 581.4 mm in 2012. This indicates that the rainfall in the region can be quite unpredictable, leading to fluctuations in annual rainfall levels. Overall, this data indicates that TRNC experiences a Mediterranean climate with a distinct wet season during the winter months and a dry season in summer and water year of Cyprus starts in the month of October since, some remarkable rainfall starts taking place during this month according to the analyzed data .

Table 8. Monthly Average Temperatures of TRNC in °C (Meteorology Office).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
2004	10.5	11.0	14.2	16.9	20.8	25.6	28.8	27.9	25.5	22.8	16.6	11.7	19.0
2005	11.5	10.5	13.8	17.4	21.2	24.8	28.5	28.4	26.0	20.4	15.3	13.4	19.0
2006	10.7	11.6	13.6	17.8	21.6	26.0	28.5	29.0	26.4	21.6	15.2	11.9	19.5
2007	10.9	12.1	13.8	16.5	22.1	26.7	29.4	29.0	26.0	23.1	17.5	12.8	20.0
2008	9.8	10.6	16.0	18.1	21.0	26.5	28.6	28.9	25.5	21.3	18.1	13.0	19.8
2009	16.3	16.3	17.7	22.9	26.9	32.8	34.6	34.4	30.4	28.7	21.6	18.5	25.1
2010	16.8	16.7	19.8	23.5	27.2	30.4	32.9	35.7	32.3	27.5	25.3	20.2	25.7
2011	12.1	12.0	13.5	16.3	20.4	25.2	28.2	28.6	26.2	20.9	14.5	12.5	19.2
2012	10.5	10.1	12.1	16.9	20.6	25.8	29.4	29.4	26.0	22.3	18.0	13.5	19.6
2013	11.4	12.8	14.3	17.8	22.6	25.4	28.0	28.9	25.4	20.5	18.5	11.9	19.8
2014	13.1	12.7	14.9	17.7	20.6	25.3	27.5	28.3	25.6	21.2	16.3	14.7	19.8
2015	10.9	11.3	14.1	15.8	21.3	24.0	27.7	29.1	26.9	22.7	18.0	13.0	19.6
2016	10.6	14.1	15.1	19.6	21.2	26.6	28.8	28.4	25.7	22.6	17.0	11.2	20.1
2017	9.9	11.0	14.0	17.1	21.0	25.6	29.5	28.0	26.0	21.5	16.6	14.0	19.5
2018	12.2	13.7	15.8	19.3	23.6	25.1	28.4	28.3	26.2	22.1	17.5	13.5	20.5
2019	11.0	12.0	13.4	15.8	22.2	25.7	28.1	28.5	26.6	22.8	18.6	13.4	19.8

The analysis of the table provided above reveals distinctive seasonal variations, with the summer months of June, July, and August experiencing the highest average temperatures, reaching around 30°C. Conversely, the winter months from December to February record the lowest average temperatures, ranging from approximately 10°C to 15°C. This suggests a temperate climate during the winter season. Between the years 2004 to 2019 provided above, the average temperatures exhibit a relatively stable trend, with no significant upward or downward trend observed. The yearly average temperature range varies between approximately 6°C to 12°C, with the highest variation measured in the years 2009 and 2010. Overall, this data implies a consistent climate in TRNC with mild winters and hot summers by reflecting a stable and relatively predictable temperature pattern over the years.

Table 9.Monthly Relative Humidity of TRNC in % (Meteorology Office).

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Yearly Avg**
2004	78.7	75.5	66.2	65.5	67.0	64.5	57.8	68.6	63.2	68.3	72.4	74.0	68.5
2005	76.0	72.6	71.5	65.7	63.5	64.2	66.5	67.8	63.8	64.2	69.9	73.4	68.3
2006	73.8	74.9	76.7	70.8	65.4	59.8	62.1	64.8	65.0	72.9	69.1	94.6	70.8
2007	68.4	75.1	67.7	60.0	69.0	56.5	54.7	66.9	60.4	64.7	67.7	72.0	65.2
2008	58.8	61.2	63.3	62.0	59.4	59.4	57.3	63.5	64.7	64.6	65.4	66.1	62.1
2009	70.6	73.7	67.7	65.0	57.5	51.8	55.1	57.2	60.6	62.0	66.3	75.3	63.6
2010	73.3	73.1	68.9	62.3	62.9	62.8	65.6	61.9	60.6	62.4	59.6	67.9	65.1
2011	69.7	68.3	68.4	68.0	63.8	61.3	61.0	57.6	62.0	56.3	61.5	68.1	63.8
2012	71.9	65.4	61.6	65.9	67.4	61.7	56.2	52.8	61.2	65.7	68.5	73.3	64.3
2013	73.3	74.0	62.4	61.6	61.1	57.4	56.0	55.2	57.7	46.5	64.7	62.2	61.0
2014	71.8	66.6	62.9	64.8	66.4	55.7	63.9	65.9	60.0	64.5	62.9	74.5	65.0
2015	71.9	72.7	67.4	61.0	62.2	62.6	57.7	57.2	61.4	65.4	57.6	63.7	63.4
2016	67.7	67.4	61.7	56.4	59.2	54.4	59.0	62.9	59.0	60.2	57.3	69.5	61.2
2017	68.0	65.2	67.6	62.0	61.4	58.5	54.4	62.4	62.6	59.2	65.9	70.2	63.1
2018	73.1	73.3	66.8	56.6	60.0	63.4	59.5	61.8	59.4	64.4	66.9	13.5	59.9
2019	73.0	74.5	72.2	68.6	54.7	62.9	56.9	61.6	59.4	65.8	64.3	74.7	65.7

The provided data above offers insights into the average relative humidity values for each month of the years 2004 to 2019 of TRNC. Seasonal patterns in relative humidity are evident, with the summer months from June to August exhibiting lower average values, ranging from approximately 54% to 62%, indicating drier conditions during the summer season. Conversely, the winter months, particularly from December to February, tend to have slightly higher average relative humidity levels, ranging from about 56% to 59%. These months experience relatively more humid conditions compared to the summer. Over the observed period of 15 years, the data shows consistent patterns in relative humidity, with no significant upward or downward trends observed. However, among them there is an anomaly within the data of December 2018, where the relative humidity is unusually low at 13.5%. This could be due to a data entry error or a unique weather event during that period.

The rivers in the Güzelyurt-Lefke region of Northern Cyprus, that have the largest water potential and constitute the largest part of the drainage area, are fed from the Troodos Mountains, the highest topographic elevation of the island. The flow of these rivers is generally observed from December to May, during the winter and early spring months. In fact, during this period, the typical hydrograph shows a continuous flow resulting from the melting of snow from the upper regions. After the end of snow melting in May, the base flow shows a sudden decrease, and the rivers start to flow due to groundwater contribution, gradually decreasing with the summer months. Sparse storms in the higher elevations may cause some flood-like flow, but the infrequent summer rains in a typical season do not significantly affect surface runoff. In the summer months, the flow decreases, and flow is only observed for a very short period of time. After the dry winter months with low precipitation, the flow in the riverbeds suddenly ceases, starting from the higher elevations (Tarım ve Doğal Kaynaklar Bakanlığı, 2017).

4.2 General Information About Studied Reservoirs

Even though at the preliminary stage of this study, 27 distinct reservoirs were observed that are located at the northern part of Cyprus, only 16 of them are actively used for irrigation where, the presence of water is almost permanent and monitored regularly. In TRNC, there are no facilities currently operational for utilizing surface water resources as drinking water sources. Likewise, the potential for surface water storage for the same purpose is severely limited. All the reservoirs studied are only used for irrigation purposes.

Before and after the establishment of TRNC, there have been issues with the constructed reservoirs in the Turkish Republic of Northern Cyprus (TRNC). Many of these reservoirs have been built without sufficient hydrological data, leading to inadequate water storage. As a result, there are difficulties in irrigation water supply. Another significant problem is the substantial increase in water salinity when the stored water remains in the reservoir for a period of year, which negatively affects the quality of irrigation water due to highly saline soil texture. Reservoirs built for irrigation purposes have not undergone sufficient maintenance and repair over the years, and the dead storage volume of the reservoirs has either filled up or is close to filling up due to severe erosion in their catchment basins. Neglected maintenance at the source and outlet of the reservoirs has allowed various plants and trees to grow, covering the reservoirs with vegetation. Reservoirs constructed as groundwater-fed storage also face significant problems in recent years due to the disposal of solid waste from developing settlements and deficiencies in maintenance and repairs (Aksu, 2017).

Table 10. List of studied reservoirs with their irrigated areas.

No	Name of the Reservoir	Location	Construction Year	Irrigation Area (ha)
1	Akdeniz	Güzelyurt (Morphou)	1994	430
2	Geçitkale-Eğridere	Gazimağusa (Famagusta)	1989	24
3	Ergazi-Sayadere	Yeni Iskele (Trikomo)	1989	84
4	Değirmenlik-Çataldere	Lefkoşa (Nicosia)	1990	30
5	Dağyolu-Üçparmakdere	Girne (Kyrenia)	1994	58
6	Serdarlı-Ağıllıdere	Gazimağusa (Famagusta)	1992	38
7	Arapköy-Ayanidere	Girne (Kyrenia)	1968	65
8	Arapköy-Uzundere	Girne (Kyrenia)	1990	41
9	Beşparmak-Çiftlikdere	Girne (Kyrenia)	1993	67
10	Mersinlik-Azganlıdere	Yeni Iskele (Trikomo)	1989	170
11	Gemikonağı-Madendere	Lefke (Lefka)	1995	130
12	Gönyeli	Lefkoşa (Nicosia)	1962	85
14	Kanlıköy	Lefkoşa (Nicosia)	1963	400
13	Haspolat-Mia Milia	Lefkoşa (Nicosia)	1964	130
15	Şirinevler- Polatdere	Lefkoşa (Nicosia)	1994	40
16	Hamitköy-Baştanlıkdere	Lefkoşa (Nicosia)	1992	95

Chapter 5

METHODOLOGY

5.1 Collected Data

For the relevant calculations, data used was gathered from Water Works Office, Meteorology Office of TRNC and NASA's Data Access Viewer (DAV) website. Monthly cumulative rainfall, monthly average evaporation, monthly average wind speed measured from 2 meters, monthly average actual sunshine hours, monthly average relative humidity, monthly average temperatures of relevant stations were all collected from Meteorology Office of TRNC. On the other hand, monthly volume measurements and surface area-storage capacity relationships of the reservoirs were gathered from the Water Works Office. In addition, hourly rainfall values, which were corrected by using monthly cumulative rainfall values, were obtained from NASA's Data Access Viewer (DAV).

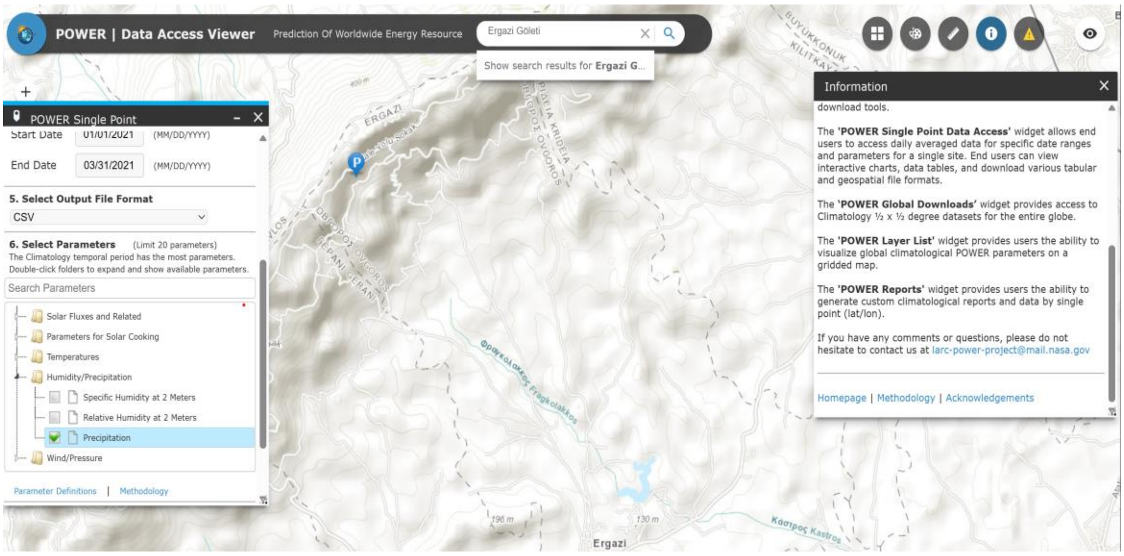

Figure 9. User interface of NASA's Data Acess Viewer.

5.2 Rainfall Data Correction

The monthly cumulative rainfall values for 10 stations were gathered from the Meteorology Office. The representative stations used in this study are Akdeniz, Alevkaya, Kantara, Kozanköy, Lefke, Boğazköy, Taşkent, Değirmenlik, Yeşilrmak, and Tatlısu. The determinations of the relevant stations were made by considering the distance of station to that specific reservoir catchment. Table below shows the closest meteorological stations to each reservoir catchments:

Table 11. List of closest meteorological stations to the reservoir catchments.

Name of the Reservoir	Catchment Station
Akdeniz	Akdeniz
Arapköy-Ayanidere	Alevkaya
Arapköy-Uzundere	Alevkaya
Beşparmak-Çiftlikdere	Alevkaya
Dağyolu-Üçparmakdere	Kozanköy & Boğazköy
Değirmenlik-Çataldere	Değirmenlik
Ergazi-Sayadere	Kantara
Geçitkale-Eğridere	Tatlısu
Gemikonağı-Madendere	Lefke
Gönyeli	Boğazköy
Hamitköy-Baştanlıkdere	Taşkent, Boğazköy & Değirmenlik
Haspolat	Taşkent, Boğazköy & Değirmenlik
Kanlıköy	Boğazköy
Mersinlik-Azganlıdere	Kantara
Serdarlı-Ağıllıdere	Alevkaya
Şirinevler-Polatdere	Kozanköy & Boğazköy

Based on the provided table above, the following station selections and rainfall data utilization can be observed. Alevkaya Station has been chosen as the monitoring station for the Arapköy Ayanidere, and Uzundere Reservoirs, as well as the Beşparmak-Çiftlikdere Reservoir and Serdarlı-Ağıllıdere Reservoir. The rainfall data from Akdeniz, Değirmenlik, and Lefke stations were used for the calculations of

Akdeniz, Değirmenlik-Çataldere, and Gemikonağı-Madendere Reservoirs, respectively. Amongst the available stations, Kantara station being the closest meteorological station to the catchments of Ergazi and Mersinlik Reservoirs. Furthermore, Taşkent station has been specifically selected for Hamitköy-Baştanlıkdere and Haspolat Reservoirs,since the data for Taşkent station between years 2014 to 2021 were missing, so missing values were determined by taking the averages of Boğazköy and Değirmenlik stations. When it comes to the Gönyeli and Kanlıköy Reservoirs, the nearest meteorological station is the Boğazköy station. Lastly, the average monthly cumulative rainfall values from Kozanköy and Boğazköy stations were used for the Dağyolu-Üçparmakdere and Şirinevler-Polatdere Reservoirs, while the Tatlısu station relevant meteorological datasets used for the Geçitkale-Eğridere Reservoir.

From the NASA's Data Access Viewer (DAV) website (NASA POWER | Data Access Viewer) hourly estimated cumulative rainfall of the selected coordinate can be obtained and it gives satellite and model-based measurement results which can be used to provide reliable solar and meteorological resource data over regions where surface measurements are sparse or non-existent. The ratio of data obtained from both NASA and the Meteorology Office was determined, and the data correction factors were found for each month for the years between 2005 to 2022. These data correction factors were multiplied with the hourly rainfall data collected from DAV to obtain reliable hourly cumulative rainfall values in the light of surface measurements.

Table 12. Data correction factor calculation for the Kantara station.

Year	Total Rainfall (mm)		Data Correction Factor
	NASA	Meteorology Office	
2005	98.82	242.7	2.46
2006	47.47	163	3.43
2007	32.72	27.01	0.83
2008	28.45	74.4	2.62
2009	74.72	76	1.02
2010	76.86	77.5	1.01
2011	74.06	87.5	1.18
2012	152.91	255.6	1.67
2013	44.88	99.1	2.21
2014	28.31	8	0.28
2015	93.88	99	1.05
2016	71.17	45.3	0.64
2017	53.31	35.4	0.66
2018	121.38	156.3	1.29
2019	130.07	87.7	0.67
2020	100.32	90.1	0.90
2021	72.86	52.7	0.72
2022	128.47	113.2	0.88

5.3 Estimating Evaporation from the Reservoirs

Class-A Pan Evaporation measurements were obtained from the Meteorology Office. The evaporation measurements are only recorded in Gazimağusa, Girne, Lefkoşa, and Güzelyurt stations. Since evaporation from the metal pan and soil will not be the same, determination of relevant coefficient is necessary. For deciding pan coefficient to estimate evaporation from each reservoir, Combined Penman method was used. The Penman method gives reliable answers since it takes into consideration some parameters such as wind speed, average daily sunshine hours, average monthly temperature, relative humidity and solar radiation. After dividing Penman evaporation value with the measured pan evaporation by Meteorology Office, the Pan coefficient of that specific month of the year was obtained. After deciding monthly average pan coefficients these correction factors were multiplied with the pan evaporation measurements to obtain the effective evaporation per month of that region. Table below shows the closest reservoirs to each meteorological station where the evaporation measurements took place:

Table 13. Reservoirs and their nearest representative meteorological stations.

Name of the Reservoir	Nearest Meteorology Station
Akdeniz	Güzelyurt
Arapköy-Ayanidere	Girne
Arapköy-Uzundere	Girne
Beşparmak-Çiftlikdere	Girne
Dağyolu-Üçparmakdere	Lefkoşa
Değirmenlik-Çataldere	Lefkoşa
Ergazi-Sayadere	Gazimağusa
Geçitkale-Eğridere Reservoir	Gazimağusa
Gemikonağı-Madendere	Güzelyurt
Gönyeli Reservoir	Lefkoşa
Hamitköy-Baştanlıkdere	Lefkoşa
Haspolat	Lefkoşa
Kanlıköy	Lefkoşa
Mersinlik-Azganlıdere	Gazimağusa
Serdarlı-Ağıllıdere	Gazimağusa
Şirinevler-Polatdere	Lefkoşa

5.3.1 A Calculation for Finding the Average Monthly Penman Evaporation

An example calculation of monthly evaporation by Penman method for Güzelyurt region during year 2005 is given below:

- Month: January (31 days)
- Latitude: 35.2 °N
- Mean monthly temperature (T): 10.6 °C (from Meteorology Office)
- Mean actual sunshine hours (n): 5 hours (from Meteorology Office)
- Mean possible sunshine hours (D): 10 hours (by interpolation from Table 4).
- Mean wind velocity at 2 meters of height (U_2): 2.9 m/s (from Meteorology Office)
- Albedo of the water surface (r): 0.06 (constant)

- Mean monthly relative humidity: 60% (from Meteorology Office)
- Lummer and Pringsheim constant (σ): 117.74×10^{-9} gr.cal/cm^2/day
- Saturated vapor pressure of air (e_s): 9.7 mm Hg (by interpolation from Table 5).
- Ta: 283.6 Kelvin (by converting mean monthly air temperature obtained from Meteorology Office from °C to Kelvin).
- e: 7.6 mm Hg (by multiplying saturated vapor pressure of air (e_s) with the relative humidity).
- Ratio of Gradient of saturation vapor pressure to Psychrometer constant (Δ/γ): 1.2 (by interpolation from Table 2).
- Angot's value of solar radiation (R_A): 565.5 g.cal/cm^2/day (by interpolation from Table 3).
- Net radiation remaining at free water surface (Q_n) was calculated by inserting Equations 3.4 and 3.5 into Equation 3.3. Hence,

$$Q_n = 565.5 \times \left(0.20 + 0.48 \times \frac{5}{10}\right) \times (1 - 0.06) - 1.177 \times 10^{-7} \times 283.6^4 \times \left(0.47 - 0.077 \times \sqrt{9.7}\right) \times \left(0.2 + 0.8 \times \frac{5}{10}\right) = 128.3 \text{ g.cal/day/cm}^2$$

- After dividing Q_n by 59 to obtain dimensional consistency, mm/day.

$$Q_n = \frac{128.3}{59} = 2.2\, mm/day$$

- Finding evaporation due to mass transfer of vapor (E_a): 1.3 mm/day (from Equation 3.6)
- Mean monthly evaporation depth (E_0): 1.8 mm/day (from Equation 3.2).

Penman evaporation results for the other months of the year 2005 are shown in the table below:

Table 14. Monthly Penman Evaporation values of Güzelyurt region for year 2005.

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Number of Days	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
T (°C)	10.6	10.1	13.4	17.2	20.4	24.1	27.2	27.5	24.7	19.4	14.5	12.5
U_2 (m/s)	2.9	2.9	2.8	3.1	3	3	2.9	3.1	2.7	2.3	2.3	2.1
R	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
n (day/hr)	5.0	6.0	8.0	8.5	11.3	12.5	12.0	11.3	9.9	8.8	6.6	5.2
Relative Humidity (%)	78.8	76.4	72.6	67.9	66.9	67.8	72.3	73.4	69.2	68.7	74.4	76.0
σ (g.cal/cm^2/day)	1.177E-07	1.177E-07	1.177E-07	1.177E-07	1.177E-07	1.177E-07	1.177E-07	1.177E-07	1.177E-07	1.177E-07	1.177E-07	1.177E-07
T_a (Kelvin)	283.6	283.1	286.4	290.2	293.4	297.1	300.2	300.5	297.7	292.4	287.5	285.5
e_s (mm Hg)	9.7	9.3	11.7	14.9	18.1	22.7	27.4	27.9	23.4	17.0	12.5	11.0
e (mm Hg)	7.6	7.1	8.5	10.1	12.1	15.4	19.8	20.4	16.2	11.7	9.3	8.4
R_A (g.cal/cm^2/day)	565.5	733.3	783.1	897.9	916.3	960.0	919.0	876.4	823.1	689.1	601.4	531.6
D (hr)	10.0	10.9	11.9	13.1	14.1	14.6	14.3	13.5	12.5	11.3	10.3	9.8
n/D	0.5	0.6	0.7	0.6	0.8	0.9	0.8	0.8	0.8	0.8	0.6	0.5
Q_n (g.cal/day/cm^2)	128.3	206.8	263.0	327.7	399.2	467.9	464.4	443.3	374.1	262.2	173.3	123.1
Q_n (mm/day)	2.2	3.5	4.5	5.6	6.8	7.9	7.9	7.5	6.3	4.4	2.9	2.1
E_a (mm/day)	1.3	1.4	2.4	3.7	4.3	5.3	5.3	4.8	5.1	3.1	1.8	1.7
Δ/ϒ	1.2	1.2	1.5	1.9	2.2	2.6	3.0	3.1	2.7	2.1	1.4	1.4
E_0 (mm/day)	1.8	2.5	3.6	4.9	6.0	7.2	7.2	6.9	6.0	4.0	2.5	1.9

5.3.2 A Calculation for Estimating Monthly Average Pan Coefficients

A sample calculation for determining the monthly average pan coefficient of Güzelyurt region for the month of January:

- Mean monthly evaporation depths (E_0) between years 2005 to 2022 were determined by Penman Evaporation method as mentioned in the previous sub-section.
- Penman evaporation results were divided by Pan evaporation values gathered from Meteorology Office of TRNC for January month between years 2005 to 2022.
- Averages of ratios obtained were taken between years 2005 to 2022 to find a representative pan coefficient of month January for the Güzelyurt region as it is shown in Table 30 below:

Table 15. Calculated Pan Coefficient of the month January for the Güzelyurt.

Years	**Penman/Pan**
2005	1.0
2006	1.0
2007	1.0
2008	1.0
2009	1.1
2010	1.3
2011	1.2
2012	1.2
2013	1.1
2014	1.1
2015	1.5
2016	1.9
2017	1.5
2018	1.5
2019	1.6
2020	1.3
2021	2.5
2022	1.6
Average	1.4

5.4 Generating Surface Area- Storage Capacity Curves

Surface Area-Storage Capacity curves are very important for planners, designers, and operators to monitor and observe the characteristics of reservoir or Dam. Surface Area-Storage Capacity curves can be changed over time due to sediment deposition to the bottom of the reservoirs through rivers or streams. Importance of predicting Surface Area-Storage Capacity curves for the different sedimentation levels are as listed below:

- Determining the depth of sedimentation at a reservoir site,
- Estimating the new active (live) storage capacity of the reservoir,
- Estimating how backwater conditions will affect the reservoir's upstream flood level,

- Designing the bottom outlet's elevation,
- assessing how reservoir storage capacity has changed during the lifespan of the reservoir (Issa et al., 2017).

According to latest observations of Devlet Su İşleri (DSİ) in 1990, storage capacities of Gönyeli, Kanlıköy and Haspolat reservoirs were reduced since they are under operation over 50 years. The table below shows the initial storage capacities of Gönyeli, Kanlıköy and Haspolat reservoirs versus the current storage capacities in m^3.

Table 16. Older reservoirs with their initial and current storage capacities.

Name of the Reservoir	**Designed Active Storage Capacity (m^3)**	**Current Active Storage Capacity Observed by DSİ (m^3)**
Gönyeli	1 000 000	453 857
Kanlıköy	1 000 000	730 294
Haspolat	340 000	117 390

As it is obvious from the table above, Gönyeli reservoir and Haspolat reservoir lost more than half of their designed (initial) active storage capacity. Despite being constructed in a similar time period Kanlıköy reservoir almost retained its original volume by just losing 269 706 m^3 of its storage capacity.

For all the studied reservoirs the Surface Area- Storage Capacity curves for different sedimentation levels were obtained accordingly to determine the equal elevation level differences provided in the table. Firstly, the Storage capacity differences for each depth (ΔS) was obtained from the original curve and for each sedimentation level these values were subtracted gradually from the original storage capacity to make the necessary correction. For further calculations, generated Surface Area- Storage

Capacity curves were used for the Gönyeli, Haspolat and Kanlıköy Reservoirs, however for the remaining studied reservoirs designed Surface Area- Storage Capacity curves were used since, not having known sedimentation values available in other reservoirs. These newly obtained curves will benefit the practical engineers (technicians) to detect accurate monthly storage capacity of the reservoirs in the future for the further sedimentation levels because as the sedimentation increases the volume of the reservoir decreases and according to new depth of the reservoir new Surface Area-Storage Capacity curves were generated for accurate measurements.

5.5 Obtaining Average Φ Index values for the Reservoir Catchments

Average Φ index values of each catchments studied were generated by the following steps:

1. Missing monthly volumes of each reservoir collected from Water Works Office were obtained by subtracting the weighted average of rainfall from the weighted average of effective evaporation value in the missing period.
2. The runoff-volumes were generated by subtracting difference between monthly measured volumes from the difference of Evaporated volume and direct rainfall volume. During calculations, for accuracy, runoff depths which were below 1 mm for the catchment were neglected. Also, with the runoff volumes, the utilized volume from the reservoir can be identified if subtraction of monthly measured volumes from the difference of evaporated volume and direct rainfall volume gives negative value. In addition, it should be noted that during the calculations of runoff volume, utilized volume was considered as zero and no consumption of water from the reservoir assumption was made. In addition, since irrigation reservoirs are lined with clay, which prevents water from seeping into the ground,

during water budget calculations infiltration volume into or out from was neglected.

3. Total effective runoff depths were calculated by dividing total effective runoff volume to the catchment area.
4. Hourly rainfall values obtained from DAV were corrected by using monthly rainfall values from the Meteorology Office of TRNC.
5. After the correction process, hourly rainfall values in a month where runoff occurs were ordered from highest intensity to lowest intensity and one by one adding them together and dividing them gradually with the total effective runoff depth the Φ index value for each rainfall month was estimated.
6. Φ index values for each runoff month were collected and their averages were taken between years 2005 to 2022 (except for Mersinlik-Azganlıdere
7. and Arapköy-Uzundere Reservoirs) and for each individual catchment, one representative Φ index value was determined.

5.6 Delineation of Reservoir Watershed for Finding the Morphologic Parameters

To delineate the catchment and obtain geomorphologic parameters in ArcGIS, a systematic approach was employed. The first step involved the integration of a Digital Elevation Model (DEM) of Cyprus into the ArcGIS software, providing access to detailed topographic data. Subsequently, flow directions were calculated across the DEM, allowing for the identification of the natural movement of surface water runoff. Flow accumulations were then determined, which revealed areas where flow paths converged, often indicative of stream networks within the landscape. These streams, along with their tributaries, were delineated and could be visually differentiated based on their Strahler stream order, offering insights into the hierarchical organization of the drainage system. Further analysis involved the creation of polylines or polygons representing the boundaries of the relevant sub-catchment, effectively delineating the watershed of the specific reservoir. Precise measurements of the lengths of these delineated features were taken at specific points, allowing for the estimation of critical morphologic parameters essential for a comprehensive understanding of the catchment's characteristics and behavior.

Chapter 6

RESULTS & DISCUSSION

6.1 Obtained Pan Coefficients of Each Region by Using Penman (Combination) Method

In accordance with the aforementioned methodology, the investigation involved the identification of Penman Evaporation values pertaining to the geographical regions of Lefkoşa, Gazimağusa, Girne, and Güzelyurt. After the acquisition of these values, their respective ratios in relation to the measured pan evaporation were computed. These computed ratios were then utilized to establish distinct pan coefficients for each region during every month under consideration. This intricate process of pan coefficient determination stands as a crucial foundation for the subsequent computations integral to the comprehensive water budget analysis. The table below illustrate the obtained pan coefficients for each month from the Penman evaporation values:

Table 17. Obtained pan coefficients from Penman evaporation method.

	Regions			
Months	**Gazimağusa**	**Lefkoşa**	**Girne**	**Güzelyurt**
January	1.94	1.44	1.17	1.35
February	2.06	1.58	1.31	1.37
March	1.65	1.35	1.13	0.97
April	1.41	1.18	1.08	0.86
May	1.09	1.02	0.94	0.73
June	0.99	1.01	0.89	0.71
July	0.93	0.96	0.86	0.70
August	0.95	1.00	0.81	0.70
September	1.09	1.07	0.86	0.73
October	1.34	1.19	0.90	0.76
November	1.62	1.29	0.97	0.96
December	1.65	1.43	1.06	1.14

The derived pan coefficients for the Gazimağusa, Lefkoşa, Girne, and Güzelyurt, exhibit discernible variations across the temporal spectrum. These coefficients, representing the ratio of Penman Evaporation to measured pan evaporation, provide valuable insights into the evaporative dynamics of each region.

Upon a meticulous analysis of the data, it becomes evident that Gazimağusa consistently manifests the highest pan coefficients for most months throughout the year. This observation implies that the evaporation process in Gazimağusa is relatively more efficient compared to the other regions under consideration. This could potentially be attributed to the unique climatic and geographical characteristics of the Gazimağusa region, which might facilitate increased rates of evaporation.

Lefkoşa, on the other hand, displays moderately high pan coefficients, suggesting a substantial level of evaporation. However, its coefficients tend to be slightly lower than those of Gazimağusa, possibly indicating variations in environmental factors such as temperature and humidity that influence the evaporation rates in this region.

Girne and Güzelyurt consistently exhibit lower pan coefficients in comparison to Gazimağusa and Lefkoşa. These coefficients imply a comparatively reduced level of evaporation in these regions. This might be attributable to factors such as geographical features, vegetation cover, and microclimatic conditions that collectively influence the overall evaporative potential of these areas.

Moreover, notable discrepancies between the regions are evident during certain months. For instance, during the drier months of June, July, and August, Lefkoşa and Gazimağusa demonstrate relatively higher coefficients compared to the other regions. This could be indicative of local climate variations impacting evaporation dynamics during this period.

6.2 Yearly Average Evaporated Volume from the Reservoirs

The estimated average yearly evaporation volumes of different reservoirs, revealing significant variations in water loss due to this natural process. Notably, the evaporation volumes span a wide range, from the lowest value of 15000 cubic meters for Haspolat to the highest of 520 000 cubic meters for Kanlıköy. Rate of Evaporation is influenced by factors such as Temperature, Humidity, Wind Speed and Surface Area.

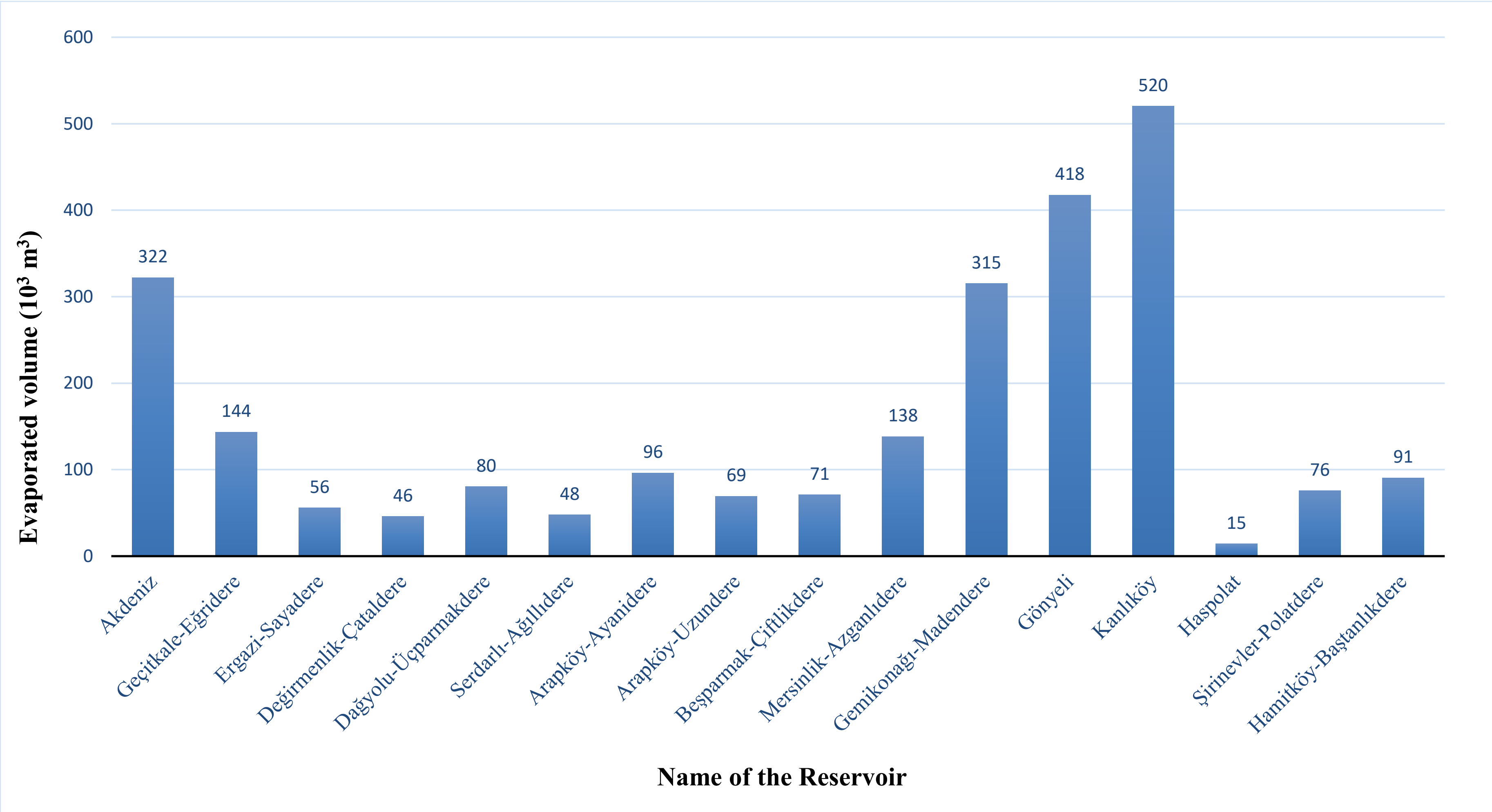

Figure 10. Annual average evaporated volume from each reservoir.

6.3 Yearly Average Utilized Volume from the Reservoirs

The calculated values reveal distinct trends in the utilization of reservoirs in TRNC. Notably, the Gemikonağı-Madendere reservoir stands out with an exceptionally high average yearly withdrawal volume of 1 637 570 m^3, indicating its vital role in catering to substantial water demands for irrigation in that region. Reservoirs like Akdeniz (390 000 m^3) and Geçitkale-Eğridere (322 000 m^3) also exhibit notable withdrawal rates, suggesting their significance in regional water supply for irrigation. On the other end of the spectrum, reservoirs such as Haspolat (19 364 m^3) and Serdarli-Ağıllıdere (91 000 m^3) show contrasting withdrawal volumes. Gönyeli Reservoir is not currently utilized for irrigation purposes. Although there were some negligible calculated volumes that appeared to be utilized over the years, these could be attributed to potential margin of error during calculations.

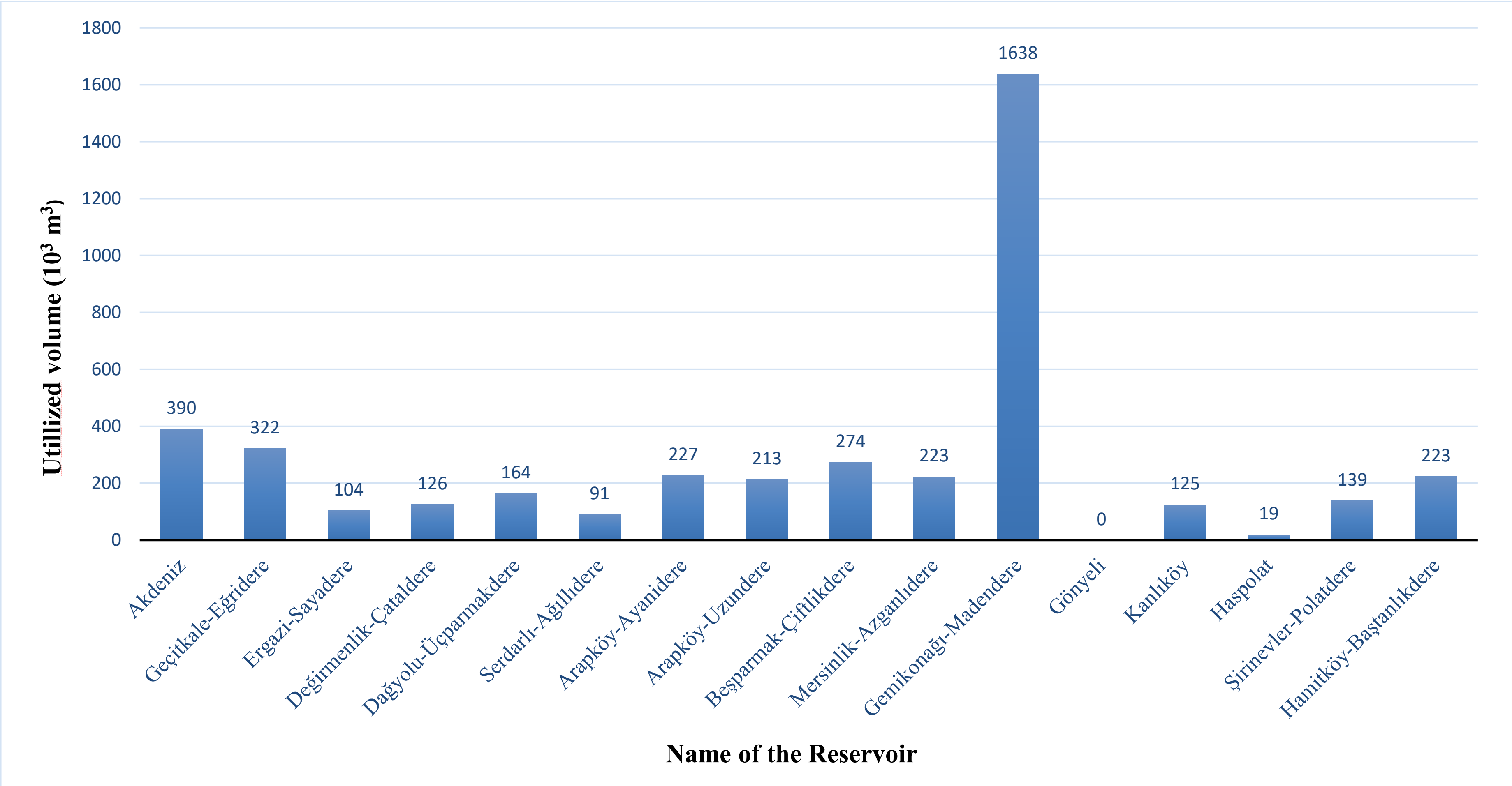

Figure 11. Annual average Utilized volume from each reservoir.

6.4 Yearly Average Efficiency of the Reservoirs

According to the calculations, all the reservoirs were under 50% efficiency this means that less than half of their full active volume on a yearly average scale is used for irrigation. Also, according to the trend of the findings, Arapköy-Uzundere has the highest efficiency compared to all the studied reservoirs and Haspolat reservoir has the lowest.

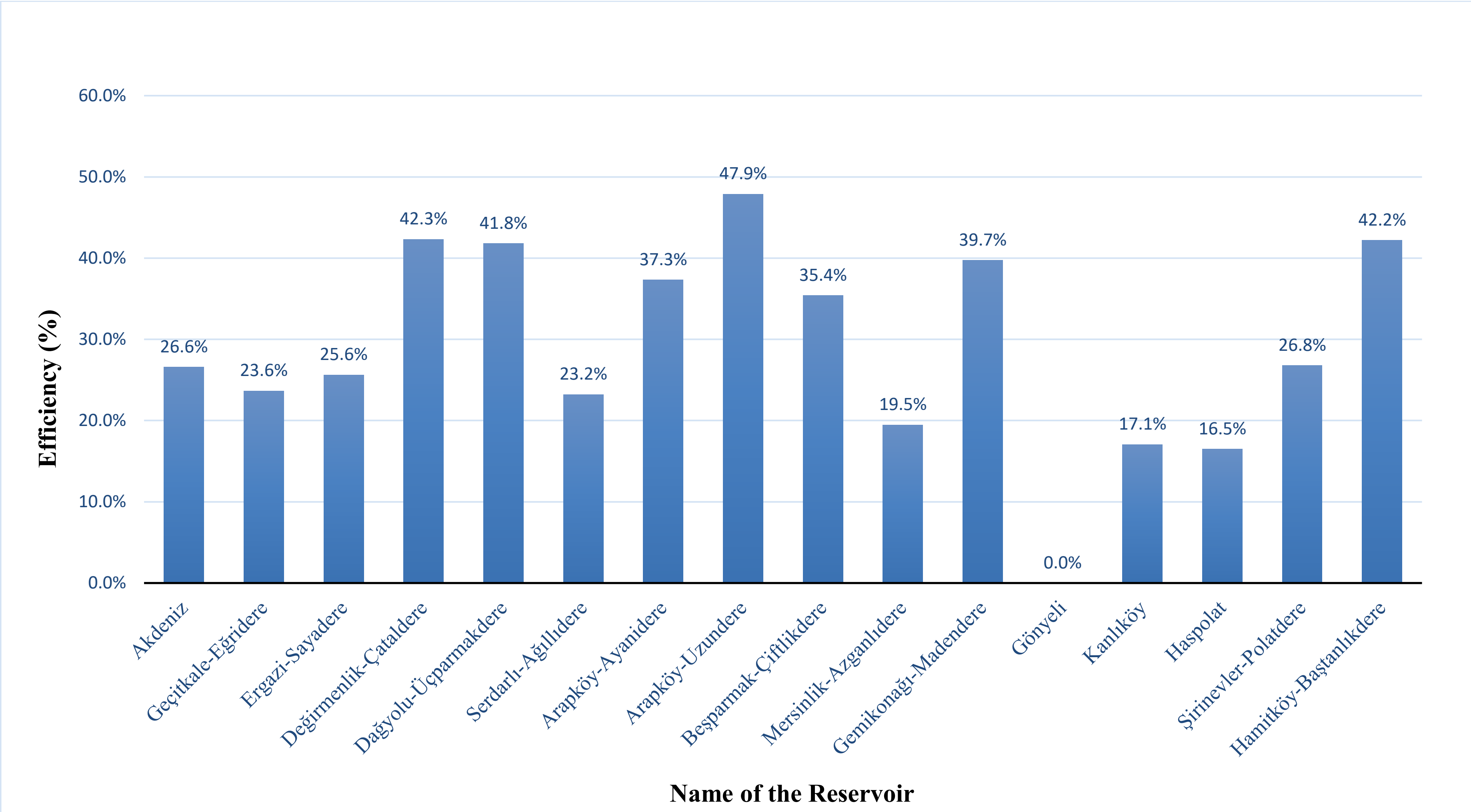

Figure 12. Yearly average efficiency of the reservoirs.

6.5 Yearly Average Runoff Volume Entering to the Reservoirs

When it comes to Yearly Average Runoff Volume findings for each reservoir, the results indicates that Gemikonağı-Madendere Reservoir has significantly higher yearly average runoff volume entering with approximately 2 MCM due to its location at Troodos foothills. On the other hand, findings indicate that Haspolat Reservoir has the lowest yearly average runoff volume entering to it by around 29 000 cubic meters. This means that the reservoir is mostly dry, and its streams are not active enough to carry water volume effectively due to debris or sediment accumulation.

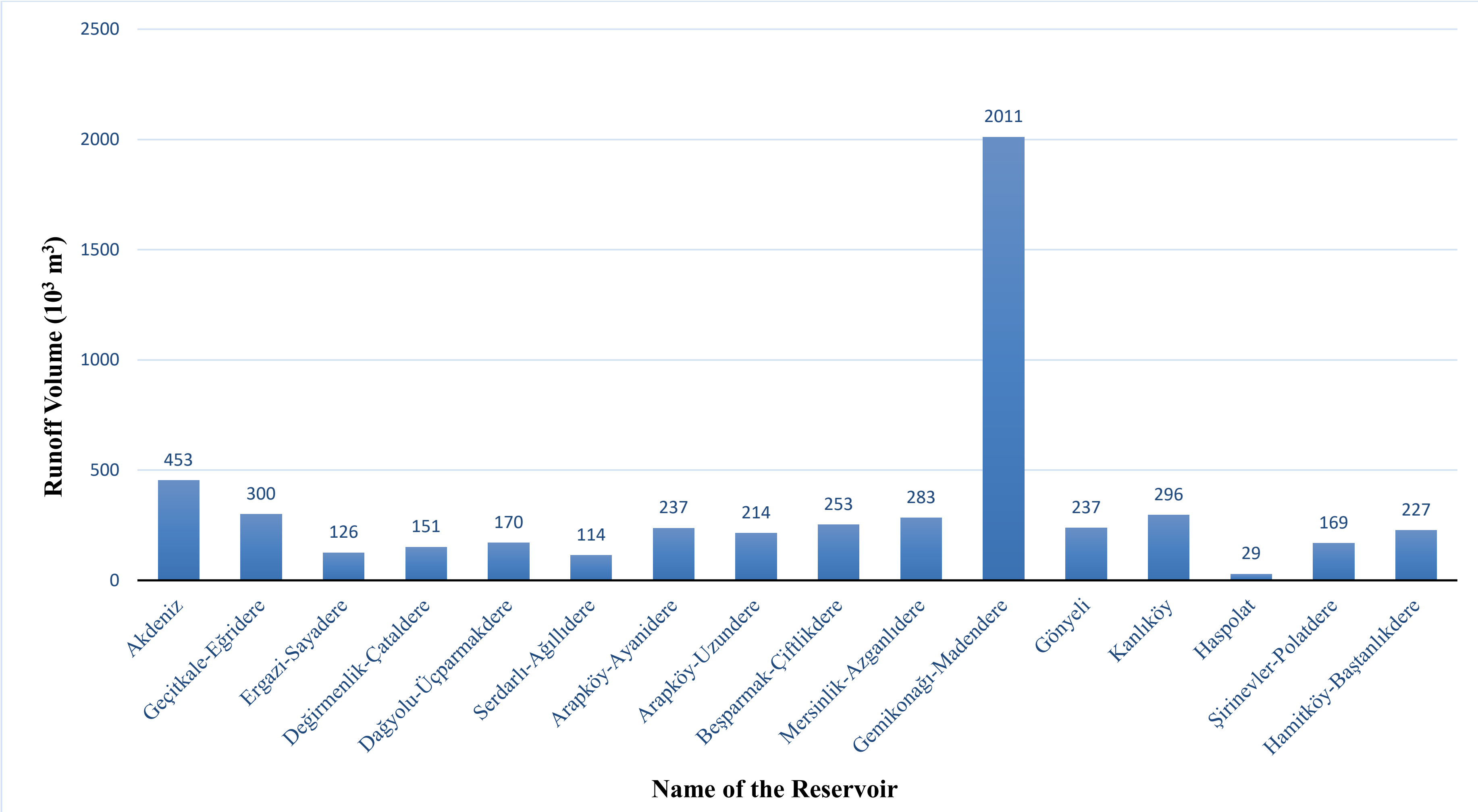

Figure 13.Yearly average runoff volume entering to the reservoirs.

6.6 Obtained Representative Φ Index Values for Each Reservoir Catchment

Among the obtained representative Φ Index values, it is observed that Arapköy-Ayanidere exhibits the smallest Φ Index value, signifying its elevated runoff potential. This outcome suggests that a substantial volume of precipitation is effectively converted into runoff during rainfall events and subsequently enters the reservoir. In contrast, Haspolat Reservoir demonstrates the highest Φ Index value, implying that it necessitates a more intense and prolonged rainfall event to generate runoff that can enter the into the reservoir.

Table 18. Estimated representative Φ Index values of the reservoir catchments.

Name of the Reservoir	Φ Index (mm/hr)
Akdeniz	1.71
Geçitkale-Eğridere	1.87
Ergazi-Sayadere	2.20
Değirmenlik-Çataldere	1.57
Dağyolu-Üçparmakdere	1.72
Serdarlı-Ağıllıdere	2.40
Arapköy-Ayanidere	1.14
Arapköy-Uzundere	1.76
Beşparmak-Çiftlikdere	2.34
Mersinlik-Azganlıdere	2.29
Gemikonağı-Madendere	1.20
Gönyeli	2.87
Kanlıköy	2.34
Haspolat	3.99
Şirinevler-Polatdere	2.55
Hamitköy-Baştanlıkdere	2.10

6.7 Estimated Sediment Volume Deposition Rate Per Year

The yearly sedimentation rates calculated for the Geçitkale-Eğridere Reservoir, Değirmenlik-Çataldere Reservoir, and Dağyolu-Üçparmakdere Reservoir, which amount to 1571 m^3/year, 2656 m^3/year, and 1818 m^3/year, respectively, underscore the critical issue of sediment accumulation in these bodies of water. These sedimentation rates indicate the volume of soil and debris that settles within the reservoirs each year, reducing their storage capacity. It is evident that the Değirmenlik-Çataldere Reservoir is experiencing the most significant sedimentation, likely due to factors such as erosion from surrounding catchment areas. Sedimentation can lead to a multitude of problems, including reduced water storage capacity, decreased water quality, and increased maintenance costs for reservoirs and downstream infrastructure. It necessitates effective sediment management strategies, such as sediment removal and erosion control measures, to ensure the long-term functionality and sustainability of these vital water resources.

Table 19. Sediment deposited per year for the reclaimed reservoirs.

Name of the Reservoir	Sediment deposited per year (m^3/year)
Geçitkale-Eğridere Reservoir	1571
Değirmenlik-Çataldere Reservoir	2656
Dağyolu-Üçparmakdere Reservoir	1818

Chapter 7

CONCLUSIONS AND RECOMMENDATIONS

In this study, based on Penman (Combination) method, the monthly pan evaporation values gathered from Meteorology Office were compared and proper monthly coefficients were suggested for estimating the evaporation value separately from the reservoirs located at Mağusa, Lefkoşa, Girne and Güzelyurt regions. Hence, the evaporation volumes, the utilized amount of water volume from the reservoirs, and the effective runoff volumes of 16 reservoirs were calculated by using the reservoir water budget method. Additionally, the average Φ index of the catchment area for each individual reservoir was determined. Moreover, for each reservoir its storage capacity at different sedimentation levels were identified.

Based on the annual averages of evaporation volumes, utilized amount of water volumes from the reservoirs, and the effective runoff volumes from the reservoir catchments, having a total storage capacity of 13.756 million cubic meters (MCM), the following results were obtained:

- an estimated 2.505 MCM is lost due to evaporation,
- approximately 4.277 MCM is withdrawn for irrigation purposes, and
- annual average runoff is quantified at 5.270 MCM.
- Additionally, from the total utilized volume, the efficiency of all the reservoirs were determined to be 31%, hence, the remaining volume is either lost by evaporation or since during the arid periods the reservoirs maximum

active volume capacity were not reached, it causes a decrease in the amount of water volume used from these reservoirs,

- Approximate sediment volume rate is found to be ranging between 1571 to 2656 cubic meters per year,
- The obtained representative Φ Index values range from 1.14 to 3.99 millimeters per hour,
- Amongst the studied watersheds Akdeniz and Geçitkale Reservoir has the highest Strahlers stream order of Ω = 5,
- From the generated synthetic unit hydrographs maximum time of base (t_b) is 48 hours, the maximum peak time (t_p) is 18 hours (Akdeniz Reservoir's catchment).And maximum peak discaarge is 1.465 $m^3/s/mm$ (Gemikonağı-Madendere Reservoir's catchment) .

Additionally, from the total utilized volume, the efficiency of all the reservoirs were determined to be 31%, hence, the remaining volume is either lost by evaporation or since during the arid periods the reservoirs maximum active volume capacity were not reached, it causes a decrease in the amount of water volume used from these reservoirs.

According to the findings, 18% of the total storage capacity of the reservoirs is lost by evaporation (almost half). This is most likely due to the insufficient fullness ratio of the reservoirs during the study period, ie. less water volume inside the reservoir means less surface area and hence less evaporation.

Annual average runoff volume to the reservoirs from their related catchments were found to be 38% of the total storage capacity of all the studied reservoirs. This shows that, most of the reservoirs could not be able to receive enough runoff to reach their full capacity at the end of the water year based on the average values obtained between years 2005 to 2022.

In light of the research findings and analysis presented in this thesis, the following recommendations are proposed:

- Removing accumulated sediments and managing erosion can prevent blockages and even maintain the stream's capacity, promoting efficient water movement and higher runoff volumes. It is important to do this rehabilitation process carefully to avoid harming the environment and to collaborate with experts to ensure the best results,
- In addition, the storage capacity of the reservoirs should be restored to their designed capacities by removing the accumulated sediments carried by the streams to these reservoirs over the years. From the day the reservoirs started functioning, only 3 of them; Geçitkale-Eğridere, Değirmenlik-Çataldere, Dağyolu-Üçparmakdere having nearly 1571, 2656 and 1818 cubic meters accumulated sediment per year respectively; were reclaimed for this purpose so, this process should be applied for the other reservoirs as well to achieve efficient water storage,
- Monthly volume measurements of reservoirs should be taken to monitor the monthly water usage effectively,
- In order to determine rainfall-runoff relationship for each basin a flowrate measuring device should be installed,
- River and reservoir routing techniques for each reservoir should be studied for sustainable water resource management, flood prevention, environmental conservation,

- A proper site investigation should be done to determine the surface area-storage capacity relationship of Gönendere Reservoir which was omitted in this study due to lack of surface area-storage capacity relationship,
- Annual sieve analysis of the accumulated sediments for each reservoir should be done during the dry seasons to monitor and manage the sediment volume, its composition, and its impact on reservoir capacity and on water quality.

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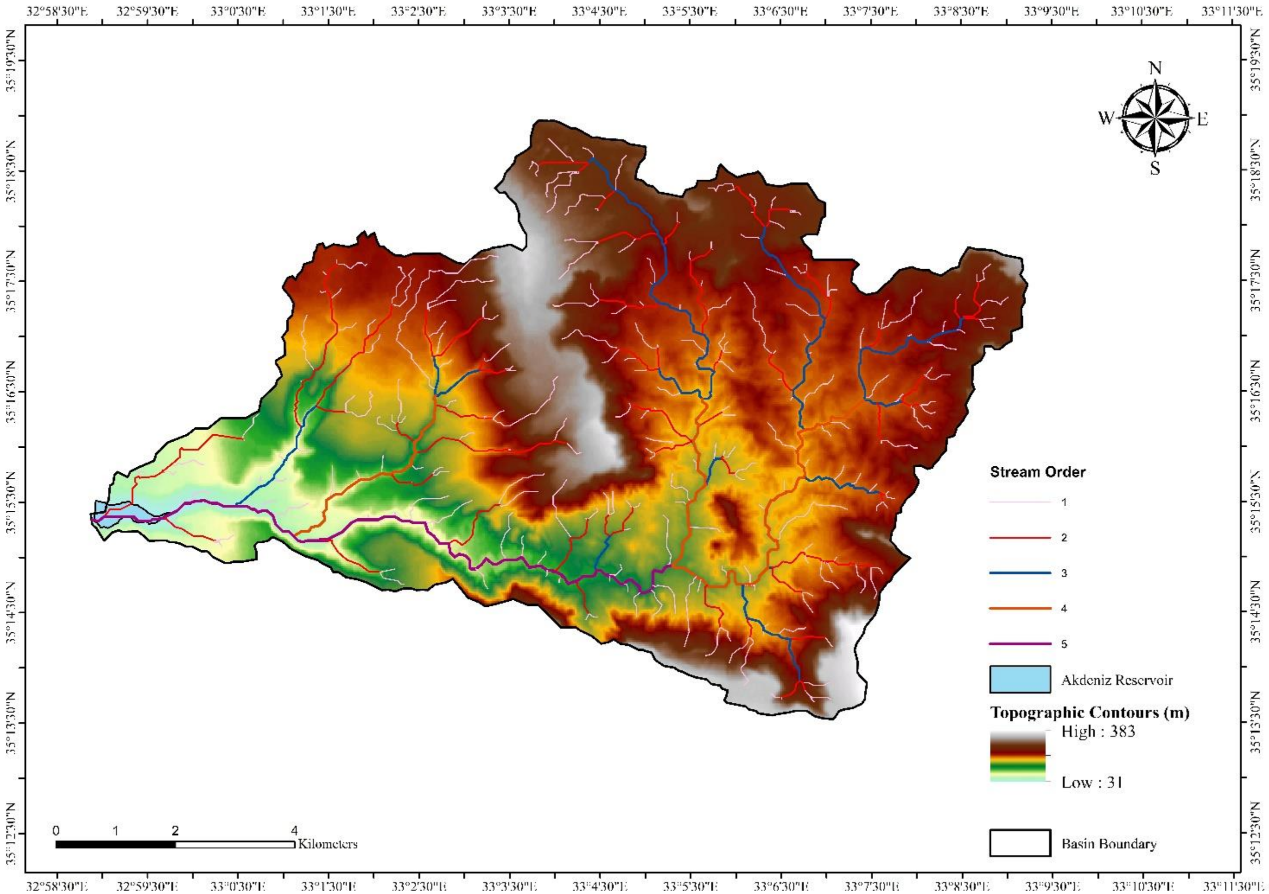
APPENDICES

Appendix A: Akdeniz Reservoir

Akdeniz Reservoir is the biggest reservoir studied in terms of its catchment area of 83.466 square kilometers (delineated by using ARCGIS). Water reservoir was constructed in 1994 by Republic of Turkey on the Hoşpınar river for the irrigation of 430 ha land. It is located at Akdeniz Village of Güzelyurt Region. Reservoir has Bottom weir elevation of 35 meters, normal water level of 40.50 meters and crest elevation of dam is 43 meters which means that it can sustain a maximum water level of 5.5 meters at its full active volume of 1468157 cubic meters (Water Works Office).

Thalweg Elevation	31	m
Bottom Elevation of Weir (Spillway)	35	m
Normal Water Level	40.5	m
Maximum Water Elevation	42	m
Crest Level	43	m
Maximum Active Volume Depth	5.5	m
Dead Storage	136368	m^3
Active (Live) Storage Capacity	1468157	m^3
Spillway Type	Ogee	-
Catchment Area (Delineated from ArcGIS)	83.466	km^2

A1. Delineated Akdeniz Reservoir's Catchment with Strahler's Stream Order



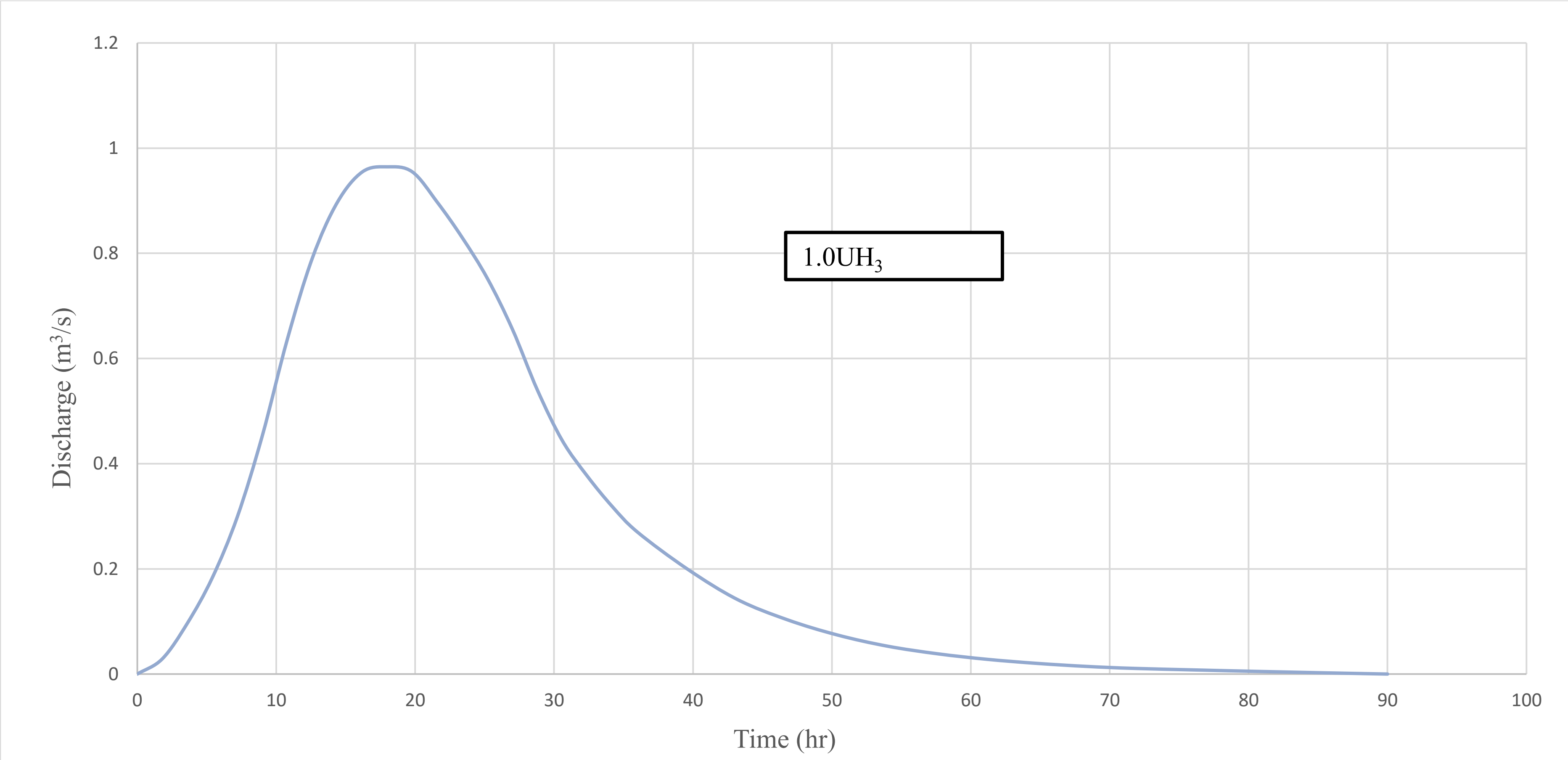
A2. Geomorphological Details of Akdeniz Reservoir's Catchment

Name of Parameter	Unit	Catchment's Value
Stream Order	-	5
Total Number of 1st Order Stream	-	362
Total Number of 2nd Order Stream	-	52
Total Number of 3rd Order Stream	-	12
Total Number of 4th Order Stream	-	3
Total Number of 5th Order Stream	-	1
Total Number of All Order Streams	-	430
Basin Length	km	16.2
Basin Perimeter	km	51.4
Length of Main Channel	km	23.4
Length of Highest Order Stream	km	12.2
Length of 1st Order Stream	km	90.1
Length of 2nd Order Stream	km	47.0
Length of 3rd Order Stream	km	24.3
Length of 4th Order Stream	km	14.2
Length of All Order Streams	km	187.8
Basin Area	km^2	83.5
Basin Maximum Elevation	m	383
Basin Minimum Elevation	m	31
Maximum Stream Elevation	m	331
Minimum Stream Elevation	m	31
Mean Bifurcation Ratio	-	5.6
Bifurcation Ratio Order 1:2	-	7.0
Bifurcation Ratio Order 2:3	-	4.3
Bifurcation Ratio Order 3:4		4.0
Bifurcation Ratio Order 4:5		3.0
Circularity Ratio	-	0.397
Quadratic Harmonic Mean Slope	-	0.009

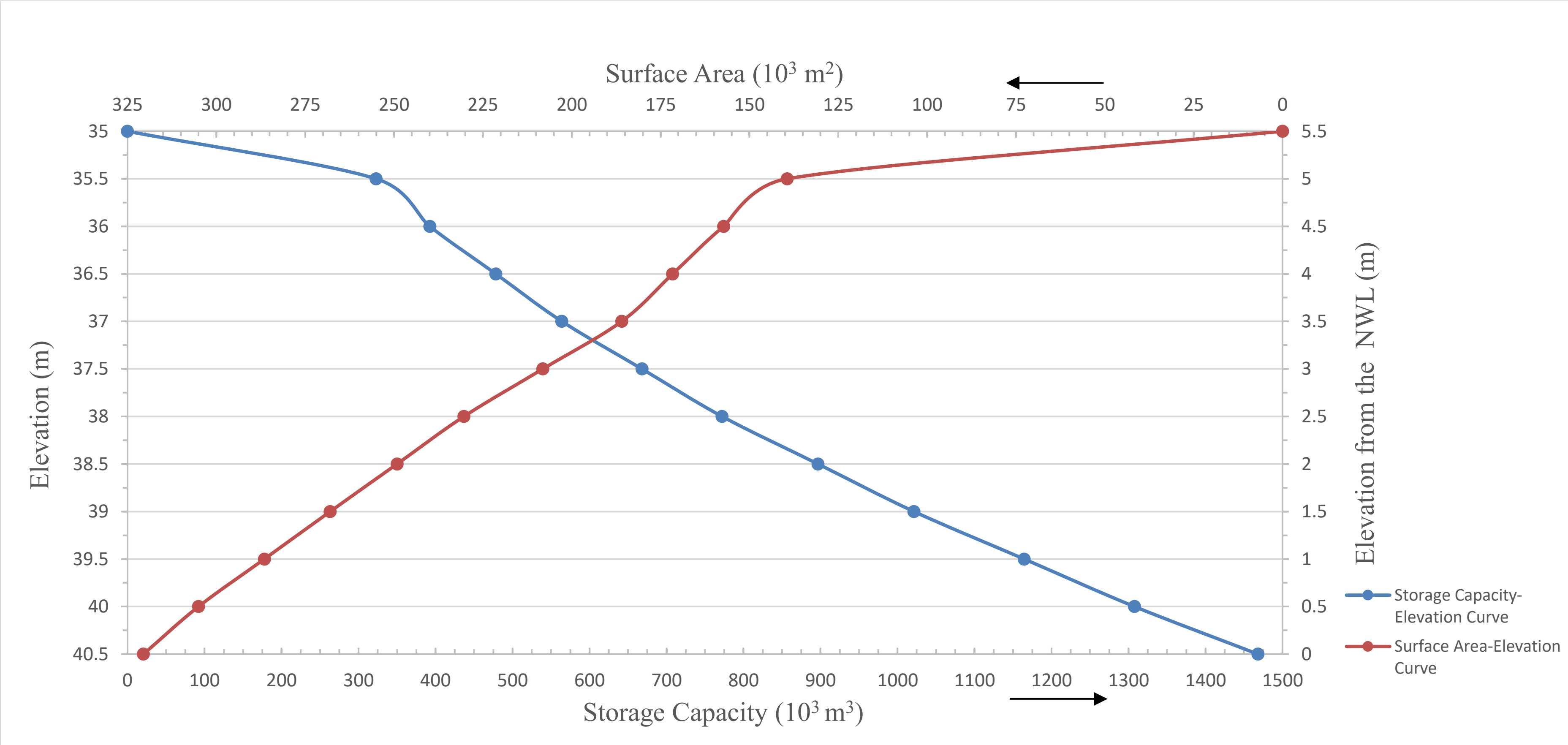
A3. Estimated Monthly Φ Index Values of Akdeniz Reservoir's Catchment (mm/hr)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2005	-	5.00	-	-	2.72	-	0.83	-
2006	-	-	-	1.62	0.83	-	-	-
2007	-	0.94	1.00	3.68	2.85	-	0.34	2.85
2008	-	-	-	-	1.42	-	-	-
2009	-	-	1.74	-	-	-	-	-
2010	-	-	-	1.76	4.43	1.21	-	0.27
2011	-	9.47	2.91	2.89	0.79	3.03	-	0.47
2012	-	5.57	1.21	2.33	-	0.58	-	3.26
2013	-	-	-	1.35	-	-	-	-
2014	-	-	1.87	-	-	-	-	-
2015	-	-	2.02	2.19	3.63	4.81	1.87	-
2016	-	-	-	-	-	7.62	-	-
2017	-	-	-	0.39	-	-	-	-
2018	-	-	2.58	7.25	-	0.84	-	-
2019	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	-
2022	-	-	-	-	-	-	-	-
Monthly Avg.	-	5.24	1.90	2.61	2.38	3.01	1.02	1.71
Total Avg.	2.55							

A4. Synthetic Unit Hydrograph of Akdeniz Reservoir's Catchment



A5. Designed Surface Area-Storage Capacity Curve of Akdeniz Reservoir



A6. Surface Area-Storage Capacity Details of Akdeniz Reservoir due to Sediment Accumulation within the Active Volume at Various Sedimentation Levels

Table A6.1. Surface Area-Storage Capacity details at sedimentation level 0.5 m.

Elevation(m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
40.5	0	320535	1145372
40	0.5	305040	985105
39.5	1	286510	841850
39	1.5	267980	698595
38.5	2	249160	574015
38	2.5	230340	449435
37.5	3	208140	345365
37	3.5	185940	241295
36.5	4	171595	155497
36	4.5	157250	69700
35.5	5	0	0

Table A6.2. Surface Area-Storage Capacity details at sedimentation level 1 m.

Elevation(m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
40.5	0	320535	1075672
40	0.5	305040	915405
39.5	1	286510	772150
39	1.5	267980	628895
38.5	2	249160	504315
38	2.5	230340	379735
37.5	3	208140	275665
37	3.5	185940	171595
36.5	4	171595	85797
36	4.5	0	0

Table A6.3. Surface Area-Storage Capacity details at sedimentation level 1.5 m.

Elevation(m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
40.5	0	320535	989875
40	0.5	305040	829608
39.5	1	286510	686353
39	1.5	267980	543098
38.5	2	249160	418518
38	2.5	230340	293938
37.5	3	208140	189868
37	3.5	185940	85798
36.5	4	0	0

Table A6.4. Surface Area-Storage Capacity details at sedimentation level 2 m.

Elevation(m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
40.5	0	320535	904077
40	0.5	305040	743810
39.5	1	286510	600555
39	1.5	267980	457300
38.5	2	249160	332720
38	2.5	230340	208140
37.5	3	208140	104070
37	3.5	0	0

Table A6.5. Surface Area-Storage Capacity at sedimentation level 2.5 m.

Elevation(m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
40.5	0	320535	800007
40	0.5	305040	639740
39.5	1	286510	496485
39	1.5	267980	353230
38.5	2	249160	228650
38	2.5	230340	104070
37.5	3	0	0

Table A6.6. Surface Area-Storage Capacity at sedimentation level 3 m.

Elevation(m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
40.5	0	320535	695937
40	0.5	305040	535670
39.5	1	286510	392415
39	1.5	267980	249160
38.5	2	249160	124580
38	2.5	0	0

Table A6.7. Surface Area-Storage Capacity details at sedimentation level 3.5 m.

Elevation(m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
40.5	0	320535	571357
40	0.5	305040	411090
39.5	1	286510	267835
39	1.5	267980	124580
38.5	2	0	0

Table A6.8. Surface Area-Storage Capacity details at sedimentation level 4 m.

Elevation(m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
40.5	0	320535	446777
40	0.5	305040	286510
39.5	1	286510	143255
39	1.5	0	0

Table A6.9. Surface Area-Storage Capacity details at sedimentation level 4.5 m.

Elevation(m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
40.5	0	320535	303522
40	0.5	305040	143255
39.5	1	0	0

Table A6.10. Surface Area-Storage Capacity details at sedimentation level 5 m.

Elevation(m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
40.5	0	320535	160267
40	0.5	0	0

A7. Estimated Monthly Evaporation Volumes from Akdeniz Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	20653	27366	33402	41222	46533	50399	43518	33218
2005-2006	19771	13750	12040	94987	16850	20451	26637	32108	36529	34833	30097	23565
2006-2007	12420	7802	7747	49687	7865	12691	15316	17927	30873	32535	26627	20304
2007-2008	14582	10245	6974	8838	7876	12622	11793	11670	13821	12139	9467	6781
2008-2009	4629	4174	4041	3314	3280	4409	5368	3654	Dry	Dry	Dry	Dry
2009-2010	Dry	Dry	Dry	Dry	12293	24122	41960	51543	63852	66171	66993	53465
2010-2011	37072	30928	21554	18889	22031	27927	34691	43688	59501	57410	57217	43188
2011-2012	31998	16647	15285	13903	22791	25225	31920	36572	48322	56819	52585	38234
2012-2013	22388	13899	10441	19472	19888	37663	53478	59528	72777	73974	62252	48632
2013-2014	36205	21452	21821	22559	32506	34225	45386	42498	57710	54072	50966	44021
2014-2015	21394	16397	13072	12647	14702	27725	35443	44405	52389	55886	49711	33611
2015-2016	21885	17613	12280	11133	19660	32780	45369	44527	50295	44763	37078	38575
2016-2017	29089	19780	8044	10725	13839	16674	26874	33546	39289	41848	39900	28868
2017-2018	20450	13702	11156	10379	19264	29034	30202	35265	42312	48260	39773	33354
2018-2019	21738	10571	13576	14757	15981	27017	35378	61706	63737	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	16150	29331	41743	63718	64080	70031	67708	55513
2021-2022	38422	23948	13626	12298	18364	25109	52948	53787	53237	55990	42348	38469
2022-2023	28524	19690	13125	-	-	-	-	-	-	-	-	-

A8. Estimated Monthly Utilized Volumes from Akdeniz Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	0	90540	0	219847	0	79517	82811	55555
2005-2006	101552	0	9093	0	0	0	40914	45945	10686	13067	15150	16395
2006-2007	21207	0	32751	0	0	5430	0	0	902	6617	8933	10275
2007-2008	16696	0	0	105891	0	3925	32720	0	1890	3517	4523	3365
2008-2009	0	2205	0	11903	0	3350	0	100237	Dry	Dry	Dry	Dry
2009-2010	Dry	Dry	Dry	0	0	0	0	0	0	0	0	278421
2010-2011	0	181015	0	127100	0	0	0	0	58882	63904	72831	0
2011-2012	138914	4282	0	0	106501	0	74387	30339	0	0	137138	0
2012-2013	111218	0	0	0	0	0	0	0	0	137618	130464	115989
2013-2014	32372	0	0	344833	158414	0	163343	0	0	209639	0	220544
2014-2015	55581	0	0	0	0	0	53543	0	53270	54463	165426	57317
2015-2016	0	132697	0	0	137750	0	0	7641	62450	67460	66706	0
2016-2017	162369	0	0	0	213517	0	130052	0	134427	0	0	82026
2017-2018	0	15214	20876	0	69397	187882	111511	0	0	125842	0	37134
2018-2019	7774	71556	0	0	0	0	0	0	0	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	0	0	25623	0	0	0	0	0
2021-2022	0	20843	54686	0	0	0	255084	0	86720	108075	101145	0
2022-2023	0	0	34160	-	-	-	-	-	-	-	-	-

A9. Estimated Monthly Effective Runoff Volumes of Akdeniz Reservoir (m^3)

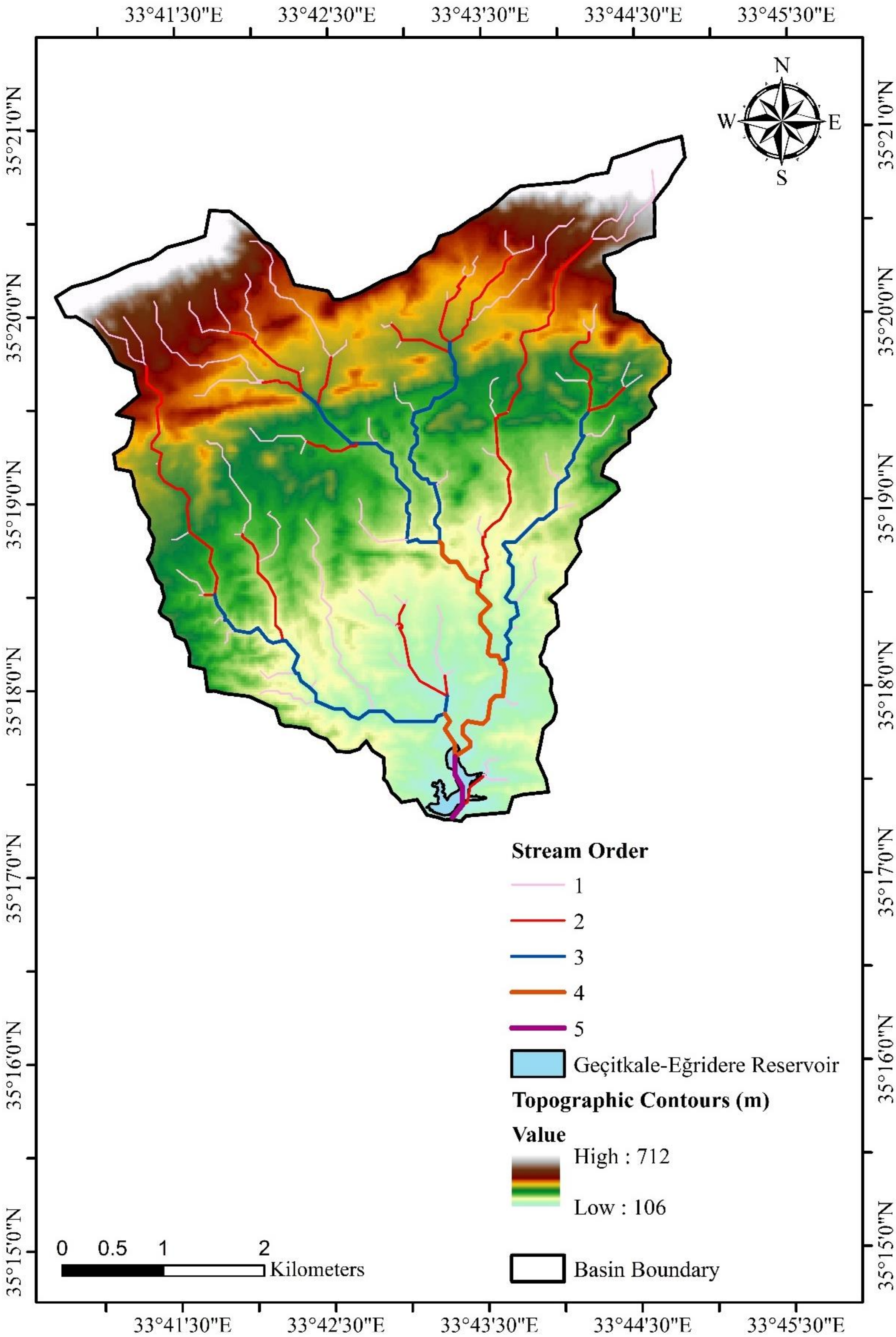
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Total
2004-2005	-	-	-	-	0	0	149484	0	149484
2005-2006	0	161015	0	94272	0	0	0	0	255288
2006-2007	0	0	0	0	0	0	0	148290	148290
2007-2008	0	0	0	0	0	0	0	0	0
2008-2009	0	0	0	0	0	0	0	0	0
2009-2010	0	0	0	0	1452740	0	0	0	1452740
2010-2011	0	0	213854	0	0	0	0	109332	323187
2011-2012	0	0	0	220212	0	84996	0	0	305208
2012-2013	0	110998	356223	376392	0	0	0	0	843613
2013-2014	0	409084	249730	0	0	411450	0	0	1070264
2014-2015	0	0	112435	245801	0	0	0	120062	478298
2015-2016	294057	0	0	0	0	159708	0	0	453765
2016-2017	0	89134	0	0	0	276527	0	150253	515913
2017-2018	118204	0	0	277749	0	0	0	111229	507182
2018-2019	0	0	1155834	0	Overflow	Overflow	Overflow	0	1155834
2019-2020	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	0	0	0	0	0
2021-2022	0	0	0	116824	0	0	0	0	116824
2022-2023	130711	246732	0	-	-	-	-	-	377443
Average	33936	63560	130505	88750	90796	58293	9343	37598	452963

Appendix B: Geçitkale-Eğridere Reservoir

Geçitkale Reservoir was constructed on Üçşehitler stream by the Republic of Turkey in 1989. Main purpose of this water reservoir is for irrigation of 24 hectares of land. However, since its completion in 1989, effective irrigation has not been possible from this reservoir. There are two main reasons for this: firstly, insufficient water supply to the reservoir during dry years due to low rainfall, and secondly, the inadequacy and deficiencies of the irrigation facilities, as well as difficulties in marketing the cultivated crops(Aksu, 2017). Its active storage volume has been reduced since its construction year and nearly 44 000 cubic meters of sediment extracted from this reservoir during the rehabilitation in September 2022, implying nearly 1571 cubic meters of accumulated sediment per year (Water Works Office).

Thalweg Elevation	94	m
Bottom Elevation of Weir (Spillway)	98.8	m
Normal Water Level	109	m
Maximum Water Elevation	110.10	m
Crest Level	111.3	m
Maximum Active Volume Depth	10.2	m
Dead Storage	76340	m^3
Active (Live) Storage Capacity	1360510	m^3
Spillway Type	Ogee	-
Catchment Area (Delineated from ArcGIS)	23.622	km^2

B1. Delineated Geçitkale-Eğridere Reservoir's Catchment with Strahler's Stream Order



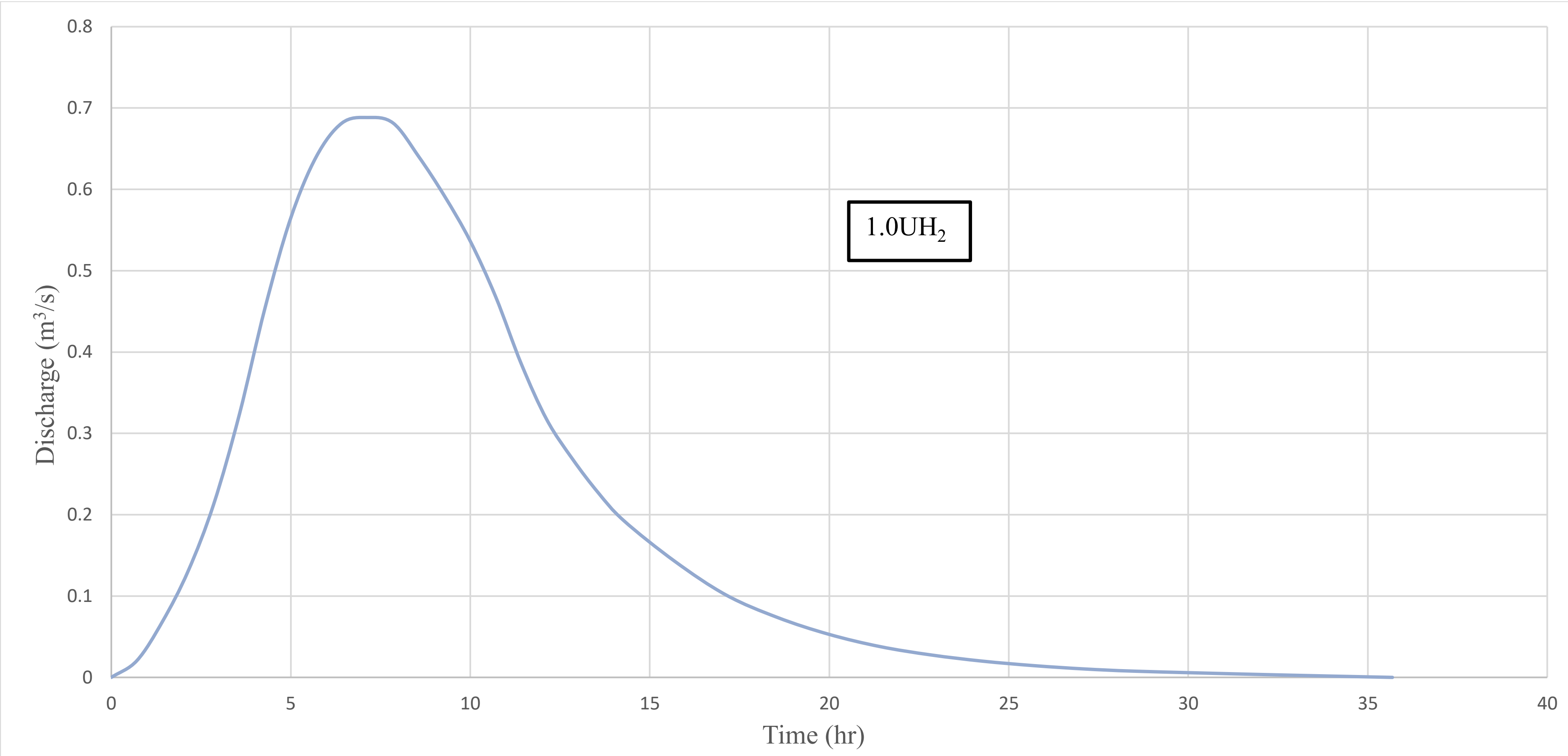
B2. Geomorphological Details of Geçitkale-Eğridere Reservoir's Catchment

Name of Parameter	Unit	Catchment's Value
Stream Order	-	5
Total Number of 1st Order Stream	-	85
Total Number of 2nd Order Stream	-	14
Total Number of 3rd Order Stream	-	5
Total Number of 4th Order Stream	-	2
Total Number of 5th Order Stream	-	1
Total Number of All Order Streams	-	107
Basin Length	km	6.8
Basin Perimeter	km	25.1
Length of Main Channel	km	8.3
Length of Highest Order Stream	km	0.7
Length of 1st Order Stream	km	27.4
Length of 2nd Order Stream	km	16.7
Length of 3rd Order Stream	km	11.6
Length of 4th Order Stream	km	3.6
Length of All Order Streams	km	59.9
Basin Area	km^2	23.6
Basin Maximum Elevation	m	712
Basin Minimum Elevation	m	106
Maximum Stream Elevation	m	510
Minimum Stream Elevation	m	106
Mean Bifurcation Ratio	-	4.4
Bifurcation Ratio Order 1:2	-	6.1
Bifurcation Ratio Order 2:3	-	2.8
Bifurcation Ratio Order 3:4		2.5
Bifurcation Ratio Order 4:5		2.0
Circularity Ratio	-	0.470
Quadratic Harmonic Mean Slope	-	0.014

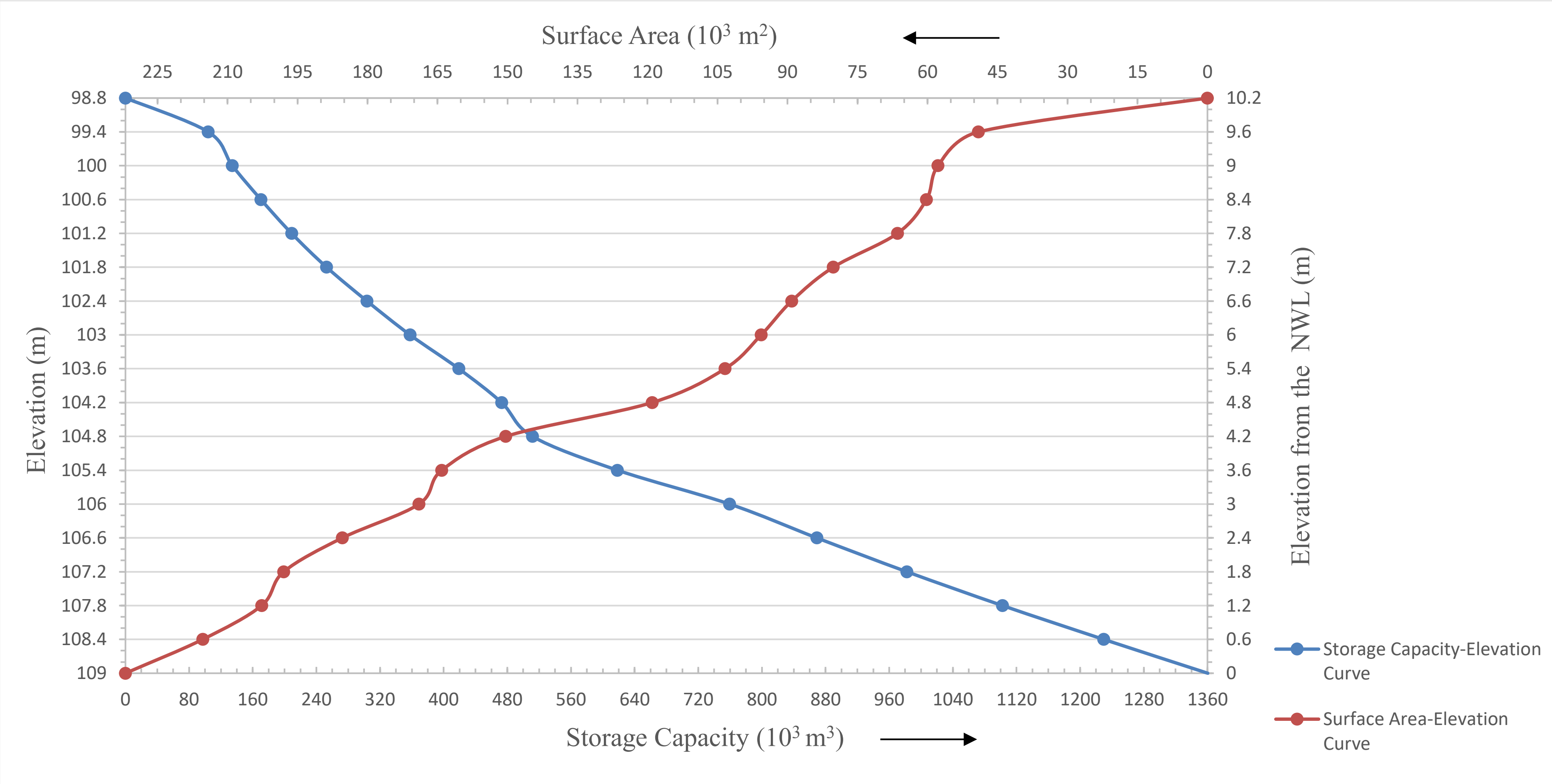
B3. Estimated Monthly Φ Index Values of Geçitkale-Eğridere Reservoir's Catchment (mm/hr)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2005	-	6.56	-	-	-	-	0.14	-
2006	-	-	-	1.98	1.32	-	-	-
2007	-	-	-	-	4.77	-	-	3.83
2008	0.12	-	2.01	-	-	-	-	1.16
2009	-	-	5.83	0.90	0.96	-	-	-
2010	-	-	1.39	-	4.97	0.07	0.18	-
2011	-	-	-	-	2.20	-	-	-
2012	-	-	-	4.22	2.51	-	-	-
2013	-	-	-	-	-	-	-	-
2014	0.73	-	0.79	-	-	-	-	-
2015	0.58	-	2.88	-	0.03	-	-	-
2016	-	2.93	5.37	0.16	-	2.58	-	-
2017	0.42	1.45	-	0.94	-	1.09	-	0.72
2018	0.67	2.19	1.31	4.15	-	-	-	-
2019	-	-	-	2.75	3.07	-	2.67	-
2020	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	-
2022	-	0.96	-	2.82	-	-	-	-
Monthly Avg.	0.50	2.82	2.80	2.24	2.48	1.25	0.99	1.91
Total Avg.	1.87							

B4. Synthetic Unit Hydrograph of Geçitkale-Eğridere Reservoir's Catchment



B5. Designed Surface Area-Storage Capacity Curve of Geçitkale-Eğridere Reservoir



B6. Surface Area-Storage Capacity Details of Geçitkale-Eğridere Reservoir due to Sediment Accumulation within the Active Volume at Various Sedimentation Levels

Table B6.1. Surface Area-Storage Capacity details at sedimentation level 1.2 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
109	0	231880	1226095
108.4	0.6	215320	1095247
107.8	1.2	202698	967949
107.2	1.8	197952	847755
106.6	2.4	185414	734619
106	3	168980	625015
105.4	3.6	164078	484060
104.8	4.2	150362	377158
104.2	4.8	119018	338362
103.6	5.4	103398	284588
103	6	95640	223325
102.4	6.6	89118	169201
101.8	7.2	80190	118456
101.2	7.8	66450	74464
100.6	8.4	60214	35880
100	9	0	0

Table B6.2. Surface Area-Storage Capacity details at sedimentation level 2.4 m..

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
109	0	231880	1151631
108.4	0.6	215320	1020783
107.8	1.2	202698	893485
107.2	1.8	197952	773291
106.6	2.4	185414	660155
106	3	168980	550551
105.4	3.6	164078	409596
104.8	4.2	150362	302694
104.2	4.8	119018	263898
103.6	5.4	103398	210124
103	6	95640	148861
102.4	6.6	89118	94737
101.8	7.2	80190	43992
101.2	7.8	0	0

Table B6.3. Surface Area-Storage Capacity details at sedimentation level 3.6 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
109	0	231880	1056894
108.4	0.6	215320	926046
107.8	1.2	202698	798748
107.2	1.8	197952	678554
106.6	2.4	185414	565418
106	3	168980	455814
105.4	3.6	164078	314859
104.8	4.2	150362	207957
104.2	4.8	119018	169161
103.6	5.4	103398	115387
103	6	95640	54124
102.4	6.6	0	0

Table B6.4. Surface Area-Storage Capacity details at sedimentation level 4.8 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
109	0	231880	941507
108.4	0.6	215320	810659
107.8	1.2	202698	683361
107.2	1.8	197952	563167
106.6	2.4	185414	450031
106	3	168980	340427
105.4	3.6	164078	199472
104.8	4.2	150362	92570
104.2	4.8	119018	53774
103.6	5.4	0	0

Table B6.5. Surface Area-Storage Capacity details at sedimentation level 6 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
109	0	231880	848937
108.4	0.6	215320	718089
107.8	1.2	202698	590791
107.2	1.8	197952	470597
106.6	2.4	185414	357461
106	3	168980	247857
105.4	3.6	164078	106902
104.8	4.2	0	0

Table B6.6. Surface Area-Storage Capacity details at sedimentation level 7.2 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
109	0	231880	601080
108.4	0.6	215320	470232
107.8	1.2	202698	342934
107.2	1.8	197952	222740
106.6	2.4	185414	109604
106	3	0	0

Table B6.7. Surface Area-Storage Capacity details at sedimentation level 8.4 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
109	0	231880	378340
108.4	0.6	215320	247492
107.8	1.2	202698	120194
107.2	1.8	0	0

Table B6.8. Surface Area-Storage Capacity details at sedimentation level 9.6 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
109	0	231880	130848
108.4	0.6	0	0

B7. Estimated Monthly Evaporation Volumes from Geçitkale-Eğridere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	19033	26706	28721	37768	44078	48545	38297	34631
2005-2006	28117	16346	11592	115134	16068	21264	29251	35252	38844	36169	35335	33204
2006-2007	21243	12801	12340	67016	9610	13738	13602	15363	23045	25897	22951	18295
2007-2008	12335	3061	Dry	Dry	Dry	Dry	689	11154	24373	23053	17160	12049
2008-2009	14116	9768	9416	15097	13061	15704	16522	21449	19569	22220	21481	15878
2009-2010	11001	7179	6659	5096	7590	14348	24437	25798	32006	38055	37864	23706
2010-2011	12590	7446	5937	6720	7700	3488	Dry	Dry	Dry	Dry	Dry	Dry
2011-2012	Dry	230	264	764	3277	4133	Dry	Dry	Dry	Dry	Dry	Dry
2012-2013	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2013-2014	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2014-2015	3941	4239	3411	18632	8394	13597	8159	Dry	10346	12946	Dry	Dry
2015-2016	6877	6427	811	4388	8676	10302	Dry	Dry	Dry	Dry	Dry	Dry
2016-2017	Dry	Dry	6482	7905	10914	12642	16994	19122	22370	23000	18729	16445
2017-2018	12348	11628	6578	8932	8676	12617	14846	14914	12228	9849	7752	3285
2018-2019	4475	6857	8017	12431	17037	22439	21403	31635	32061	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	18277	22986	23650	32174	29973	37520	37859	26913
2021-2022	18728	13029	11890	8343	11560	11993	15619	18060	27185	37212	29157	21452
2022-2023	16674	12468	9930	-	-	-	-	-	-	-	-	-

B8. Estimated Monthly Utilized Volumes from Geçitkale-Eğridere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	47008	104362	0	115815	0	172384	154126	0
2005-2006	212531	0	75994	0	0	43790	122340	0	49378	0	47478	37023
2006-2007	91464	23266	40165	0	0	37780	19272	0	0	0	0	0
2007-2008	204405	122082	Dry	Dry	Dry	Dry	0	0	44731	49956	48088	42409
2008-2009	0	73490	0	0	0	204240	62524	55527	66461	0	60815	0
2009-2010	31232	355	0	29354	0	0	0	0	0	2516	4756	239432
2010-2011	13750	7181	0	66957	0	178742	Dry	Dry	Dry	Dry	Dry	Dry
2011-2012	Dry	0	3780	0	0	117135	Dry	Dry	Dry	Dry	Dry	Dry
2012-2013	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2013-2014	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2014-2015	0	0	0	0	0	445	395934	Dry	0	361237	Dry	Dry
2015-2016	0	265590	0	0	46178	0	248472	Dry	Dry	Dry	Dry	Dry
2016-2017	Dry	Dry	0	0	133991	0	57018	0	93906	0	36474	37744
2017-2018	0	0	134471	0	31154	39038	0	90355	114927	16976	0	68704
2018-2019	0	0	0	0	0	0	0	0	0	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	2488	0	51314	0	9900	0	0	0
2021-2022	25500	22297	39638	0	0	0	59577	42148	0	55426	52361	0
2022-2023	0	0	133854	-	-	-	-	-	-	-	-	-

B9. Estimated Monthly Effective Runoff Volumes of Geçitkale-Eğridere Reservoir (m^3)

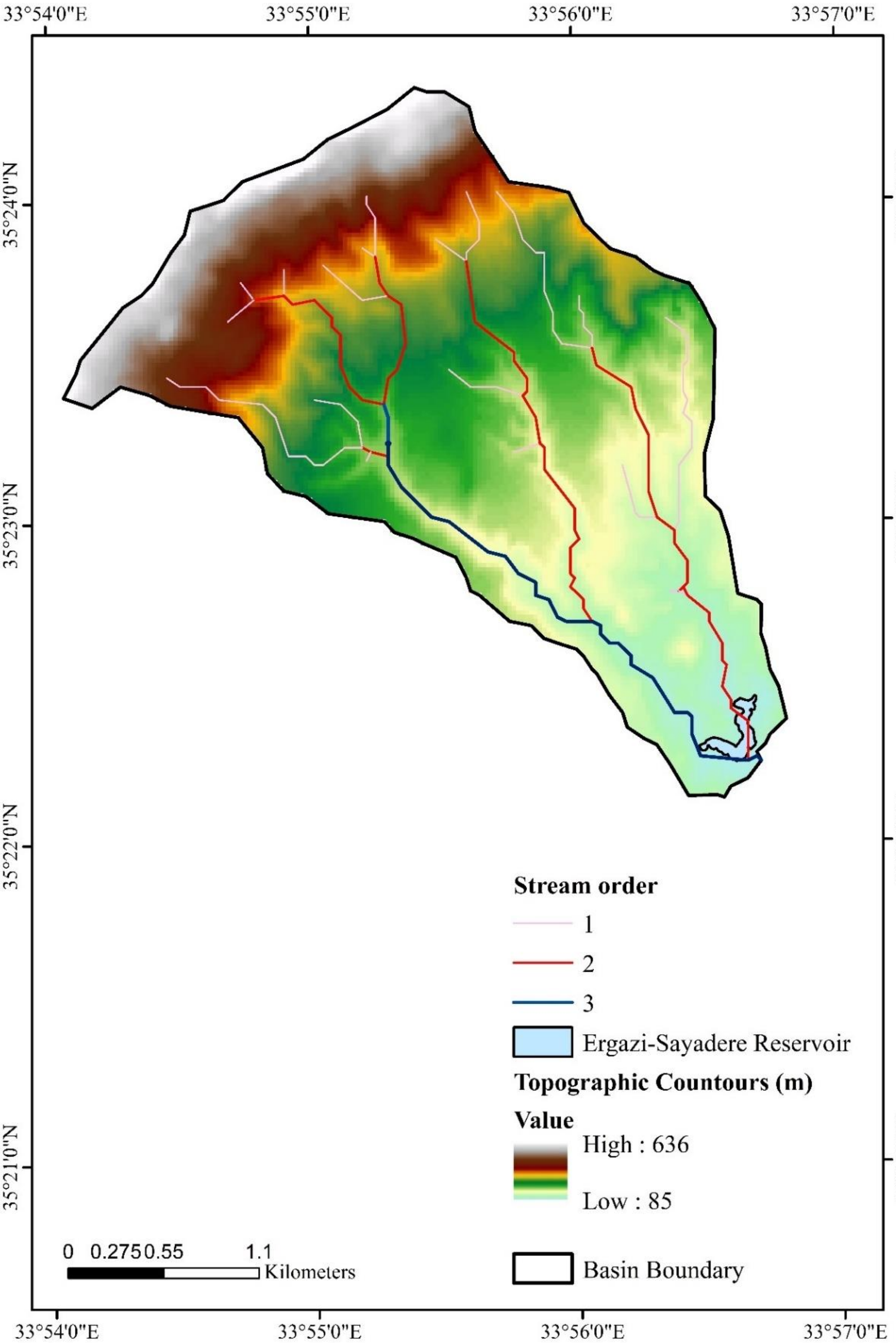
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Total
2004-2005	-	-	-	-	0	0	104270	0	104270
2005-2006	0	266994	0	321501	37310	0	0	0	625806
2006-2007	0	0	0	0	63764	0	0	99130	162894
2007-2008	0	0	0	0	0	0	0	388473	388473
2008-2009	246783	0	184566	113583	45558	0	0	0	590489
2009-2010	0	0	52016	0	170792	76696	53989	0	353494
2010-2011	0	0	27033	0	25589	0	0	0	52622
2011-2012	0	0	0	25716	89587	0	0	0	115304
2012-2013	0	0	0	0	0	0	0	0	0
2013-2014	0	0	0	0	0	0	0	0	0
2014-2015	95857	0	71200	0	271396	0	0	0	438453
2015-2016	272160	0	35478	221284	0	54983	0	0	583906
2016-2017	0	69419	191460	158091	0	179449	0	94464	692883
2017-2018	84253	101528	0	145000	0	0	0	0	330780
2018-2019	119394	43242	294996	118302	156086	0	84611	0	816630
2019-2020	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	0	0	0	0	0
2021-2022	0	0	0	58862	0	0	0	0	58862
2022-2023	0	86384	0	-	-	-	-	-	86384
Average	51153	35473	53547	77489	50593	18302	14286	34239	300069

Appendix C: Ergazi-Sayadere Reservoir

The reservoir is located in the Sayadere basin over the Büyükkuyu stream, with a catchment area of 7.769 km^2. Ergazi Reservoir is considered a small water reservoir with an active storage capacity of 405 025 m^3 and is constructed for irrigation purposes, with a designated irrigation area of 84 hectares (Water Works Office).. At the first years after construction, irrigation took place by 5800 meters long open channel however due to loss of water from the channel as a result of high rate of evaporation, resulting ineffective irrigation so, irrigation channel reconstructed as a closed conduit (Şener, 1997).

Thalweg Elevation	65	m
Bottom Elevation of Weir (Spillway)	71	m
Normal Water Level	81.50	m
Maximum Water Elevation	82.60	m
Crest Level	83.50	m
Maximum Active Volume Depth	10.5	m
Dead Storage	19.055	m^3
Active (Live) Storage Capacity	405025	m^3
Spillway Type	Ogee	-
Catchment Area (Delineated from ArcGIS)	7.769	km^2

C1. Delineated Ergazi-Sayadere Reservoir's Catchment with Strahler's Stream Order



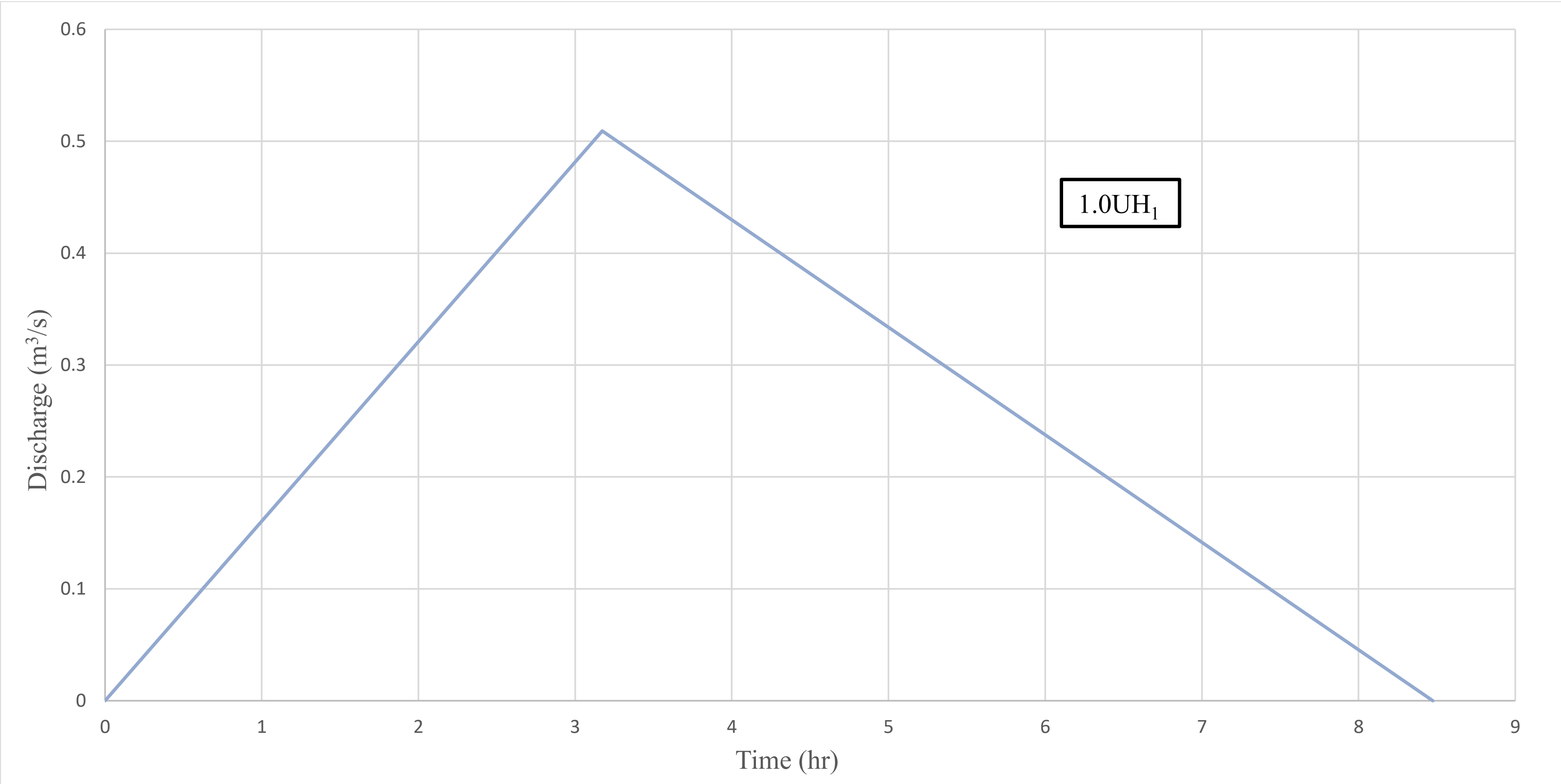
C2. Geomorphological Details of Ergazi-Sayadere Reservoir's Catchment

Name of Parameter	Unit	Catchment's Value
Stream Order	-	3
Total Number of 1st Order Stream	-	19
Total Number of 2nd Order Stream	-	5
Total Number of 3rd Order Stream	-	1
Total Number of All Order Streams	-	25
Basin Length	km	4.6
Basin Perimeter	km	13.2
Length of Main Channel	km	4.8
Length of Highest Order Stream	km	3.4
Length of 1st Order Stream	km	8.0
Length of 2nd Order Stream	km	7.5
Length of All Order Streams	km	18.9
Basin Area	km^2	7.8
Basin Maximum Elevation	m	636
Basin Minimum Elevation	m	85
Maximum Stream Elevation	m	390
Minimum Stream Elevation	m	85
Mean Bifurcation Ratio	-	4.4
Bifurcation Ratio Order 1:2	-	3.8
Bifurcation Ratio Order 2:3	-	5.0
Circularity Ratio	-	0.562
Quadratic Harmonic Mean Slope	-	0.040

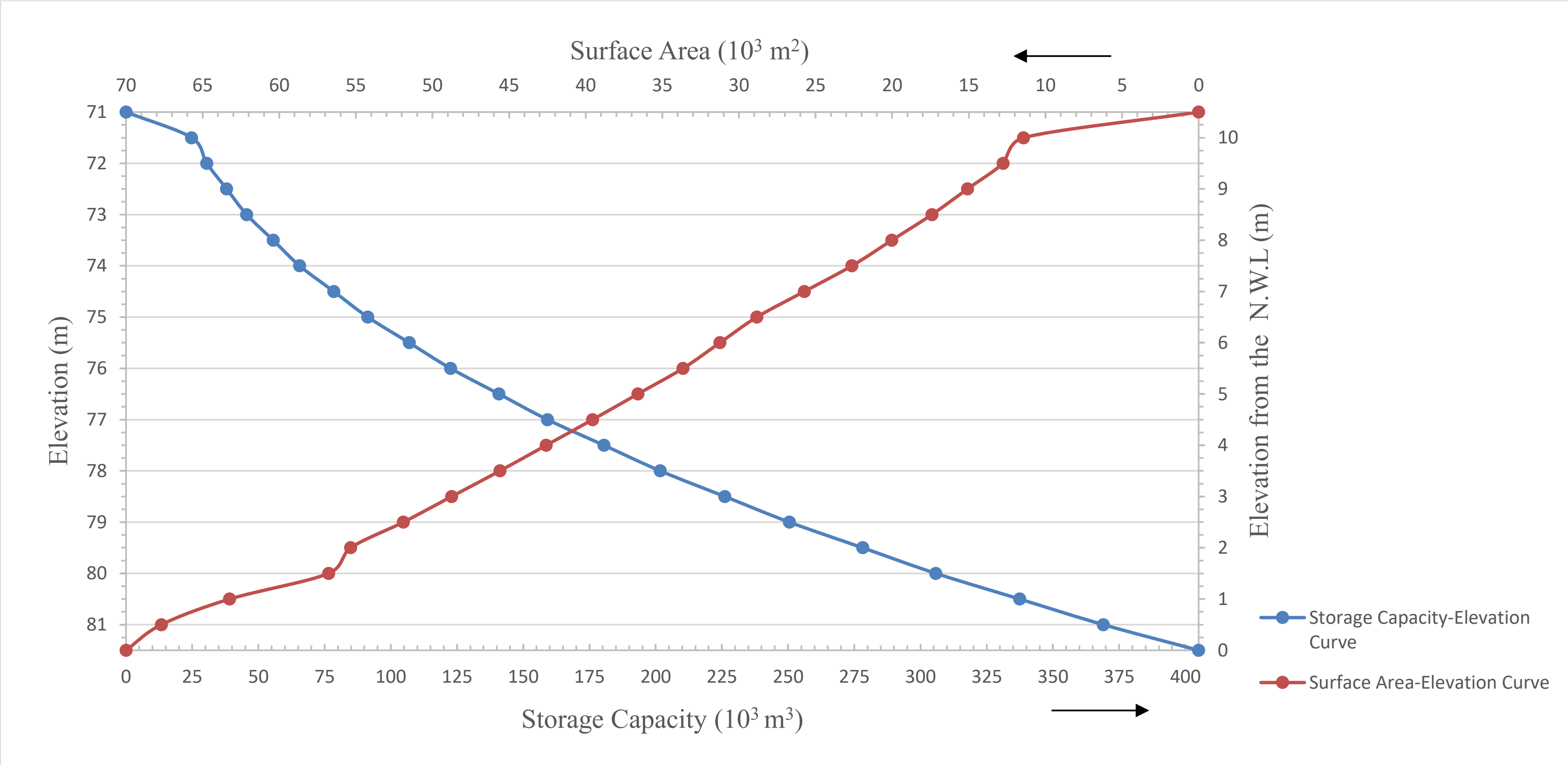
C3. Estimated Monthly Φ Index Values of Ergazi-Sayadere Reservoir's Catchment (mm/hr)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2005	-	6.56	-	-	-	-	0.14	-
2006	-	-	-	1.98	1.32	-	-	-
2007	-	-	-	-	4.77	-	-	3.83
2008	0.12	-	2.01	-	-	-	-	1.16
2009	-	-	5.83	0.90	0.96	-	-	-
2010	-	-	1.39	-	4.97	0.07	0.18	-
2011	-	-	-	-	2.20	-	-	-
2012	-	-	-	4.22	2.51	-	-	-
2013	-	-	-	-	-	-	-	-
2014	0.73	-	0.79	-	-	-	-	-
2015	0.58	-	2.88	-	0.03	-	-	-
2016	-	2.93	5.37	0.16	-	2.58	-	-
2017	0.42	1.45	-	0.94	-	1.09	-	0.72
2018	0.67	2.19	1.31	4.15	-	-	-	-
2019	-	-	-	2.75	3.07	-	2.67	-
2020	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	-
2022	-	0.96	-	2.82	-	-	-	-
Monthly Avg.	0.50	2.82	2.80	2.24	2.48	1.25	0.99	1.91
Total Avg.	1.87							

C4. Synthetic Unit Hydrograph of Ergazi-Sayadere Reservoir's Catchment



C5. Designed Surface Area-Storage Capacity Curve of Ergazi-Sayadere Reservoir



C6. Surface Area-Storage Capacity Details of Ergazi-Sayadere Reservoir due to Sediment Accumulation within the Active Volume at Various Sedimentation Levels

Table C6.1. Surface Area-Storage Capacity details at sedimentation level 1 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
81.5	0	70000	374545
81	0.5	67690	338575
80.5	1	63235	306957
80	1.5	56780	275340
79.5	2	55340	247670
79	2.5	51900	220000
78.5	3	48750	195625
78	3.5	45600	171250
77.5	4	42575	149962
77	4.5	39550	128675
76.5	5	36600	110375
76	5.5	33650	92075
75.5	6	31240	76455
75	6.5	28830	60835
74.5	7	25730	47970
74	7.5	22630	35105
73.5	8	20020	25095
73	8.5	17410	15085
72.5	9	15085	7542
72	9.5	0	0

Table C6.2. Surface Area-Storage Capacity details at sedimentation level 2 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
81.5	0	70000	359460
81	0.5	67690	323490
80.5	1	63235	291872
80	1.5	56780	260255
79.5	2	55340	232585
79	2.5	51900	204915
78.5	3	48750	180540
78	3.5	45600	156165
77.5	4	42575	134877
77	4.5	39550	113590
76.5	5	36600	95290
76	5.5	33650	76990
75.5	6	31240	61370
75	6.5	28830	45750
74.5	7	25730	32885
74	7.5	22630	20020
73.5	8	20020	10010
73	8.5	0	0

Table C6.3. Surface Area-Storage Capacity details at sedimentation level 3 m.

Elevation(m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
81.5	0	70000	339440
81	0.5	67690	303470
80.5	1	63235	271852
80	1.5	56780	240235
79.5	2	55340	212565
79	2.5	51900	184895
78.5	3	48750	160520
78	3.5	45600	136145
77.5	4	42575	114857
77	4.5	39550	93570
76.5	5	36600	75270
76	5.5	33650	56970
75.5	6	31240	41350
75	6.5	28830	25730
74.5	7	25730	12865
74	7.5	0	0

Table C6.4. Surface Area-Storage Capacity details at sedimentation level 4 m.

Elevation(m)	Elevation from NWL (m)	Area(m^2)	Storage Capacity (m^3)
81.5	0	70000	313710
81	0.5	67690	277740
80.5	1	63235	246122
80	1.5	56780	214505
79.5	2	55340	186835
79	2.5	51900	159165
78.5	3	48750	134790
78	3.5	45600	110415
77.5	4	42575	89127
77	4.5	39550	67840
76.5	5	36600	49540
76	5.5	33650	31240
75.5	6	31240	15620
75	6.5	0	0

Table C6.5. Surface Area-Storage Capacity details at sedimentation level 5 m.

Elevation(m)	Elevation from NWL (m)	Area(m^2)	Storage Capacity (m^3)
81.5	0	70000	282470
81	0.5	67690	246500
80.5	1	63235	214882
80	1.5	56780	183265
79.5	2	55340	155595
79	2.5	51900	127925
78.5	3	48750	103550
78	3.5	45600	79175
77.5	4	42575	57887
77	4.5	39550	36600
76.5	5	36600	18300
76	5.5	0	0

Table C6.6. Surface Area-Storage Capacity details at sedimentation level 6 m.

Elevation(m)	Elevation from NWL (m)	Area(m^2)	Storage Capacity (m^3)
81.5	0	70000	245870
81	0.5	67690	209900
80.5	1	63235	178282
80	1.5	56780	146665
79.5	2	55340	118995
79	2.5	51900	91325
78.5	3	48750	66950
78	3.5	45600	42575
77.5	4	42575	21287
77	4.5	0	0

Table C6.7. Surface Area-Storage Capacity details at sedimentation level 7 m.

Elevation(m)	Elevation from NWL (m)	Area(m^2)	Storage Capacity (m^3)
81.5	0	70000	203295
81	0.5	67690	167325
80.5	1	63235	135707
80	1.5	56780	104090
79.5	2	55340	76420
79	2.5	51900	48750
78.5	3	48750	24375
78	3.5	0	0

Table C6.8. Surface Area-Storage Capacity details at sedimentation level 8 m.

Elevation(m)	Elevation from NWL (m)	Area(m^2)	Storage Capacity (m^3)
81.5	0	70000	154545
81	0.5	67690	118575
80.5	1	63235	86957
80	1.5	56780	55340
79.5	2	55340	27670
79	2.5	0	0

Table C6.9. Surface Area-Storage Capacity details at sedimentation level 9 m.

Elevation(m)	Elevation from NWL (m)	Area(m^2)	Storage Capacity (m^3)
81.5	0	70000	99205
81	0.5	67690	63235
80.5	1	63235	31617
80	1.5	0	0

Table C6.10. Surface Area-Storage Capacity details at sedimentation level 10 m.

Elevation(m)	Elevation from NWL (m)	Area(m^2)	Storage Capacity (m^3)
81.5	0	70000	35970
81	0.5	0	0

C7. Estimated Monthly Evaporation Volumes from Ergazi-Sayadere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	4710	6043	6576	9531	12246	14166	11115	9148
2005-2006	6259	3746	2820	30996	4719	6605	9621	11410	12197	11381	10924	9613
2006-2007	7058	5274	5263	28197	4416	7211	7526	8409	12203	13282	11290	8581
2007-2008	7125	4572	4185	31308	5788	6608	7823	8619	9592	9884	8612	7025
2008-2009	4310	1371	1594	3049	3023	4465	6022	8344	8325	7886	6174	4149
2009-2010	2402	1415	1647	1928	3281	4779	5925	6617	8630	9229	9235	6177
2010-2011	3903	2442	1884	2144	2440	2102	2257	1662	Dry	Dry	Dry	Dry
2011-2012	Dry	320	357	668	2017	4778	5926	5523	6247	6107	4793	2933
2012-2013	2142	1848	1341	2041	2442	3903	5619	7339	8032	7192	5778	4984
2013-2014	4817	2452	2387	2184	2557	3446	4047	3168	2072	Dry	Dry	Dry
2014-2015	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2015-2016	Dry	Dry	464	1328	2291	2618	1750	Dry	Dry	Dry	Dry	Dry
2016-2017	Dry	Dry	1276	2239	3078	3460	4808	5587	6598	6795	5353	4529
2017-2018	3115	3108	1930	2646	2571	3529	3552	3971	5020	5335	4379	2813
2018-2019	1926	1938	2809	4223	6205	8966	8269	11863	11960	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	6251	7790	7934	10780	9944	12269	12289	8706
2021-2022	6507	4982	4676	3332	4502	4480	5722	7296	9268	10697	9912	8102
2022-2023	6109	4281	3322	-	-	-	-	-	-	-	-	-

C8. Estimated Monthly Utilized Volumes from Akdeniz Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	47008	104362	0	115815	0	172384	154126	0
2005-2006	212531	0	75994	0	0	43790	122340	0	49378	0	47478	37023
2006-2007	91464	23266	40165	0	0	37780	19272	0	0	0	0	0
2007-2008	204405	122082	Dry	Dry	Dry	Dry	0	0	44731	49956	48088	42409
2008-2009	0	73490	0	0	0	204240	62524	55527	66461	0	60815	0
2009-2010	31232	355	0	29354	0	0	0	0	0	2516	4756	239432
2010-2011	13750	7181	0	66957	0	178742	Dry	Dry	Dry	Dry	Dry	Dry
2011-2012	Dry	0	3780	0	0	117135	Dry	Dry	Dry	Dry	Dry	Dry
2012-2013	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2013-2014	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2014-2015	0	0	0	0	0	445	395934	Dry	0	361237	Dry	Dry
2015-2016	0	265590	0	0	46178	0	248472	Dry	Dry	Dry	Dry	Dry
2016-2017	Dry	Dry	0	0	133991	0	57018	0	93906	0	36474	37744
2017-2018	0	0	134471	0	31154	39038	0	90355	114927	16976	0	68704
2018-2019	0	0	0	0	0	0	0	0	0	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	2488	0	51314	0	9900	0	0	0
2021-2022	25500	22297	39638	0	0	0	59577	42148	0	55426	52361	0
2022-2023	0	0	133854	-	-	-	-	-	-	-	-	-

C9. Estimated Monthly Effective Runoff Volumes of Akdeniz Reservoir (m^3)

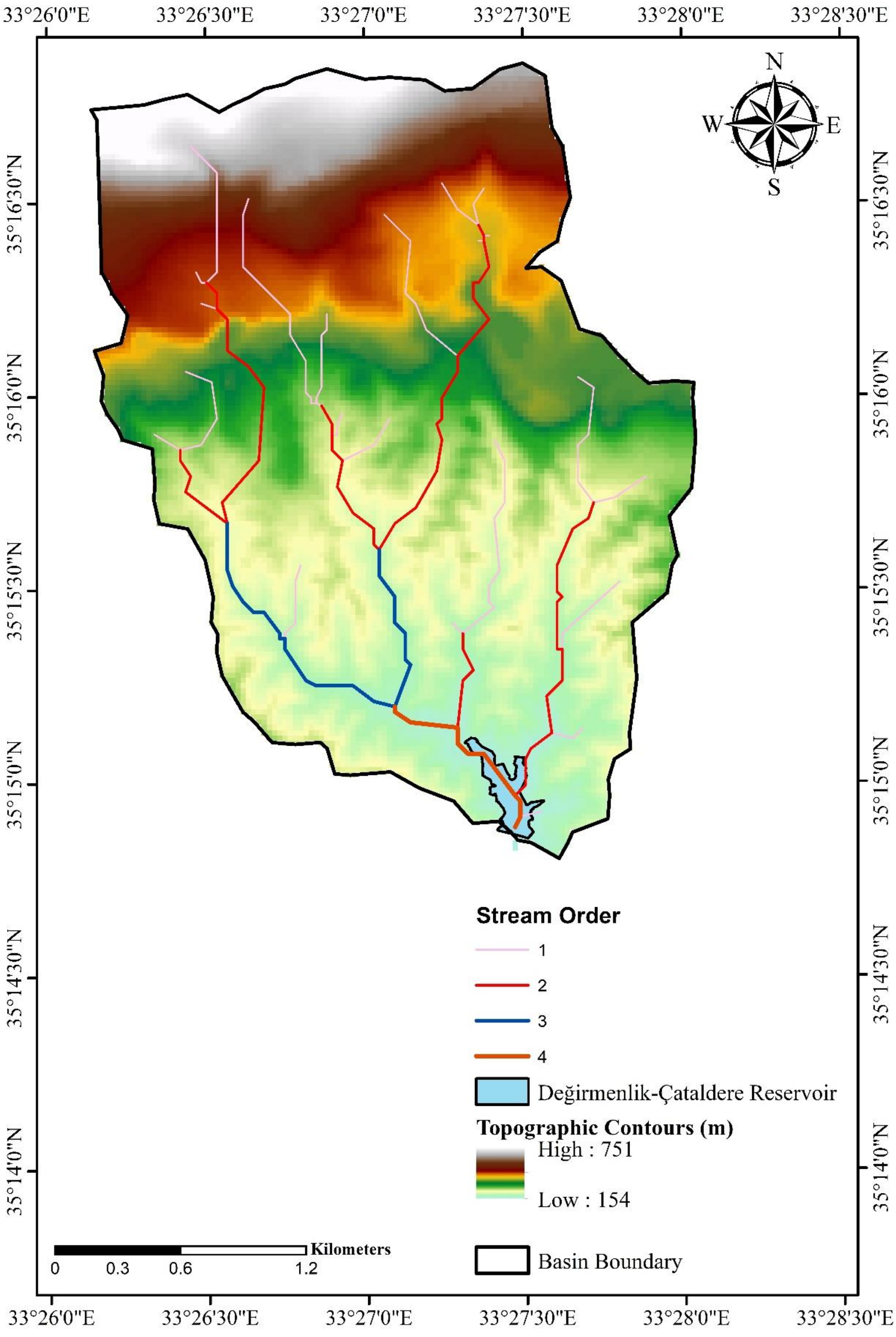
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Total
2004-2005	-	-	-	-	0	0	70718	0	70718
2005-2006	0	84348	0	173765	0	45565	0	0	303678
2006-2007	29327	0	0	0	102715	17372	0	43550	192964
2007-2008	0	0	63019	0	22258	0	40030	0	125308
2008-2009	0	0	33275	75890	33615	0	0	0	142780
2009-2010	0	0	45999	61644	46541	0	0	55386	209569
2010-2011	0	0	9243	0	0	0	0	0	9243
2011-2012	0	9987	0	28153	84078	14833	0	0	137051
2012-2013	0	9912	18835	12803	0	37140	48662	0	127351
2013-2014	0	0	37901	0	0	20453	0	0	58354
2014-2015	0	0	0	0	0	0	0	0	0
2015-2016	0	0	23042	42047	0	0	0	0	65089
2016-2017	0	0	76310	40868	0	44529	0	33463	195171
2017-2018	0	45456	0	34878	0	0	0	24427	104762
2018-2019	0	32762	125356	91900	123248	Overflow	Overflow	0	373266
2019-2020	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	0	0	0	0	0
2021-2022	0	0	0	41576	0	0	0	42837	84413
2022-2023	17018	43341	0	-	-	-	-	-	60360
Average	2897	14113	27061	40235	24262	11243	9963	11745	125560

Appendix D: Değirmenlik-Çataldere Reservoir

The reservoir was constructed in the Değirmenlik village of Nicosia Region of TRNC in 1990 by Water Works Office. Construction of the reservoir started in 1989 and was completed by the year 1990. Its main aim is to irrigate 30 hectares of land. There is a high elevation difference between irrigation field and the reservoir which provides more energy efficient irrigation by the help of gravity (Şener, 1997). During September 2022, accumulated sediments of the reservoir were removed by Water Works Office for the first time after its construction where nearly 85 000 cubic meters of sediment was extracted implying nearly 2656 cubic meters of accumulated sediment per year (Water Works Office).

Thalweg Elevation	154.50	m
Bottom Elevation of Weir (Spillway)	158.56	m
Normal Water Level	166.36	m
Maximum Water Elevation	167.56	m
Crest Level	168.41	m
Maximum Active Volume Depth	7.8	m
Dead Storage	36.364	m^3
Active (Live) Storage Capacity	296814	m^3
Spillway Type	Ogee	-
Catchment Area (Delineated from ArcGIS)	7.505	km^2

D1. Delineated Değirmenlik-Çataldere Reservoir's Catchment with Strahler's Stream Order



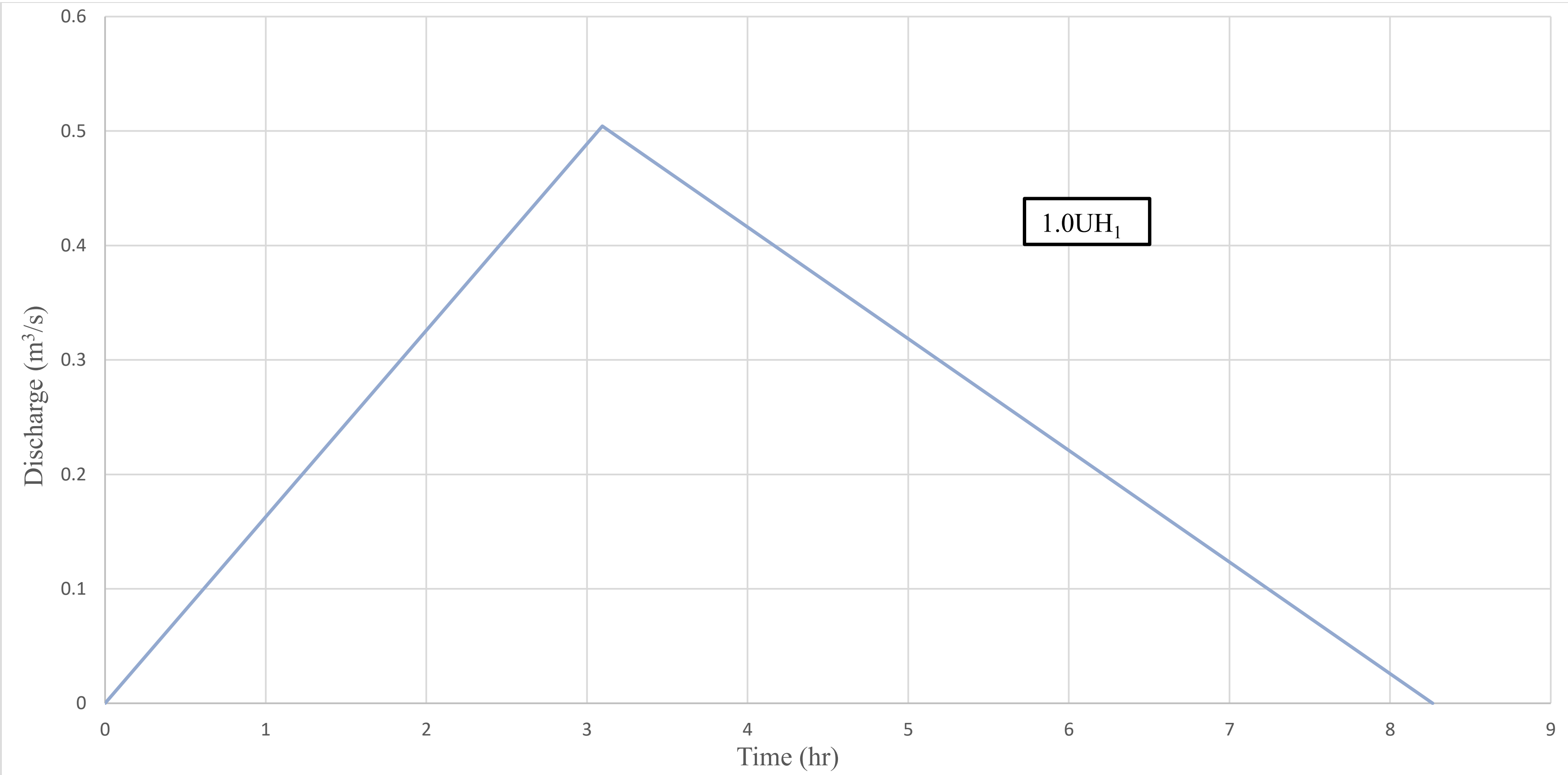
D2. Geomorphological Details of Değirmenlik-Çataldere Reservoir's Catchment

Name of Parameter	Unit	Catchment's Value
Stream Order	-	4
Total Number of 1st Order Stream	-	32
Total Number of 2nd Order Stream	-	6
Total Number of 3rd Order Stream	-	2
Total Number of 4th Order Stream	-	1
Total Number of All Order Streams	-	41
Basin Length	km	4.0
Basin Perimeter	km	12.2
Length of Main Channel	km	4.4
Length of Highest Order Stream	km	0.98
Length of 1st Order Stream	km	8.2
Length of 2nd Order Stream	km	6.5
Length of 3rd Order Stream	km	2.2
Length of All Order Streams	km	17.9
Basin Area	km^2	7.5
Basin Maximum Elevation	m	751
Basin Minimum Elevation	m	154
Maximum Stream Elevation	m	602
Minimum Stream Elevation	m	160
Mean Bifurcation Ratio	-	4.2
Bifurcation Ratio Order 1:2	-	5.3
Bifurcation Ratio Order 2:3	-	3.0
Circularity Ratio	-	0.639
Quadratic Harmonic Mean Slope	-	0.036

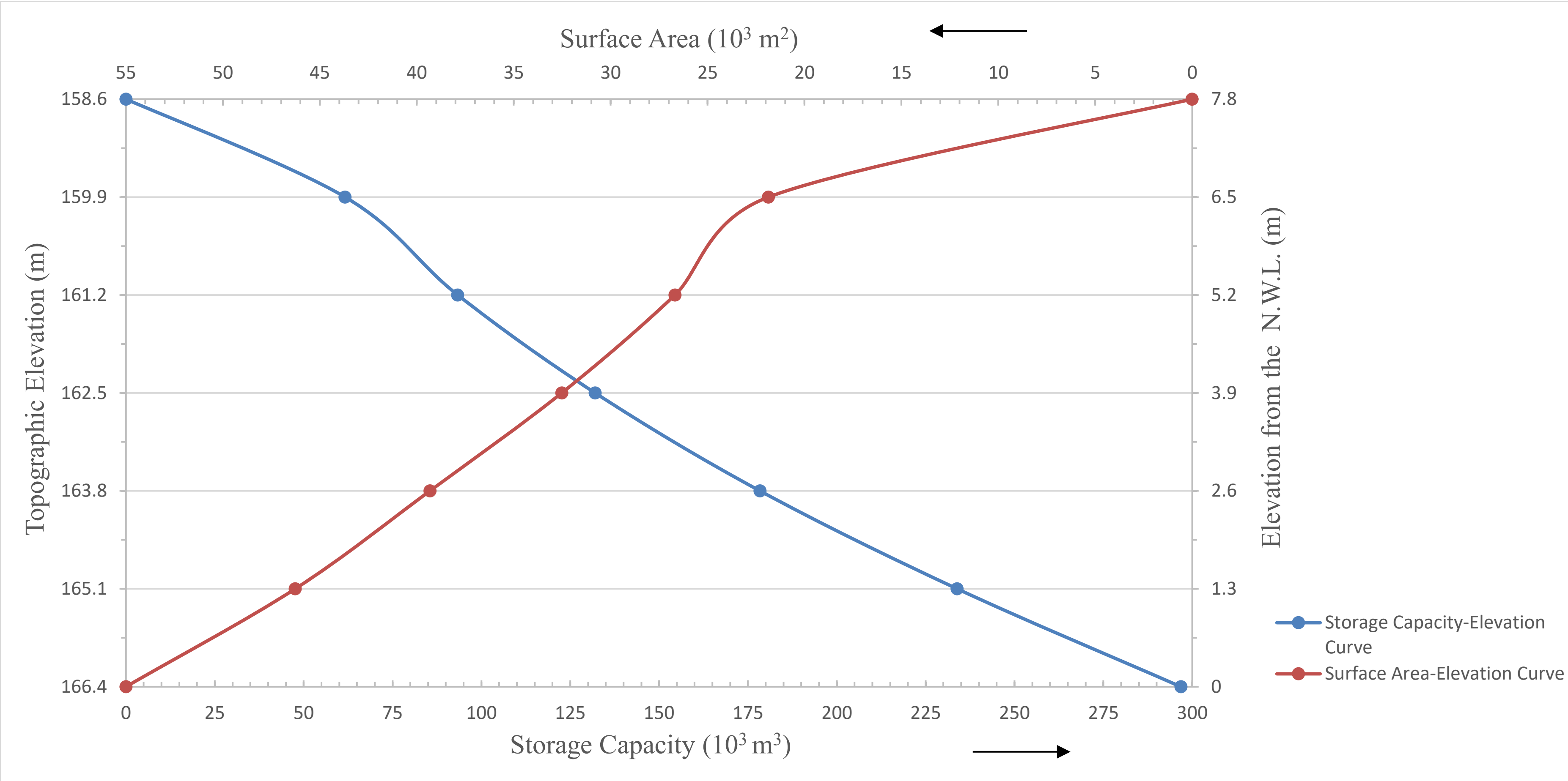
D3. Estimated Monthly Φ Index Values of Reservoir's Catchment (mm/hr)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2005	-	5.89	-	-	-	-	0.16	-
2006	0.77	-	-	0.56	0.57	1.01	-	0.40
2007	0.08	-	0.16	-	1.45	-	-	2.23
2008	-	-	-	-	0.16	-	-	-
2009	-	-	1.69	0.27	-	-	-	-
2010	-	-	0.33	0.42	3.45	-	-	-
2011	-	3.03	-	0.61	2.04	-	1.49	0.86
2012	1.84	-	0.50	0.67	-	-	-	-
2013	1.70	-	1.11	0.51	-	-	0.86	2.45
2014	-	-	-	-	-	-	-	-
2015	0.20	-	-	-	0.07	3.83	-	-
2016	-	-	1.36	1.62	-	-	-	-
2017	-	-	-	-	-	0.17	0.75	-
2018	0.21	-	0.99	2.62	-	-	-	-
2019	-	-	-	0.79	3.12	-	-	-
2020	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	-
2022	-	-	-	-	-	-	-	-
Monthly Avg.	0.80	4.46	0.88	0.90	1.55	1.67	0.82	1.48
Total Avg.	1.57							

D4. Synthetic Unit Hydrograph of Değirmenlik-Çataldere Reservoir's Catchment



D5. Designed Surface Area-Storage Capacity Curve of Değirmenlik-Çataldere Reservoir



D6. Surface Area-Storage Capacity Details of Değirmenlik-Çataldere Reservoir due to Sediment Accumulation within the Active Volume at Various Sedimentation Levels

Table D6.1. Surface Area-Storage Capacity details at sedimentation level 1.3 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
166.4	0	55000	235148
165.1	1.3	46267.5	172186
163.8	2.6	39320	116702
162.5	3.9	32520	70336
161.2	5.2	26680	31680
159.9	6.5	0	0

Table D6.2. Surface Area-Storage Capacity details at sedimentation level 2.6 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
166.4	0	55000	203468
165.1	1.3	46267.5	140506
163.8	2.6	39320	85022
162.5	3.9	32520	38656
161.2	5.2	0	0

Table D6.3. Surface Area-Storage Capacity details at sedimentation level 3.9 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
166.4	0	55000	164812
165.1	1.3	46267.5	101850
163.8	2.6	39320	46366
162.5	3.9	0	0

Table D6.4. Surface Area-Storage Capacity details at sedimentation level 5.2 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
166.4	0	55000	118446
165.1	1.3	46267.5	55484
163.8	2.6	0	0

Table D6.5. Surface Area-Storage Capacity details at sedimentation level 6.5 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
166.4	0	55000	62962
165.1	1.3	0	0

D7. Estimated Monthly Evaporation Volumes from Akdeniz Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	3687	6039	7896	9514	10712	11409	9446	7873
2005-2006	4870	3326	2538	27080	3453	6112	8389	10266	13733	12083	11636	8698
2006-2007	5107	3517	2938	19264	2839	4988	8446	8935	13911	13493	10582	8583
2007-2008	6569	4232	2511	27149	4242	6381	3669	Dry	Dry	Dry	Dry	Dry
2008-2009	Dry	Dry	Dry	1253	2747	3300	5668	3427	Dry	Dry	Dry	Dry
2009-2010	Dry	107	854	2095	4666	6658	9286	9994	9102	8675	8342	9630
2010-2011	6631	4103	2826	3007	3987	4602	5862	8293	11475	12088	11655	7928
2011-2012	5039	2500	1637	1809	2930	2250	Dry	Dry	Dry	Dry	Dry	Dry
2012-2013	827	998	1247	2038	3168	6830	8773	11265	13730	13874	12583	8269
2013-2014	7046	3214	2611	2320	1760	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2014-2015	Dry	Dry	Dry	Dry	1569	5217	7164	9285	10795	11491	9803	6876
2015-2016	4510	3581	2099	1910	1739	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2016-2017	Dry	Dry	Dry	2481	3084	4611	8699	11455	13169	13930	10221	7353
2017-2018	4712	1205	Dry	114	272	676	659	Dry	Dry	Dry	Dry	630
2018-2019	1589	1140	1880	2426	3328	5051	5641	11612	12223	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	835	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2021-2022	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2022-2023	Dry	Dry	Dry	-	-	-	-	-	-	-	-	-

D8. Estimated Monthly Utilized Volumes from Akdeniz Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	3469	26019	0	36344	0	33177	9789	0
2005-2006	51846	0	19724	0	0	0	57305	0	2044	6507	32950	0
2006-2007	0	19277	40226	561	0	2165	3456	0	21841	24886	22808	21427
2007-2008	0	7845	0	21131	0	15483	163798	Dry	Dry	Dry	Dry	Dry
2008-2009	Dry	Dry	Dry	0	4258	0	0	142309	Dry	Dry	Dry	Dry
2009-2010	Dry	0	0	0	0	0	11485	0	7905	13256	27998	0
2010-2011	46765	34274	0	0	0	18301	0	0	0	3946	4526	1935
2011-2012	101422	0	0	0	0	206888	Dry	Dry	Dry	Dry	Dry	Dry
2012-2013	0	0	0	0	0	25371	0	0	0	28668	30845	23615
2013-2014	0	33375	0	82474	166569	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2014-2015	Dry	Dry	Dry	Dry	0	0	0	0	0	30516	31695	0
2015-2016	0	34125	15061	0	152070	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2016-2017	Dry	Dry	Dry	0	65532	0	0	38	25014	11615	20815	17008
2017-2018	50060	111984	Dry	0	2840	0	18846	Dry	Dry	Dry	Dry	0
2018-2019	0	13782	0	0	0	0	0	0	0	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	0	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2021-2022	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2022-2023	Dry	Dry	Dry	-	-	-	-	-	-	-	-	-

D9. Estimated Monthly Effective Runoff Volumes of Akdeniz Reservoir (m^3)

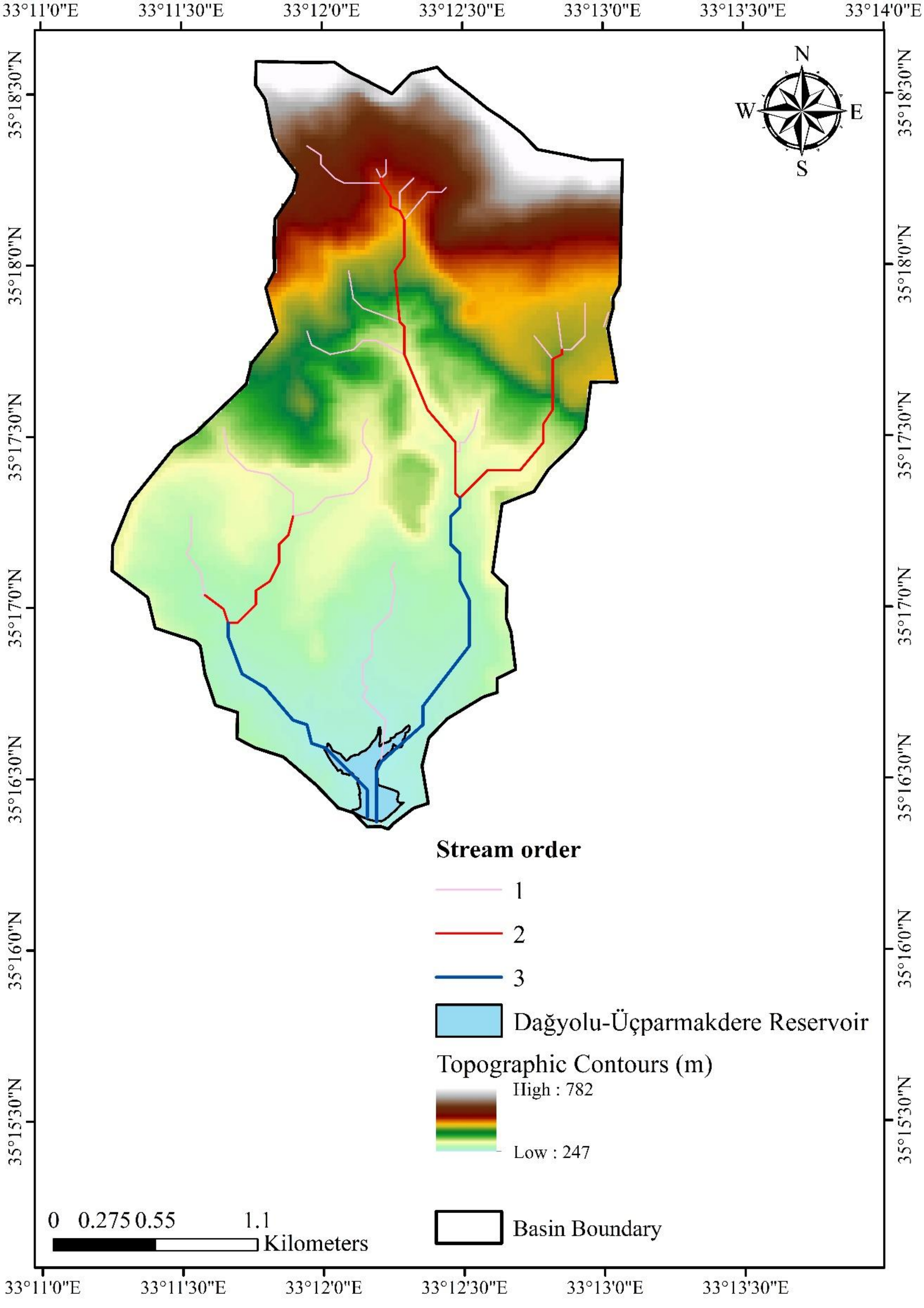
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Total
2004-2005	-	-	-	-	0	0	50546	0	50546
2005-2006	0	142033	0	55857	23582	14441	0	28545	264458
2006-2007	22240	0	0	0	139835	0	0	42155	204231
2007-2008	51926	0	37042	0	11734	0	0	0	100701
2008-2009	0	0	0	136324	0	11542	10832	0	158698
2009-2010	0	0	56211	199657	30455	0	0	0	286323
2010-2011	0	0	34300	38317	8346	0	17589	32124	130676
2011-2012	0	32038	0	37689	0	0	0	0	69727
2012-2013	35173	0	116407	137058	0	0	38388	8026	335052
2013-2014	13409	0	101919	0	0	0	0	0	115328
2014-2015	0	0	0	0	218394	9116	0	0	227510
2015-2016	34904	0	0	53588	0	0	0	0	88492
2016-2017	0	0	183125	43860	0	71713	76367	0	375064
2017-2018	0	0	0	13011	0	10152	0	0	23163
2018-2019	36050	0	194312	40292	17724	Overflow	Overflow	0	288377
2019-2020	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	0	0	0	0	0	0
2021-2022	0	0	0	0	0	0	0	0	0
2022-2023	0	0	0	-	-	-	-	-	0
Average	12106	10879	45207	47228	26475	7310	12108	6521	151019

Appendix E: Dağyolu-Üçparmakdere Reservoir

Dağyolu-Üçparmakdere reservoir was constructed by Turkey during 1994 to irrigate 58 hectares of land. Eventhrough, İt is located at Dağyolu village of Kyrenia it is closer to the Nicosia region hence, during evaporation calculations relevant data from the Nicosia station was used. It is fed by the Ovgos tributary. Dağyolu-Üçparmaklıdere also rehabilitated alongside Değirmenlik and Geçitkale reservoirs for the first time in its history by the Water Works Office and nearly 60 000 cubic meters of deposited sediment was removed from its bottom implying nearly 1818 cubic meters accumulated sediment per year (Water Works Office).

Thalweg Elevation	235	m
Bottom Elevation of Weir (Spillway)	239	m
Normal Water Level	247	m
Maximum Water Elevation	248	m
Crest Level	249	m
Maximum Active Volume Depth	8	m
Dead Storage	30150	m^3
Active (Live) Storage Capacity	392250	m^3
Spillway Type	Ogee	-
Catchment Area (Delineated from ArcGIS)	6.684	km^2

E1. Delineated Dağyolu-Üçparmakdere Reservoir's Catchment with Strahler's Stream Order



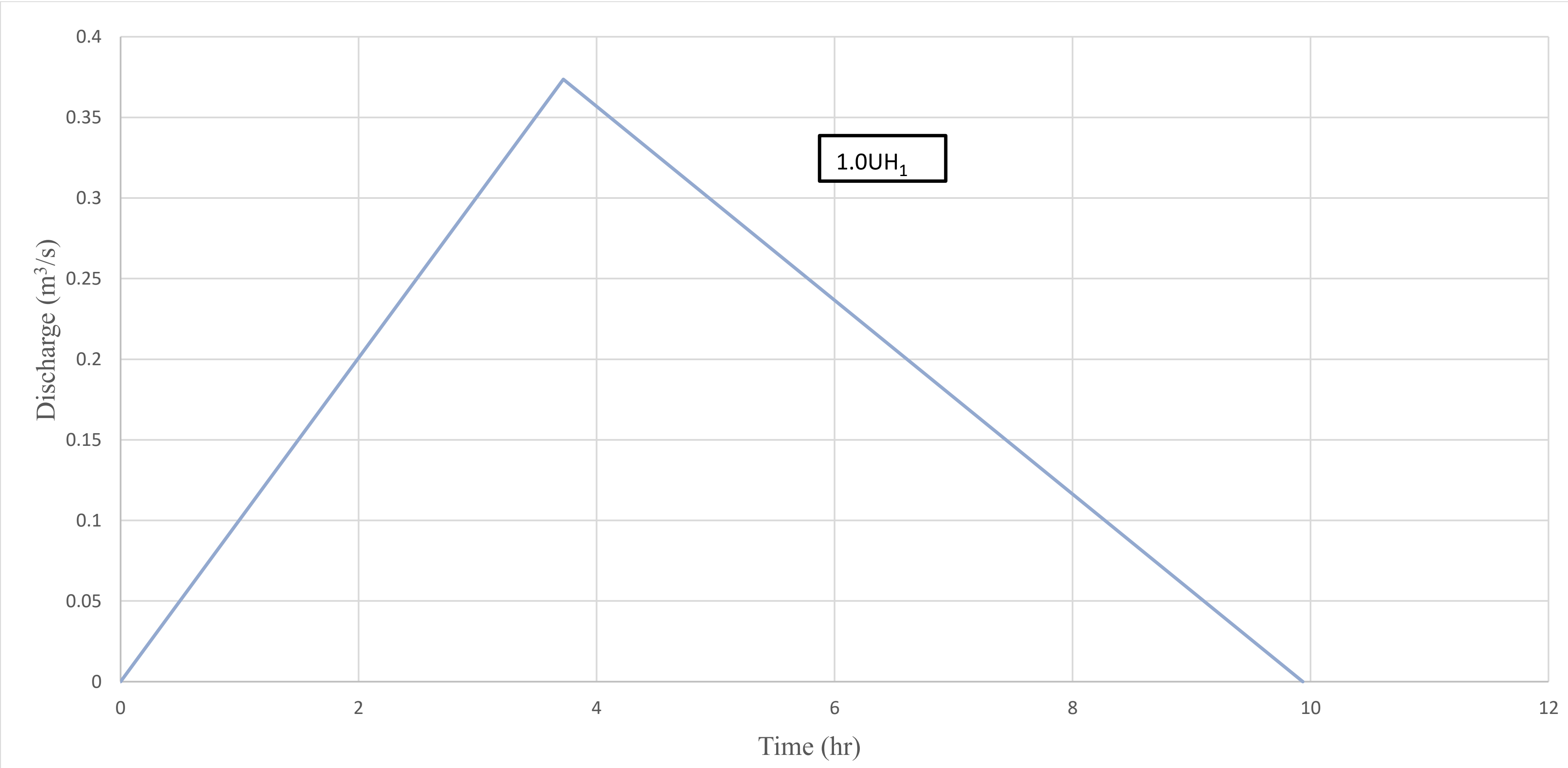
E2. Geomorphological Details of Dağyolu-Üçparmakdere Reservoir's Catchment

Name of Parameter	Unit	Catchment's Value
Stream Order	-	3
Total Number of 1st Order Stream	-	19
Total Number of 2nd Order Stream	-	4
Total Number of 3rd Order Stream	-	2
Total Number of All Order Streams	-	25
Basin Length	km	4.2
Basin Perimeter	km	12.1
Length of Main Channel	km	4.4
Length of Highest Order Stream	km	3.4
Length of 1st Order Stream	km	6.5
Length of 2nd Order Stream	km	4.0
Length of All Order Streams	km	13.9
Basin Area	km^2	6.7
Basin Maximum Elevation	m	782
Basin Minimum Elevation	m	247
Maximum Stream Elevation	m	560
Minimum Stream Elevation	m	247
Mean Bifurcation Ratio	-	3.4
Bifurcation Ratio Order 1:2	-	4.8
Bifurcation Ratio Order 2:3	-	2.0
Circularity Ratio	-	0.572
Quadratic Harmonic Mean Slope	-	0.025

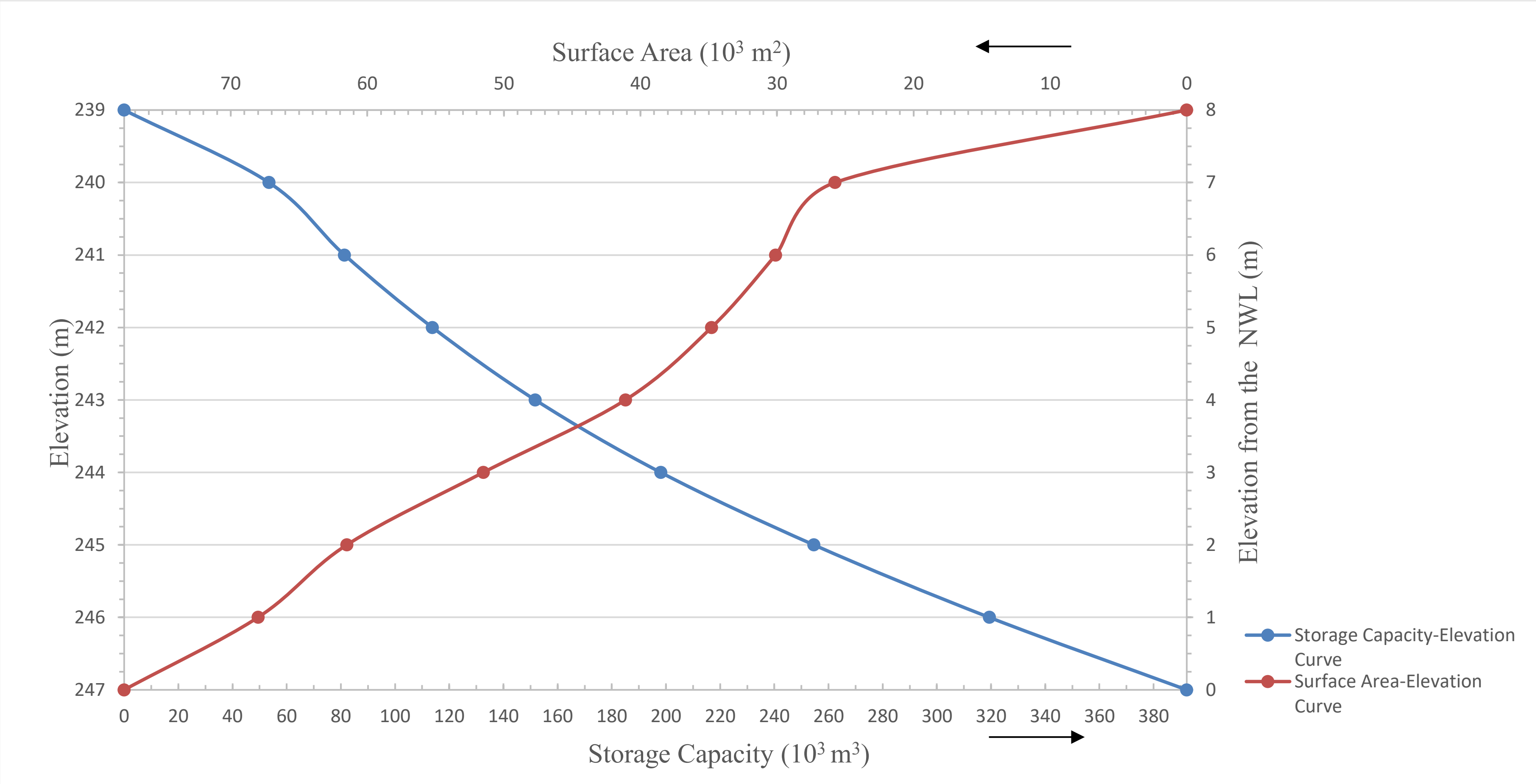
E3. Estimated Monthly Φ Index Values of Dağyolu-Üçparmakdere Reservoir's Catchment (mm/hr)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2005	-	5.44	-	-	-	-	2.11	-
2006	-	-	-	1.47	-	-	-	-
2007	-	-	-	-	-	-	-	2.77
2008	-	-	-	-	-	-	-	-
2009	-	-	-	-	-	-	-	-
2010	-	-	1.10	-	2.66	-	-	-
2011	-	-	-	-	-	-	-	0.40
2012	-	2.82	2.35	1.59	-	0.80	-	-
2013	-	0.49	0.54	0.83	-	-	-	-
2014	-	-	0.97	-	-	0.30	-	-
2015	1.12	-	-	2.46	-	-		0.68
2016	-	4.09	-	-	-	4.10	-	-
2017	0.37	-	-	-	-	0.87	-	0.32
2018	-	-	1.50	5.36	-	-	-	0.31
2019	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	-
2022	2.37	0.93	-	2.50	0.37	1.11	-	-
Monthly Avg.	1.28	2.75	1.29	2.37	1.51	1.44	2.11	0.90
Total Avg.	1.71							

E4. Synthetic Unit Hydrograph of Dağyolu-Üçparmakdere Reservoir's Catchment



E5. Designed Surface Area-Storage Capacity Curve of Dağyolu-Üçparmakdere Reservoir



E6. Surface Area-Storage Capacity Details of Dağyolu-Üçparmakdere Reservoir due to Sediment Accumulation within the Active Volume at Various Sedimentation Levels

Table E6.1. Surface Area-Storage Capacity details at sedimentation level 1 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
247	0	77800	338825
246	1	68000	265925
245	2	61500	201175
244	3	51500	144625
243	4	41100	98325
242	5	34800	60375
241	6	30100	27925
240	7	0	0

Table E6.2. Surface Area-Storage Capacity details at sedimentation level 2 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
247	0	77800	310900
246	1	68000	238000
245	2	61500	173250
244	3	51500	116700
243	4	41100	70400
242	5	34800	32450
241	6	0	0

Table E6.3. Surface Area-Storage Capacity details at sedimentation level 3 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
247	0	77800	278450
246	1	68000	205550
245	2	61500	140800
244	3	51500	84250
243	4	41100	37950
242	5	0	0

Table E6.4. Surface Area-Storage Capacity details at sedimentation level 4 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
247	0	77800	240500
246	1	68000	167600
245	2	61500	102850
244	3	51500	46300
243	4	0	0

Table E6.5. Surface Area-Storage Capacity details at sedimentation level 5 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
247	0	77800	194200
246	1	68000	121300
245	2	61500	56550
244	3	0	0

Table E6.6. Surface Area-Storage Capacity details at sedimentation level 6 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
247	0	77800	137650
246	1	68000	64750
245	2	0	0

Table E6.7. Surface Area-Storage Capacity details at sedimentation level 7 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
247	0	77800	72900
246	1	0	0

E7. Estimated Monthly Evaporation Volumes from Dağyolu-Üçparmakdere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	5511	9544	11855	14137	15023	14406	11622	8477
2005-2006	4638	2675	1849	27512	4333	7362	10244	12342	15055	13036	12761	8631
2006-2007	4730	3349	2831	19741	3112	5346	9106	10126	16497	17314	14585	12483
2007-2008	7303	3445	2122	21892	3421	5231	5511	5975	4082	Dry	Dry	Dry
2008-2009	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2009-2010	Dry	Dry	996	3005	6800	9418	13483	14955	13731	13072	12693	13938
2010-2011	9205	5834	3780	3920	5657	7246	9293	12534	17052	17644	16799	11352
2011-2012	8174	5014	3433	3751	4994	6499	9684	10238	13430	13226	12807	8428
2012-2013	4131	2667	2564	2970	4016	9435	12933	15935	18419	18001	17179	11650
2013-2014	9019	4026	3308	2723	4312	6769	8162	7487	5269	Dry	Dry	Dry
2014-2015	Dry	32	620	1380	3415	8001	11437	14486	16669	18553	16921	12530
2015-2016	6916	4356	2999	3078	4987	7033	5539	Dry	Dry	Dry	Dry	5394
2016-2017	Dry	Dry	Dry	1369	3200	4613	7355	9168	5964	Dry	Dry	Dry
2017-2018	Dry	Dry	Dry	542	1454	3506	5913	8219	10047	11362	8862	6283
2018-2019	2036	97	2507	3817	4827	7145	7980	16426	17230	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	2807	3426	4741	7699	7721	4267	Dry	Dry
2021-2022	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2022-2023	Dry	Dry	Dry	-	-	-	-	-	-	-	-	-

E8. Estimated Monthly Utilized Volumes from Dağyolu-Üçparmakdere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	0	23225	0	0	0	18762	18820	32239
2005-2006	57899	0	15026	0	0	2749	42333	5451	17441	0	18854	12279
2006-2007	0	8509	30367	0	0	18155	0	0	1454	0	2180	2585
2007-2008	107070	0	0	29980	0	25511	14997	0	65285	Dry	Dry	Dry
2008-2009	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2009-2010	Dry	Dry	Dry	0	0	0	0	0	6716	27518	29684	0
2010-2011	39712	36709	0	0	0	0	19558	0	13880	17268	18435	0
2011-2012	44815	0	0	0	114028	0	23955	0	36240	14929	0	75817
2012-2013	23771	0	0	0	24459	0	0	0	41359	22017	23672	18342
2013-2014	37832	0	0	73086	0	0	0	43566	133673	0	0	0
2014-2015	0	0	0	0	0	0	0	28742	0	26631	27716	0
2015-2016	70434	47180	0	0	26887	0	206933	Dry	Dry	Dry	Dry	Dry
2016-2017	Dry	Dry	Dry	0	44482	0	8856	0	168010	Dry	Dry	Dry
2017-2018	Dry	Dry	Dry	0	738	0	15873	0	0	24778	22778	0
2018-2019	96371	0	0	0	0	0	0	0	0	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	13662	2707	10821	2500	4895	76536	Dry	Dry
2021-2022	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2022-2023	Dry	Dry	Dry	-	-	-	-	-	-	-	-	-

E9. Estimated Monthly Effective Runoff Volumes of Dağyolu-Üçparmakdere Reservoir (m^3)

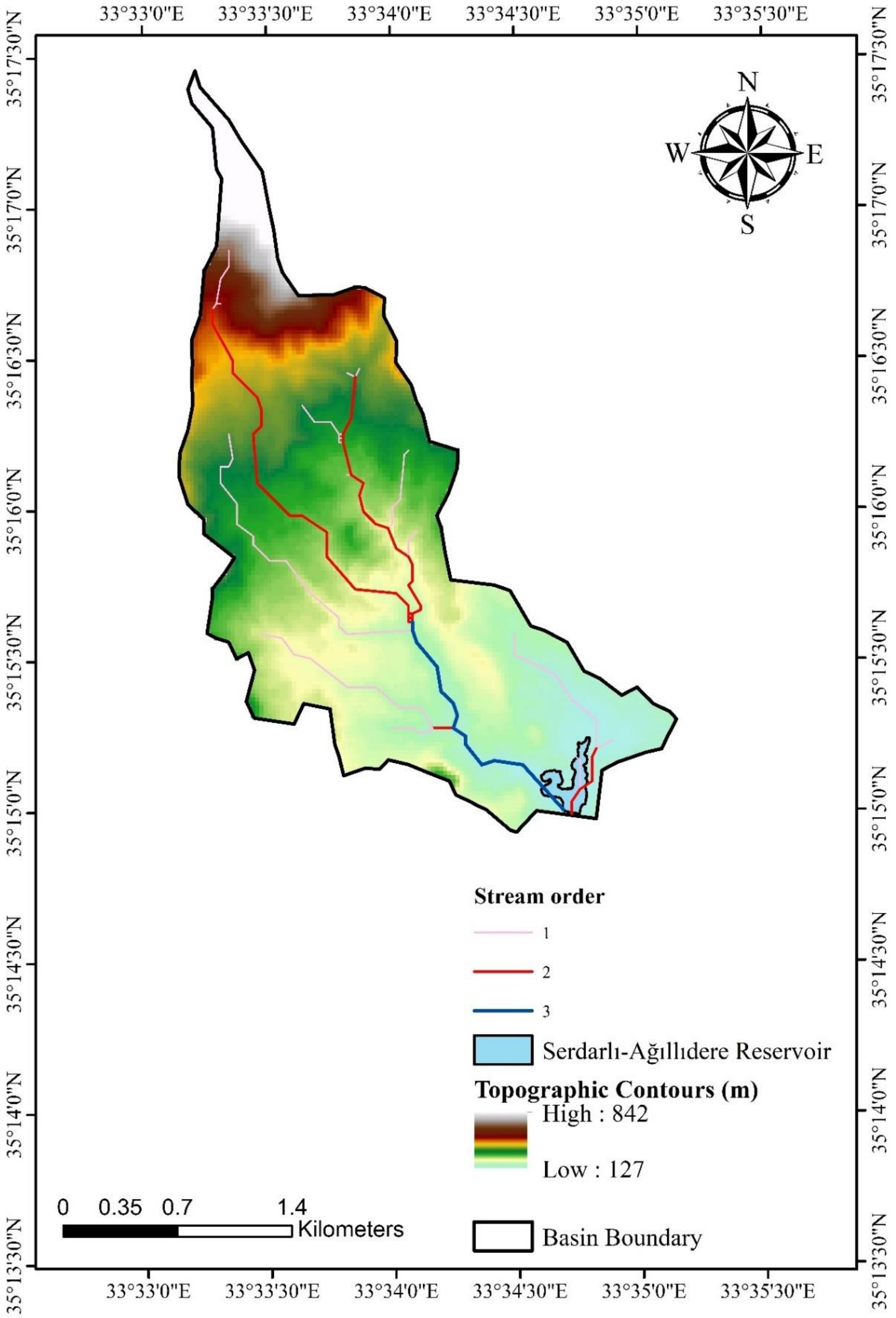
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Total
2004-2005	-	-	-	-	28313	0	9300	0	37614
2005-2006	0	60012	0	201394	12390	0	0	0	273797
2006-2007	24010	0	0	25326	108758	0	20013	56007	234113
2007-2008	0	14011	20106	0	28530	0	0	15317	77964
2008-2009	0	0	0	0	0	0	0	0	0
2009-2010	0	0	67249	301617	0	7979	12376	14329	403550
2010-2011	0	0	0	44137	77884	23579	0	46221	191820
2011-2012	0	72495	20535	60806	0	21558	0	14176	189570
2012-2013	0	80540	92227	82128	0	0	0	0	254895
2013-2014	0	9658	52353	0	27518	0	7736	0	97266
2014-2015	0	0	49947	32889	201509	53083	15446	0	352875
2015-2016	0	0	65691	12325	0	32977	0	0	110993
2016-2017	0	0	0	179063	0	36687	0	33057	248807
2017-2018	0	0	0	44679	0	56158	0	103939	204776
2018-2019	0	0	377649	0	Overflow	Overflow	Overflow	0	377649
2019-2020	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	0	0	0	0	0
2021-2022	0	0	0	0	0	0	0	0	0
2022-2023	0	0	0	-	-	-	-	-	0
Average	1501	14795	46610	65624	30306	14501	4054	16650	169760

Appendix F: Serdarlı-Ağıllıdere Reservoir

It was one of the reservoirs constructed by the Water Works Office in 1992 to the Serdarlı village of Famagusta for irrigating 38 hectares of land (Water Works Office).

Thalweg Elevation	138	m
Bottom Elevation of Weir (Spillway)	144	m
Normal Water Level	150	m
Maximum Water Elevation	151.6	m
Crest Level	153	m
Maximum Active Volume Depth	6	m
Dead Storage	53855	m^3
Active (Live) Storage Capacity	391880	m^3
Spillway Type	Ogee	-
Catchment Area (Delineated from ArcGIS)	5.434	km^2

F1. Delineated Serdarlı-Ağıllıdere Reservoir's Catchment with Strahler's Stream Order



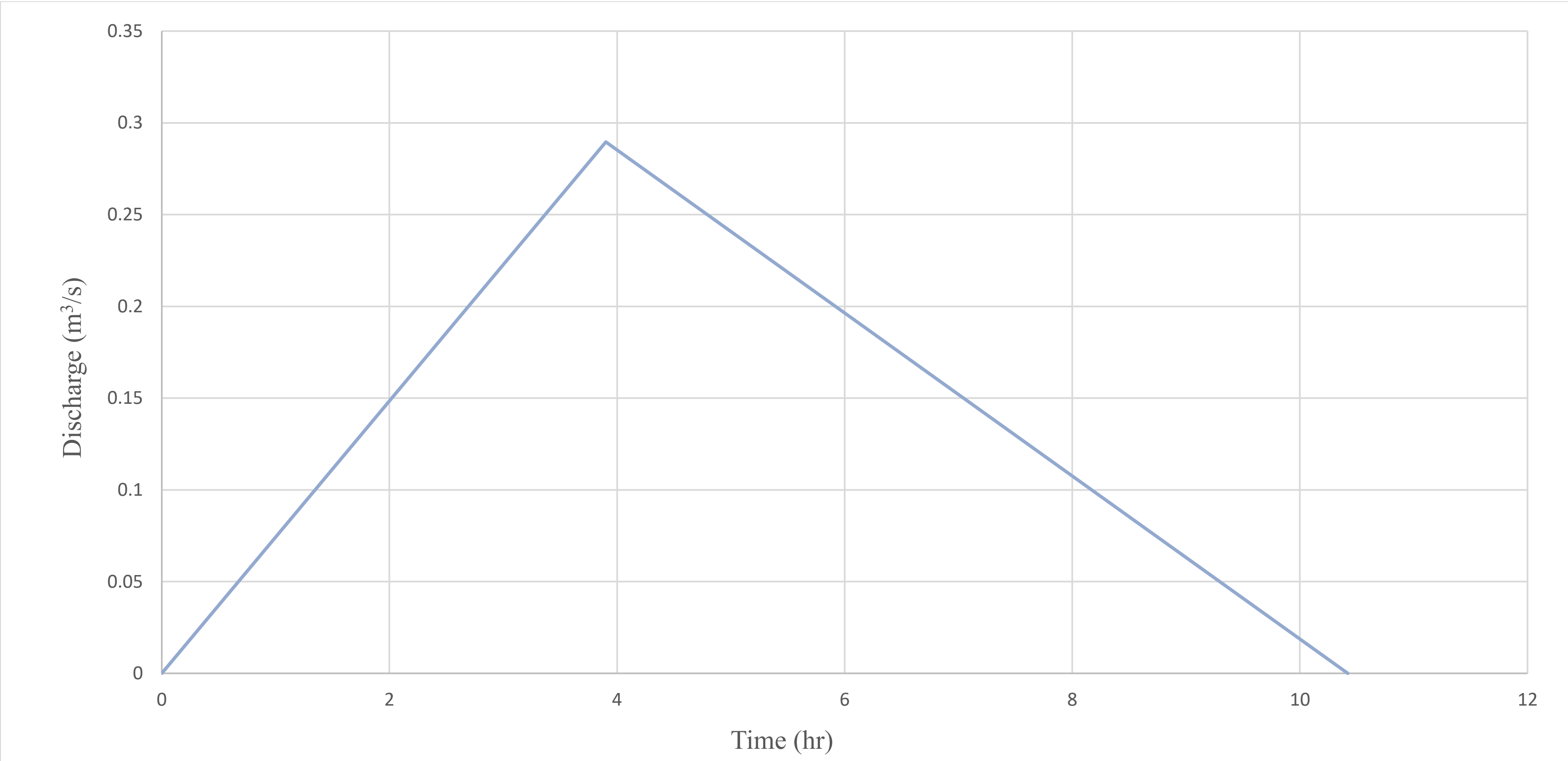
F2. Geomorphological Details of Serdarlı-Ağıllıdere Reservoir's Catchment

Name of Parameter	Unit	Catchment's Value
Stream Order	-	3
Total Number of 1st Order Stream	-	19
Total Number of 2nd Order Stream	-	3
Total Number of 3rd Order Stream	-	1
Total Number of All Order Streams	-	23
Basin Length	km	5.1
Basin Perimeter	km	14.0
Length of Main Channel	km	4.7
Length of Highest Order Stream	km	1.7
Length of 1st Order Stream	km	6.6
Length of 2nd Order Stream	km	5.0
Length of All Order Streams	km	13.3
Basin Area	km^2	5.4
Basin Maximum Elevation	m	842
Basin Minimum Elevation	m	127
Maximum Stream Elevation	m	360
Minimum Stream Elevation	m	127
Mean Bifurcation Ratio	-	4.7
Bifurcation Ratio Order 1:2	-	6.3
Bifurcation Ratio Order 2:3	-	3.0
Circularity Ratio	-	0.350
Quadratic Harmonic Mean Slope	-	0.021

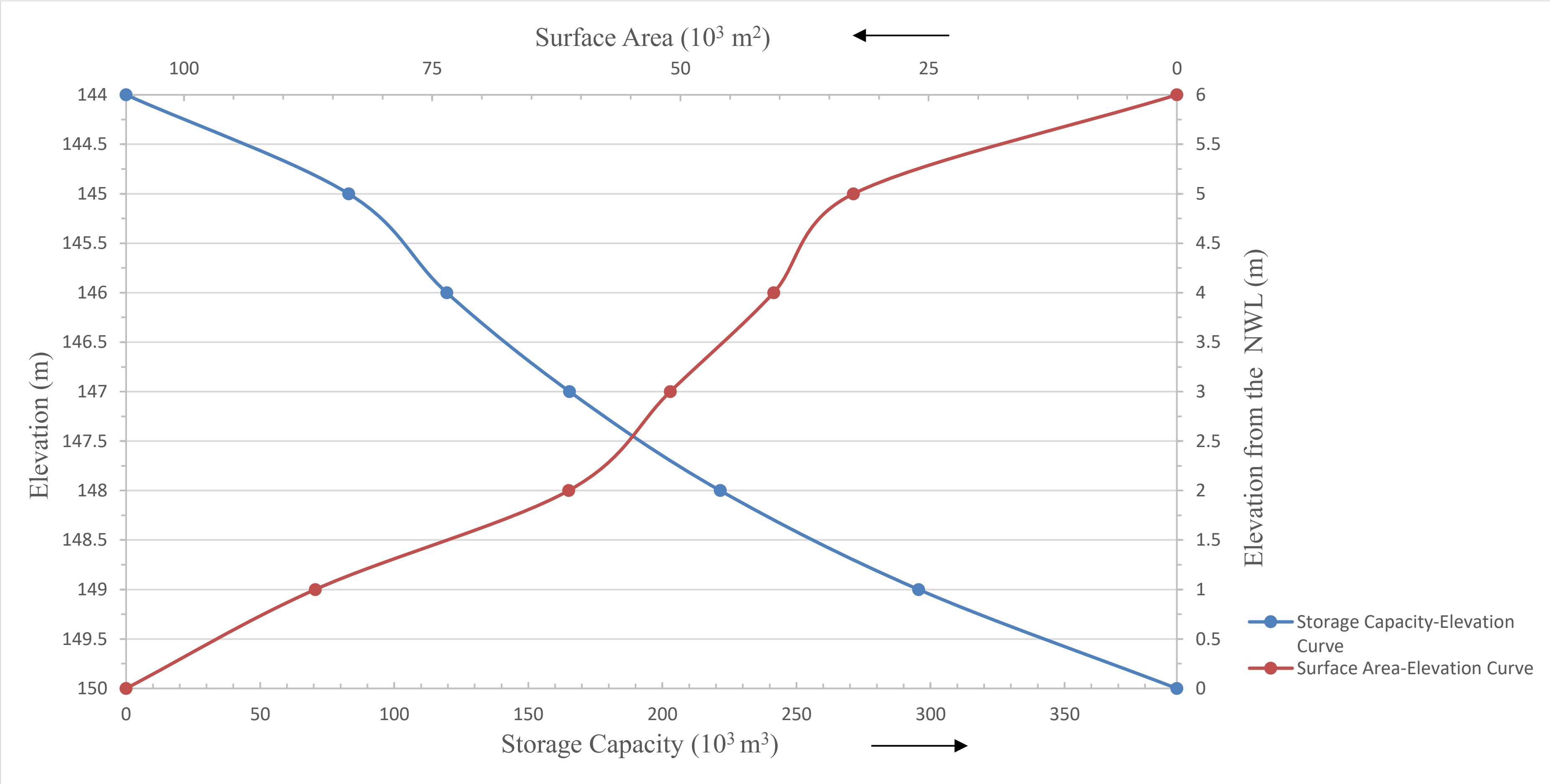
F3. Estimated Monthly Φ Index Values of Serdarlı-Ağıllıdere Reservoir's Catchment (mm/hr)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2005	-	6.00	-	-	-	-	0.07	-
2006	-	-	-	1.29	-	-	-	0.65
2007	-	-	0.31	-	4.23	-	0.43	6.08
2008	-	-	-	-	1.59	-	-	-
2009	-	-	3.44	-	-	-	-	-
2010	-	-	0.44	1.85	4.65	-	-	-
2011	-	-	-	-	-	-	5.20	-
2012	-	4.53	0.64	2.22	1.30	-	-	-
2013	-	-	2.98	3.71	-	0.11	-	6.49
2014	-	2.68	3.32	0.05	-	0.98	-	-
2015	0.42	-	-	1.42	-	-	1.60	-
2016	-	-	4.34	-	-	-	-	-
2017	0.25	2.29	-	0.08	-	0.76	1.44	-
2018	0.11	-	2.31	1.47	-	-	-	2.19
2019	-	-	-	1.80	4.77	4.66	1.82	-
2020	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	1.27	-	-
2022	3.64	-	2.25	-	-	-	-	-
Monthly Avg.	1.10	3.88	2.23	1.54	3.31	1.56	1.76	3.85
Total Avg.	2.40							

F4. Synthetic Unit Hydrograph of Serdarlı-Ağıllıdere Reservoir's Catchment



F5. Designed Surface Area-Storage Capacity Curve of Serdarlı-Ağıllıdere Reservoir



F6. Surface Area-Storage Capacity Details of Serdarlı-Ağıllıdere Reservoir due to Sediment Accumulation within the Active Volume at Various Sedimentation Levels

Table F6.1. Surface Area-Storage Capacity details at sedimentation level 1 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
150	0	105830	308875
149	1	86780	212570
148	2	61255	138552
147	3	51030	82410
146	4	40610	36590
145	5	0	0

Table F6.2. Surface Area-Storage Capacity details at sedimentation level 2 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
150	0	105830	272285
149	1	86780	175980
148	2	61255	101962
147	3	51030	45820
146	4	0	0

Table F6.3. Surface Area-Storage Capacity details at sedimentation level 3 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
150	0	105830	226465
149	1	86780	130160
148	2	61255	56142
147	3	0	0

Table F6.4. Surface Area-Storage Capacity details at sedimentation level 4 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
150	0	105830	170323
149	1	86780	74018
148	2	0	0

Table F6.5. Surface Area-Storage Capacity details at sedimentation level 5 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
150	0	105830	96305
149	1	0	0

F7. Estimated Monthly Evaporation Volumes from Serdarlı-Ağıllıdere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	Dry	Dry	3010	6198	7545	9218	7673	5934
2005-2006	3058	2005	1620	18973	2572	4423	6143	7726	10201	8787	8118	6029
2006-2007	3555	2138	1393	6629	1890	4456	7664	8954	15051	15347	12622	10696
2007-2008	6663	3420	2031	20484	3345	4843	2367	Dry	Dry	Dry	Dry	Dry
2008-2009	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2009-2010	Dry	Dry	407	1462	4159	7862	12904	13637	11816	11151	10943	11117
2010-2011	6633	4213	2912	2822	3442	3882	4956	3445	Dry	Dry	Dry	Dry
2011-2012	Dry	90	159	329	1201	1270	Dry	Dry	Dry	Dry	Dry	Dry
2012-2013	Dry	222	745	1389	2074	4676	6131	9083	12457	6232	Dry	Dry
2013-2014	Dry	Dry	997	1965	3739	5976	8033	8213	11390	6731	7995	9828
2014-2015	6337	3143	2388	2699	3844	6049	8145	10491	11616	11621	9421	5668
2015-2016	4261	4408	2915	1267	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2016-2017	Dry	Dry	1194	3148	4436	6147	10123	11637	11257	12264	9413	5882
2017-2018	4934	3744	2890	2818	4372	7590	10337	11267	11455	7103	Dry	1250
2018-2019	3957	3345	3147	3015	4354	6868	8233	17594	18262	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	3154	4020	5745	9402	9551	10536	8478	5806
2021-2022	4845	3011	1710	1776	1058	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2022-2023	557	618	1314	-	-	-	-	-	-	-	-	-

F8. Estimated Monthly Utilized Volumes from Serdarlı-Ağıllıdere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	Dry	Dry	0	17114	0	8725	0	4287
2005-2006	23340	0	4080	0	0	0	16182	0	1474	0	7487	0
2006-2007	0	18669	18519	7491	0	9786	0	0	0	1126	1709	2184
2007-2008	52114	0	0	7652	0	28157	59650	Dry	Dry	Dry	Dry	Dry
2008-2009	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2009-2010	Dry	Dry	0	0	0	0	0	4031	2140	3764	9723	35234
2010-2011	19515	15119	0	7864	0	13998	0	107196	Dry	Dry	Dry	Dry
2011-2012	Dry	0	0	0	0	60935	Dry	Dry	Dry	Dry	Dry	Dry
2012-2013	Dry	0	0	0	15298	0	6437	0	17373	140397	Dry	Dry
2013-2014	Dry	Dry	0	0	7724	0	0	857	39324	54705	0	21535
2014-2015	7354	0	0	0	20982	6154	0	0	5038	20624	22650	10734
2015-2016	0	0	0	133134	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2016-2017	Dry	Dry	0	0	43283	0	0	57064	33304	0	26490	20810
2017-2018	0	0	20277	0	28109	15328	18613	0	0	158312	Dry	0
2018-2019	0	19056	0	0	0	0	0	0	0	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	4670	0	5056	0	0	0	0	0
2021-2022	0	524	7736	7879	70887	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2022-2023	0	0	0	-	-	-	-	-	-	-	-	-

F9. Estimated Monthly Effective Runoff Volumes of Serdarlı-Ağıllıdere Reservoir (m^3)

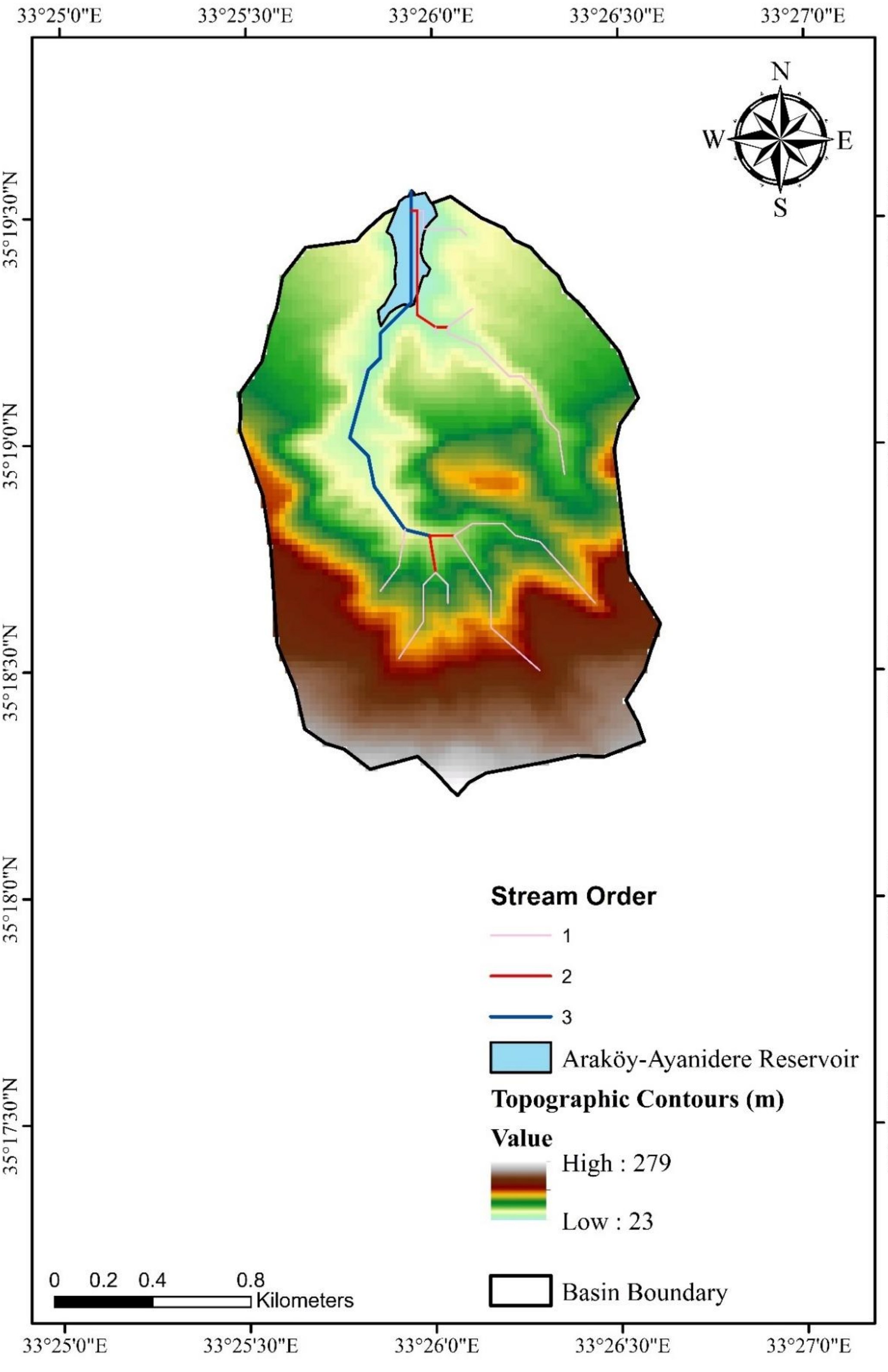
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Total
2004-2005	-	-	-	-	0	0	80155	0	80155
2005-2006	0	38508	0	48951	0	0	0	16454	103913
2006-2007	0	0	0	0	123279	0	15181	58838	197298
2007-2008	0	0	10675	0	24551	0	0	0	35226
2008-2009	0	0	0	0	0	0	0	0	0
2009-2010	0	0	28625	81016	66665	0	0	0	176306
2010-2011	0	0	18905	0	0	0	13842	0	32747
2011-2012	0	0	0	10797	40620	0	0	0	51417
2012-2013	0	15193	46099	40606	0	22373	0	79529	203800
2013-2014	0	0	79552	42870	0	42754	11774	0	176950
2014-2015	0	8854	43548	10082	0	0	7735	0	70219
2015-2016	73853	0	0	0	0	0	0	0	73853
2016-2017	0	0	133052	92550	0	10722	42080	0	278403
2017-2018	64194	26471	0	110536	0	0	0	10029	211231
2018-2019	131345	0	42842	44305	11626	5654	23976	0	259748
2019-2020	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	0	9119	0	0	9119
2021-2022	0	0	0	0	0	0	0	0	0
2022-2023	21812	0	74504	-	-	-	-	-	96316
Average	18200	5564	29863	32114	15691	5331	11455	9697	114261

Appendix G: Arapköy-Ayanidere Reservoir

Arapköy-Ayanidere Reservoir was constructed by Republic of Turkey in 1990 to irrigate 65 hectares of land. The reservoir is constructed on Ayanidere stream and fed by rainfall occurs around the Alevkaya region. It has a catchment area of 3.072 square kilometers. However, due to strong rainfalls around the region, stream feeding the reservoir generates good runoffs and helps to sustain water consistently (Water Works Office).

Thalweg Elevation	80	m
Bottom Elevation of Weir (Spillway)	87.10	m
Normal Water Level	98.10	m
Maximum Water Elevation	99.50	m
Crest Level	100.50	m
Maximum Active Volume Depth	11	m
Dead Storage	39953	m^3
Active (Live) Storage Capacity	608881	m^3
Spillway Type	Ogee	-
Catchment Area (Delineated from ArcGIS)	3.072	km^2

G1. Delineated Arapköy-Ayanidere Reservoir's Catchment with Strahler's Stream Order



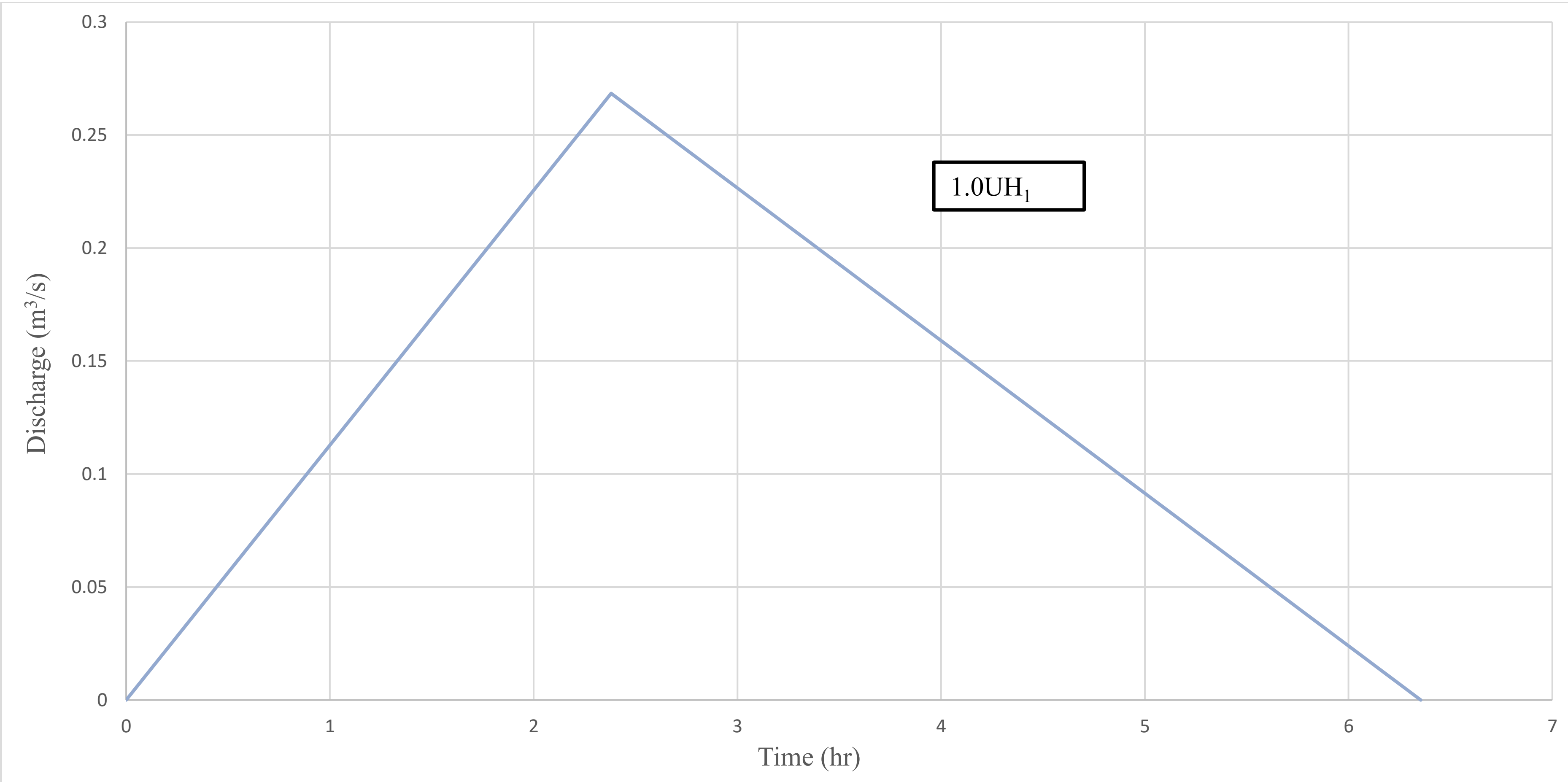
G2. Geomorphological Details of Arapköy-Ayanidere Reservoir's Catchment

Name of Parameter	Unit	Catchment's Value
Stream Order	-	3
Total Number of 1st Order Stream	-	13
Total Number of 2nd Order Stream	-	3
Total Number of 3rd Order Stream	-	1
Total Number of All Order Streams	-	17
Basin Length	km	2.5
Basin Perimeter	km	7.0
Length of Main Channel	km	2.5
Length of Highest Order Stream	km	1.6
Length of 1st Order Stream	km	3.5
Length of 2nd Order Stream	km	0.8
Length of All Order Streams	km	6.0
Basin Area	km^2	3.1
Basin Maximum Elevation	m	279
Basin Minimum Elevation	m	23
Maximum Stream Elevation	m	176
Minimum Stream Elevation	m	23
Mean Bifurcation Ratio	-	3.7
Bifurcation Ratio Order 1:2	-	4.3
Bifurcation Ratio Order 2:3	-	3.0
Circularity Ratio	-	0.788
Quadratic Harmonic Mean Slope	-	0.026

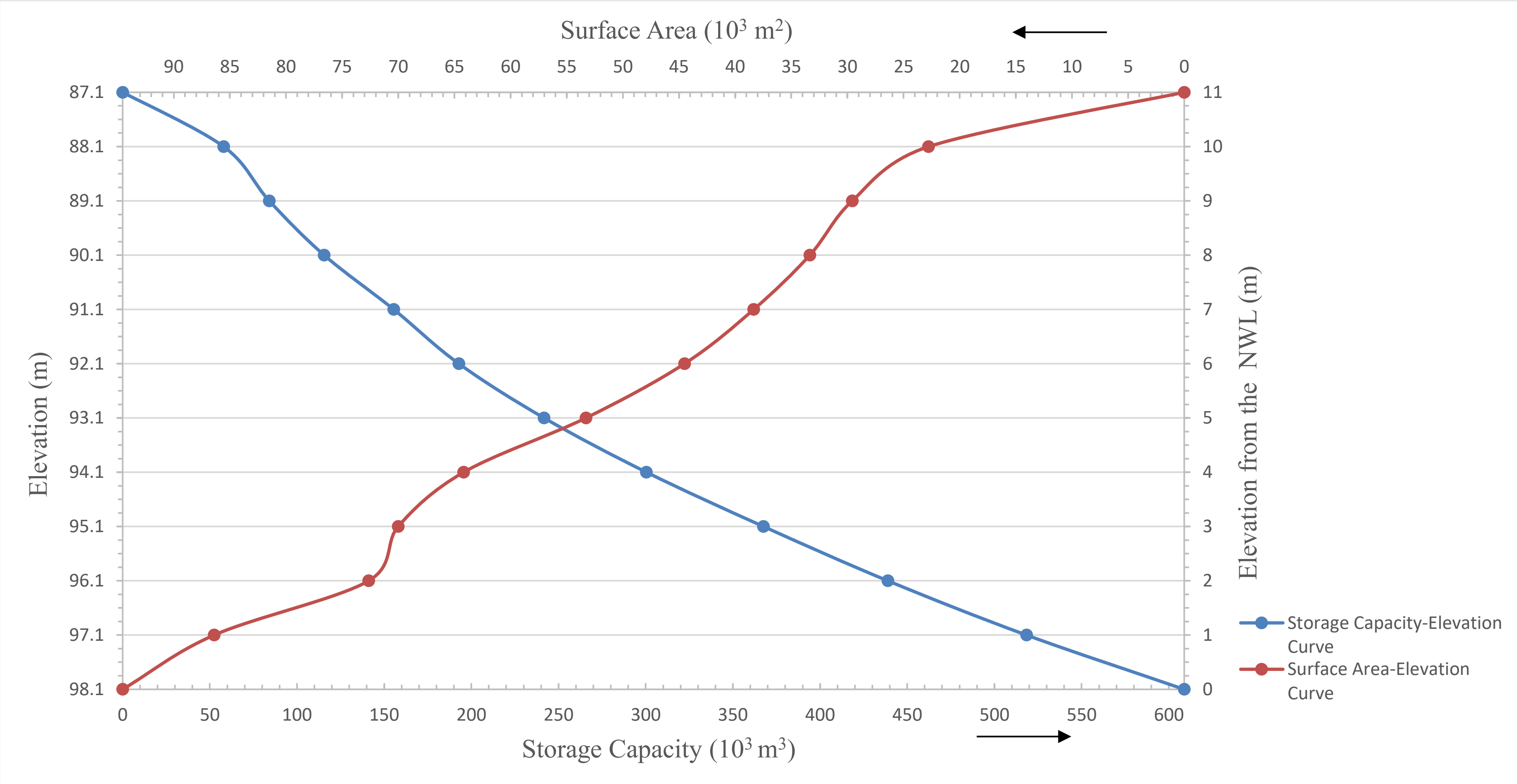
G3. Estimated Monthly Φ Index Values of Arapköy-Ayanidere Reservoir's Catchment (mm/hr)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2005	-	2.72	-	-	-	-	-	-
2006	0.28	-	-	1.18	0.64	0.86	-	-
2007	-	0.33	0.14	-	3.22	-	-	3.28
2008	0.19	-	1.11	-	0.66	-	-	-
2009	-	-	1.77	-	-	2.75	-	1.08
2010	-	-	0.00	0.32	1.91	-	-	-
2011	-	3.67	0.08	0.24	-	-	1.51	0.39
2012	-	2.37	-	-	-	-	-	2.16
2013	-	-	1.36	1.53	-	-	-	2.91
2014	-	2.26	2.01	0.07	-	0.38	-	-
2015	-	-	-	1.18	0.19	-	1.42	-
2016	-	-	0.87	0.19	-	-	-	-
2017	-	0.82	-	-	-	-	0.26	-
2018	0.25	-	0.52	0.64	-	-	-	0.94
2019	-	-	-	0.52	-	-	0.68	-
2020	-	-	-	-	-	-	-	-
2021	-	1.34	1.91	-	0.57	0.87	1.20	-
2022	0.64	0.36	-	2.31	-	-	-	-
Monthly Avg.	0.34	1.74	0.98	0.82	1.20	1.21	1.01	1.79
Total Avg.	1.14							

G4. Synthetic Unit Hydrograph of Arapköy-Ayanidere Reservoir's Catchment



G5. Designed Surface Area-Storage Capacity Curve of Arapköy-Ayanidere Reservoir



G6. Surface Area-Storage Capacity Details of Arapköy-Ayanidere Reservoir due to Sediment Accumulation within the Active Volume at Various Sedimentation Levels

Table G6.1. Surface Area-Storage Capacity details at sedimentation level 1 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
98.1	0	94550	550934
97.1	1	86400	460459
96.1	2	72640	380939
95.1	3	70012	309613
94.1	4	64183	242515
93.1	5	53290	183779
92.1	6	44509	134884
91.1	7	38341	97534
90.1	8	33346.3	57621
89.1	9	29565.7	26166
88.1	10	0	0

Table G6.2. Surface Area-Storage Capacity details at sedimentation level 2 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
98.1	0	94550	524768
97.1	1	86400	434293
96.1	2	72640	354773
95.1	3	70012	283447
94.1	4	64183	216349
93.1	5	53290	157613
92.1	6	44509	108718
91.1	7	38341	71368
90.1	8	33346.3	31455
89.1	9	0	0

Table G6.3. Surface Area-Storage Capacity details at sedimentation level 3 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
98.1	0	94550	493313
97.1	1	86400	402838
96.1	2	72640	323318
95.1	3	70012	251992
94.1	4	64183	184894
93.1	5	53290	126158
92.1	6	44509	77263
91.1	7	38341	39913
90.1	8	0	0

Table G6.4. Surface Area-Storage Capacity details at sedimentation level 4 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
98.1	0	94550	453400
97.1	1	86400	362925
96.1	2	72640	283405
95.1	3	70012	212079
94.1	4	64183	144981
93.1	5	53290	86245
92.1	6	44509	37350
91.1	7	0	0

Table G6.5. Surface Area-Storage Capacity details at sedimentation level 5 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
98.1	0	94550	416050
97.1	1	86400	325575
96.1	2	72640	246055
95.1	3	70012	174729
94.1	4	64183	107631
93.1	5	53290	48895
92.1	6	0	0

Table G6.6. Surface Area-Storage Capacity details at sedimentation level 6 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
98.1	0	94550	367155
97.1	1	86400	276680
96.1	2	72640	197160
95.1	3	70012	125834
94.1	4	64183	58736
93.1	5	0	0

Table G6.7. Surface Area-Storage Capacity details at sedimentation level 7 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
98.1	0	94550	308419
97.1	1	86400	217944
96.1	2	72640	138424
95.1	3	70012	67098
94.1	4	0	0

Table G6.8. Surface Area-Storage Capacity details at sedimentation level 8 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
98.1	0	94550	241321
97.1	1	86400	150846
96.1	2	72640	71326
95.1	3	0	0

Table G6.9. Surface Area-Storage Capacity details at sedimentation level 9 m.

Elevation (m)	Elevation from NWL	Area (m^2)	Storage Capacity (m^3)
98.1	0	94550	169995
97.1	1	86400	79520
96.1	2	0	0

Table G6.10. Surface Area-Storage Capacity details at sedimentation level 10 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
98.1	0	94550	90475
97.1	1	0	0

G7. Estimated Monthly Evaporation Volumes from Arapköy-Ayanidere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	3761	6236	6030	6675	11092	14059	11796	10763
2005-2006	6152	4058	2561	30769	3890	6304	8193	9584	11946	11448	9159	6981
2006-2007	5079	3008	2825	17836	3040	6567	7959	9711	15141	14841	11669	10699
2007-2008	5685	3604	2324	22218	4045	4976	5155	6368	7121	6438	4362	3249
2008-2009	3364	2909	2957	2297	2281	3056	2846	3298	4153	4564	3858	3249
2009-2010	1371	224	965	3364	5317	7636	10743	10786	11546	10840	15784	13883
2010-2011	9437	4774	3466	3897	5879	7586	11281	12710	19360	19901	14789	12714
2011-2012	13708	7595	4589	4450	9301	7677	9411	10765	14398	15110	14552	10803
2012-2013	6751	5722	4787	4844	5399	8862	10045	11293	14483	15001	13199	8980
2013-2014	7030	2999	3845	7402	6615	7998	9605	7933	3634	Dry	Dry	Dry
2014-2015	Dry	171	1151	2433	4149	7635	8215	9452	12989	8875	Dry	Dry
2015-2016	Dry	Dry	15	1359	2608	3665	2159	Dry	Dry	Dry	Dry	2784
2016-2017	Dry	Dry	2959	7077	7949	8003	9547	11604	15252	18633	20702	17572
2017-2018	13168	8130	6836	7815	5560	8974	11901	15230	16473	16928	12621	11763
2018-2019	9688	7544	5635	10925	12297	14223	16894	22530	23926	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	10330	14163	16145	24978	26896	26892	25372	19883
2021-2022	15048	11157	7647	8564	8863	10292	16067	15354	22074	27898	21954	19356
2022-2023	13312	8229	6445	-	-	-	-	-	-	-	-	-

G8. Estimated Monthly Utilized Volumes from Arapköy-Ayanidere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	15312	34668	39145	66541	0	58364	12776	0
2005-2006	67057	0	10108	0	0	0	44312	19375	20815	19144	36934	0
2006-2007	0	29550	35714	0	0	30007	0	0	15500	17747	15890	16931
2007-2008	49740	0	0	24989	0	42541	26431	20182	12391	9185	7007	2881
2008-2009	0	9184	0	6018	2449	0	6267	0	16424	0	7409	0
2009-2010	47575	12780	0	0	0	0	0	23763	21039	23032	61258	24781
2010-2011	86329	52591	0	0	0	63067	0	0	9825	39512	34364	13909
2011-2012	46323	0	0	0	159343	25264	44307	0	71328	70144	2305	0
2012-2013	0	0	82334	0	45932	43156	17528	0	140475	14867	15828	12688
2013-2014	64081	38105	0	0	10859	0	99978	128433	83072	Dry	Dry	Dry
2014-2015	Dry	0	0	0	0	59432	0	1968	0	284922	Dry	Dry
2015-2016	Dry	Dry	0	0	8211	5341	64870	Dry	Dry	Dry	Dry	0
2016-2017	Dry	Dry	0	40701	60632	3724	0	0	132107	0	37814	32591
2017-2018	60267	0	42496	0	44537	0	33560	0	0	55692	34341	0
2018-2019	0	71105	0	0	10240	0	0	0	0	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	0	0	0	0	0	0	0	0
2021-2022	0	0	0	0	39812	8969	77206	66878	0	89741	3539	0
2022-2023	0	0	140984	-	-	-	-	-	-	-	-	-

G9. Estimated Monthly Effective Runoff Volumes of Arapköy-Ayanidere Reservoir (m^3)

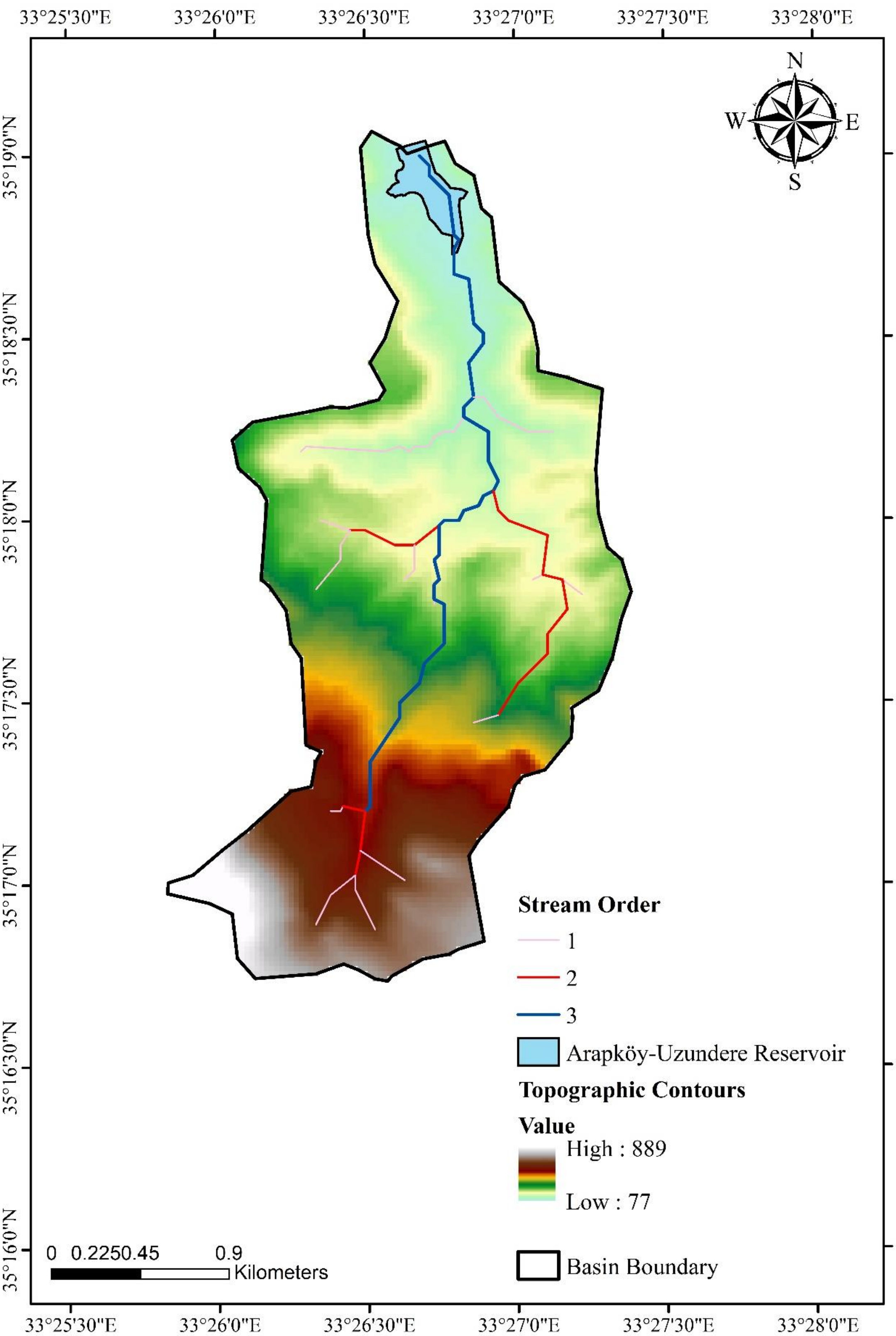
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Total
2004-2005	-	-	-	-	0	0	0	0	0
2005-2006	0	112536	0	37719	8441	4256	0	0	162952
2006-2007	64344	0	0	0	119607	0	0	115176	299127
2007-2008	0	5265	18737	0	54709	0	0	0	78711
2008-2009	49206	0	10064	0	0	11496	0	6225	76991
2009-2010	0	0	71823	247461	270517	0	0	0	589801
2010-2011	0	0	63281	70773	120508	0	69265	66237	390064
2011-2012	0	35611	237136	0	0	0	0	114960	387707
2012-2013	0	58594	0	103656	0	0	0	154191	316440
2013-2014	0	0	173578	19662	0	73770	0	0	267009
2014-2015	0	8840	77044	10463	195947	0	7631	0	299925
2015-2016	0	0	0	84732	0	0	0	0	84732
2016-2017	0	0	354066	0	0	0	80106	0	434172
2017-2018	0	44200	0	129710	0	50668	0	39645	264223
2018-2019	47766	0	195134	142596	0	0	35974	0	421470
2019-2020	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	10086	10269	10493	0	30848
2021-2022	0	7476	24935	8815	0	0	0	0	41226
2022-2023	111866	9061	0	-	-	-	-	-	120927
Average	17074	17599	76612	57039	45871	8850	11969	29202	237018

Appendix H: Arapköy-Uzundere Reservoir

The Arapköy-Uzundere Reservoir, constructed by the Republic of Turkey in 1990 on the Uzundere stream, that was intended to irrigate 41 hectares of land. Despite having a smaller live storage capacity compared to the Ayanidere Reservoir, it possesses a much larger catchment area of 5.192 square kilometers, as opposed to Ayanidere's 3.072 square kilometers. Consequently, the Arapköy-Uzundere Reservoir consistently sustains a greater volume of water, as evidenced by observations made during this study. This discrepancy in the catchment area highlights the importance of considering such geomorphological variations when assessing and comparing the water-carrying capabilities of reservoirs for agricultural purposes (Water Works Office).

Thalweg Elevation	39	m
Bottom Elevation of Weir (Spillway)	44.50	m
Normal Water Level	54	m
Maximum Water Elevation	55.10	m
Crest Level	56	m
Maximum Active Volume Depth	9.5	m
Dead Storage	51650	m^3
Active (Live) Storage Capacity	444150	m^3
Spillway Type	Ogee	-
Catchment Area (Delineated from ArcGIS)	5.192	km^2

H1. Delineated Arapköy-Uzundere Reservoir's Catchment with Strahler's Stream Order



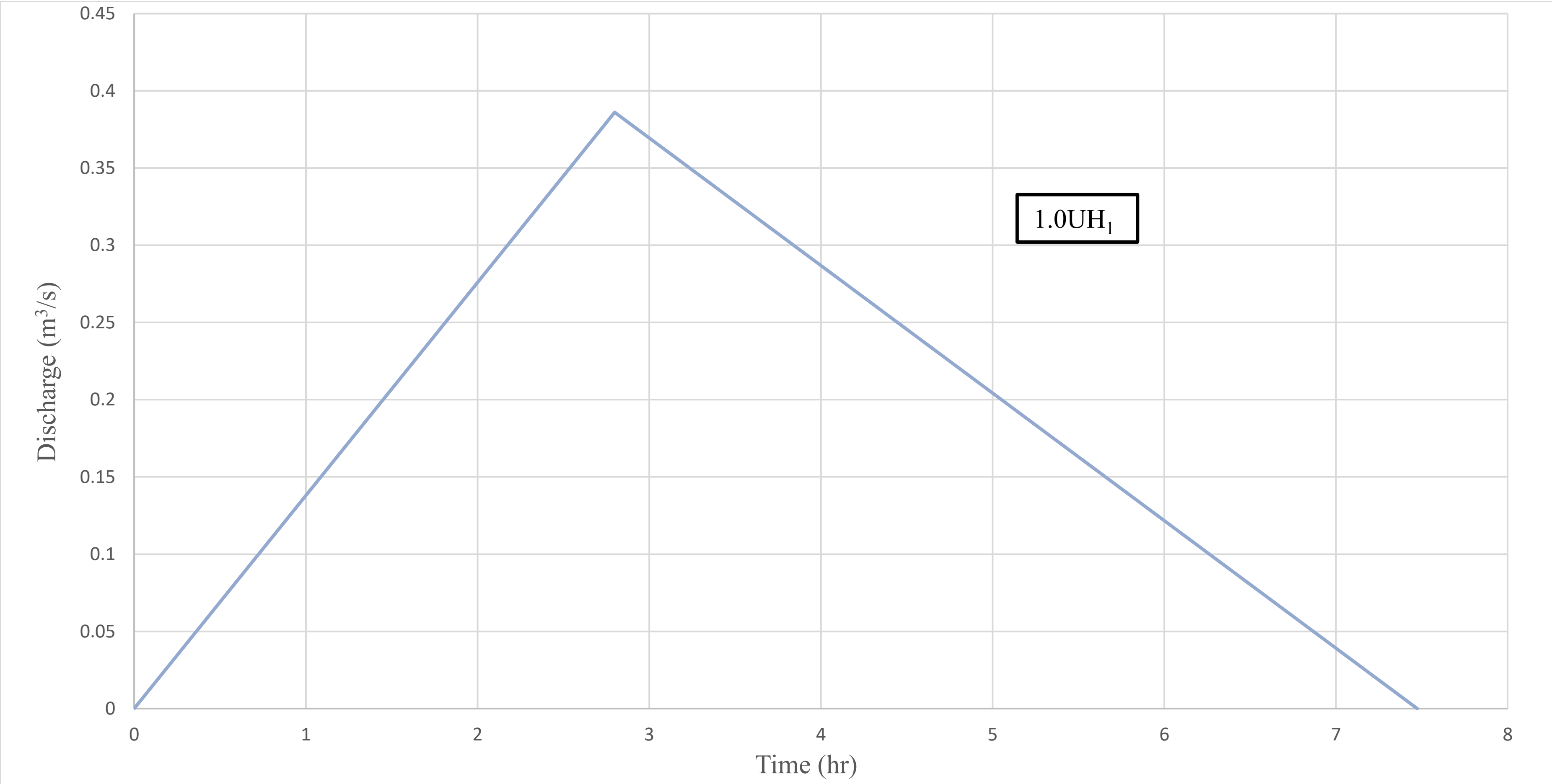
H2. Geomorphological Details of Arapköy-Uzundere Reservoir's Catchment

Name of Parameter	Unit	Catchment's Value
Stream Order	-	3
Total Number of 1st Order Stream	-	13
Total Number of 2nd Order Stream	-	4
Total Number of 3rd Order Stream	-	1
Total Number of All Order Streams	-	18
Basin Length	km	4.2
Basin Perimeter	km	12.4
Length of Main Channel	km	4.7
Length of Highest Order Stream	km	4.0
Length of 1st Order Stream	km	3.4
Length of 2nd Order Stream	km	2.5
Length of All Order Streams	km	9.9
Basin Area	km^2	5.2
Basin Maximum Elevation	m	889
Basin Minimum Elevation	m	77
Maximum Stream Elevation	m	600
Minimum Stream Elevation	m	82
Mean Bifurcation Ratio	-	3.6
Bifurcation Ratio Order 1:2	-	3.3
Bifurcation Ratio Order 2:3	-	4.0
Circularity Ratio	-	0.427
Quadratic Harmonic Mean Slope	-	0.055

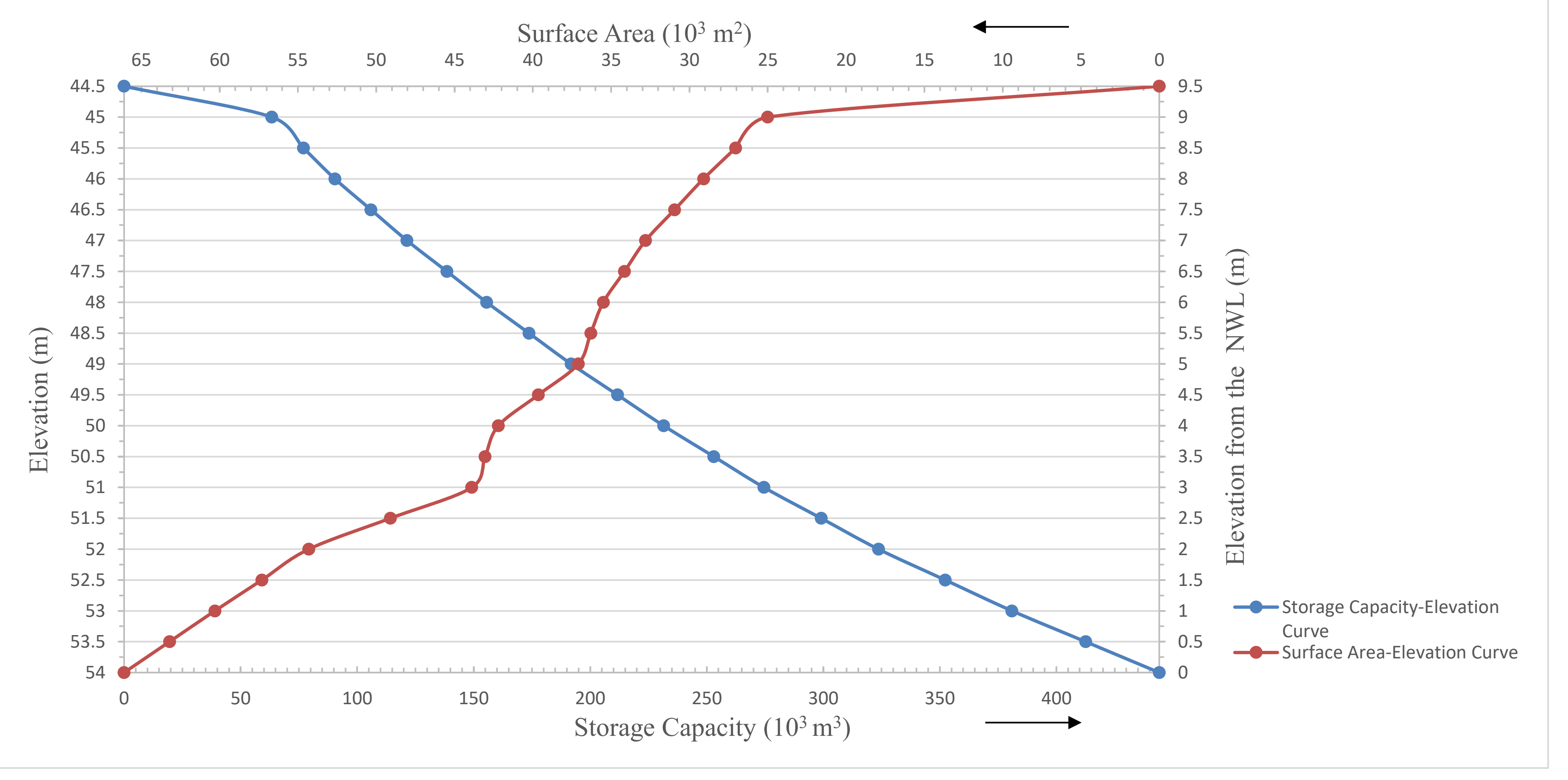
H3. Estimated Monthly Φ Index Values of Arapköy-Uzundere Reservoir's Catchment (mm/hr)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2005	-	3.73	-	-	-	-	-	-
2006	0.61	-	-	1.78	0.79	-	-	-
2007	-	0.36	0.16	-	4.46	-	0.20	4.20
2008	0.01	-	1.18	-	0.74	-	-	-
2009	-	-	2.54	1.54	-	3.03	-	1.04
2010	-	-	0.12	1.14	3.86	-	-	-
2011	-	1.55	-	0.31	2.19	-	2.94	0.96
2012	-	3.27	-	-	-	-	-	4.11
2013	-	-	2.42	2.32	-	-	-	4.46
2014	-	2.76	2.89	-	-	0.66	-	-
2015	0.47	-	-	1.47	1.18	6.13	1.65	-
2016	-	-	3.51	1.57	-	0.35	-	-
2017	0.19	1.35	-	0.03	-	0.09	0.60	-
2018	0.17	-	0.66	1.63	-	-	-	1.61
2019	-	-	-	-	-	-	2.82	-
2020	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	-
2022	-	-	-	-	-	-	-	-
Monthly Avg.	0.29	2.17	1.69	1.31	2.20	2.06	1.64	2.73
Total Avg.	1.76							

H4. Synthetic Unit Hydrograph of Arapköy-Uzundere Reservoir's Catchment



H5. Designed Surface Area-Storage Capacity Curve of Arapköy-Uzundere Reservoir



H6. Surface Area-Storage Capacity Details of Arapköy-Uzundere Reservoir due to Sediment Accumulation within the Active Volume at Various Sedimentation Levels

Table H6.1. Surface Area-Storage Capacity details at sedimentation level 1 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
54	0	66100	367225
53.5	0.5	63200	335625
53	1	60300	304025
52.5	1.5	57300	275375
52	2	54300	246725
51.5	2.5	49100	222175
51	3	43900	197625
50.5	3.5	43050	176100
50	4	42200	154575
49.5	4.5	39650	134750
49	5	37100	114925
48.5	5.5	36300	96775
48	6	35500	78625
47.5	6.5	34150	61550
47	7	32800	44475
46.5	7.5	30950	29000
46	8	29100	13525
45.5	8.5	0	0

Table H6.2. Surface Area-Storage Capacity details at sedimentation level 2 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
54	0	66100	338225
53.5	0.5	63200	306625
53	1	60300	275025
52.5	1.5	57300	246375
52	2	54300	217725
51.5	2.5	49100	193175
51	3	43900	168625
50.5	3.5	43050	147100
50	4	42200	125575
49.5	4.5	39650	105750
49	5	37100	85925
48.5	5.5	36300	67775
48	6	35500	49625
47.5	6.5	34150	32550
47	7	32800	15475
46.5	7.5	0	0

Table H6.3. Surface Area-Storage Capacity details at sedimentation level 3 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
54	0	66100	305675
53.5	0.5	63200	274075
53	1	60300	242475
52.5	1.5	57300	213825
52	2	54300	185175
51.5	2.5	49100	160625
51	3	43900	136075
50.5	3.5	43050	114550
50	4	42200	93025
49.5	4.5	39650	73200
49	5	37100	53375
48.5	5.5	36300	35225
48	6	35500	17075
47.5	6.5	0	0

Table H6.4. Surface Area-Storage Capacity details at sedimentation level 4 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
54	0	66100	270450
53.5	0.5	63200	238850
53	1	60300	207250
52.5	1.5	57300	178600
52	2	54300	149950
51.5	2.5	49100	125400
51	3	43900	100850
50.5	3.5	43050	79325
50	4	42200	57800
49.5	4.5	39650	37975
49	5	37100	18150
48.5	5.5	0	0

Table H6.5. Surface Area-Storage Capacity details at sedimentation level 5 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
54	0	66100	232475
53.5	0.5	63200	200875
53	1	60300	169275
52.5	1.5	57300	140625
52	2	54300	111975
51.5	2.5	49100	87425
51	3	43900	62875
50.5	3.5	43050	41350
50	4	42200	19825
49.5	4.5	0	0

Table H6.6. Surface Area-Storage Capacity details at sedimentation level 6 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
54	0	66100	191125
53.5	0.5	63200	159525
53	1	60300	127925
52.5	1.5	57300	99275
52	2	54300	70625
51.5	2.5	49100	46075
51	3	43900	21525
50.5	3.5	0	0

Table H6.7. Surface Area-Storage Capacity details at sedimentation level 7 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
54	0	66100	145050
53.5	0.5	63200	113450
53	1	60300	81850
52.5	1.5	57300	53200
52	2	54300	24550
51.5	2.5	0	0

Table H6.8. Surface Area-Storage Capacity details at sedimentation level 8 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
54	0	66100	91850
53.5	0.5	63200	60250
53	1	60300	28650
52.5	1.5	0	0

Table H6.9. Surface Area-Storage Capacity details at sedimentation level 9 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
54	0	66100	31600
53.5	0.5	0	0

H7. Estimated Monthly Evaporation Volumes from Arapköy-Uzundere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	3209	5106	5072	6320	10207	11773	9418	9262
2005-2006	5668	3711	2301	27089	3374	5477	7055	7853	9363	9220	7673	5912
2006-2007	4486	2775	2728	17917	2761	5448	7058	9348	14411	13878	10848	9626
2007-2008	5297	3640	2324	23386	4636	5641	5691	6887	7275	6196	3534	1961
2008-2009	3135	3498	3567	2783	2822	3736	3487	4142	5469	6268	5466	4768
2009-2010	3079	2555	2305	3154	3893	5338	7508	7488	7911	7331	10159	10061
2010-2011	7326	3505	2558	3054	4630	5656	8453	9402	14298	15099	11619	9948
2011-2012	9675	6015	3686	3111	6942	6130	7037	8060	11491	11320	10081	7573
2012-2013	4710	4292	3695	3925	4594	7268	7995	9637	12380	11802	10472	7209
2013-2014	6420	3298	3557	5513	4547	5399	7116	8332	9749	9926	7202	5427
2014-2015	3204	1851	1766	2531	3212	5557	6798	7910	9786	11348	9370	7810
2015-2016	4630	4876	3044	3264	3254	5240	3458	Dry	Dry	Dry	Dry	4459
2016-2017	Dry	Dry	1569	4498	5856	6823	9143	10047	13471	14156	12447	10131
2017-2018	9056	6585	5684	6769	4713	6628	7644	9837	10208	10369	8247	7626
2018-2019	6292	5225	4707	8854	8987	10445	12242	16122	17147	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	-	-	-	-	-	-	-	-
2021-2022	-	-	-	-	-	-	-	-	-	-	-	-
2022-2023	-	-	-	-	-	-	-	-	-	-	-	-

H8. Estimated Monthly Utilized Volumes from Arapköy-Uzundere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	19168	43170	16578	73313	0	73698	19295	0
2005-2006	74344	0	11373	0	0	0	43678	60466	31200	28610	49647	0
2006-2007	0	33062	39815	0	0	39924	0	0	28142	31409	27451	28772
2007-2008	25204	0	0	13353	0	77957	33407	72951	29857	23486	18053	9619
2008-2009	0	11447	0	0	5538	0	0	0	44134	0	20717	1709
2009-2010	44357	11649	0	0	0	0	0	25211	22768	24634	63253	0
2010-2011	88802	54082	0	0	0	49640	0	0	6497	27145	23328	9047
2011-2012	83935	0	2349	0	66831	23604	41508	0	36531	65896	5176	0
2012-2013	0	0	56898	0	48648	29099	20210	0	143472	29543	29708	22786
2013-2014	0	29936	0	57084	13226	0	43334	0	14285	24101	70993	28563
2014-2015	11545	0	0	0	0	0	0	1587	0	35388	33311	18875
2015-2016	0	26197	0	0	30823	0	212485	Dry	Dry	Dry	Dry	0
2016-2017	Dry	Dry	0	0	84183	0	0	68210	86598	0	47988	41664
2017-2018	0	0	14614	0	33000	60149	26558	0	26852	51000	29478	0
2018-2019	0	75783	0	0	Overflow	Overflow	Overflow	0	0	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	-	-	-	-	-	-	-	-
2021-2022	-	-	-	-	-	-	-	-	-	-	-	-
2022-2023	-	-	-	-	-	-	-	-	-	-		-

H9. Estimated Monthly Effective Runoff Volumes of Arapköy-Uzundere Reservoir (m^3)

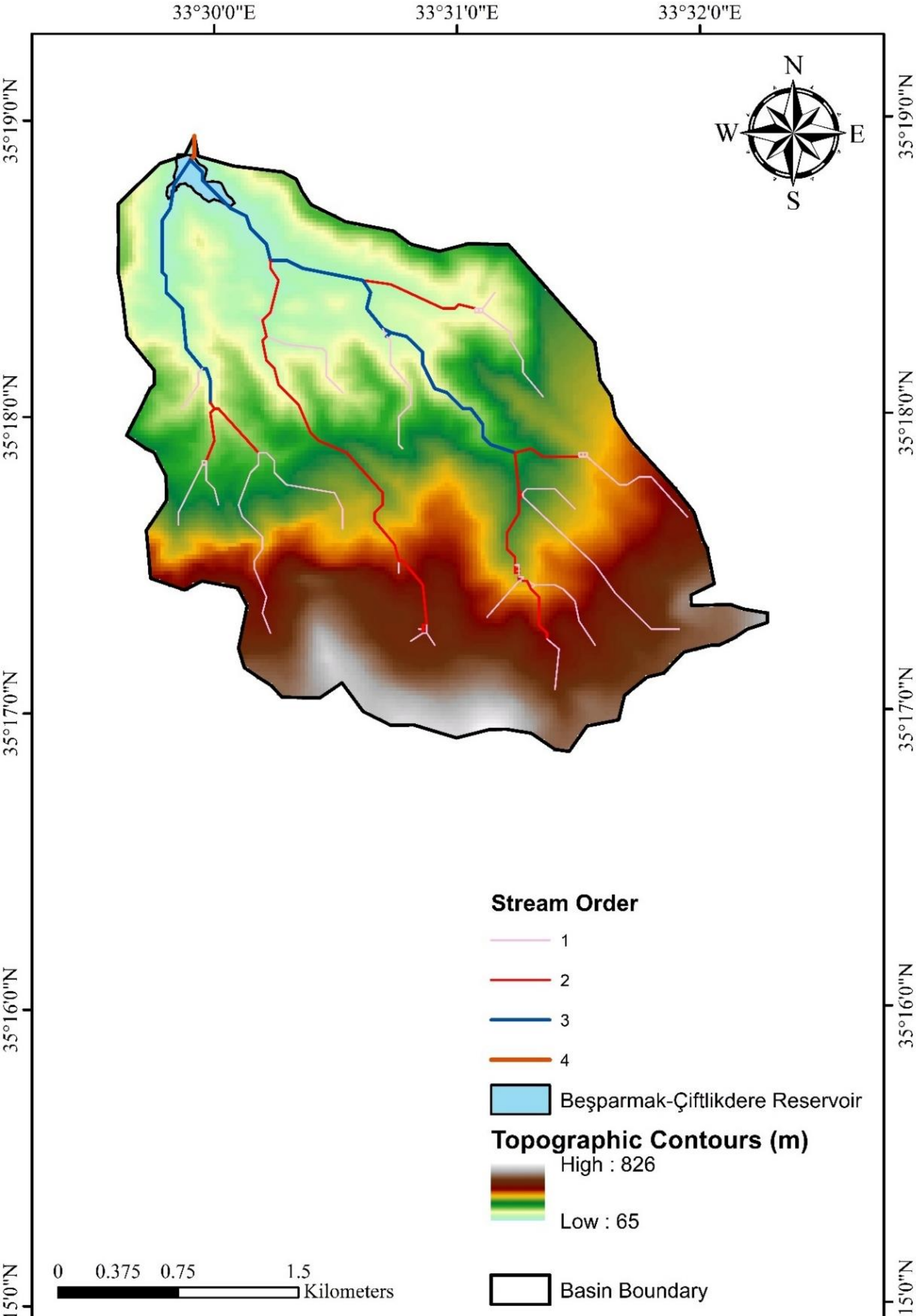
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Total
2004-2005	-	-	-	-	0	0	0	0	0
2005-2006	0	123960	0	12946	7986	0	0	0	144893
2006-2007	147402	0	0	0	101823	0	50355	138032	437613
2007-2008	0	6860	29240	0	83164	0	0	0	119264
2008-2009	158406	0	12420	5494	0	12951	0	11777	201048
2009-2010	0	0	67197	152131	122590	0	0	0	341917
2010-2011	0	0	63031	91323	6130	0	60588	62009	283081
2011-2012	0	207137	0	0	0	0	0	103750	310886
2012-2013	0	58022	0	109530	0	0	0	155953	323505
2013-2014	0	0	139381	0	0	74478	0	0	213859
2014-2015	0	7181	56230	8009	102131	26366	6319	0	206236
2015-2016	64112	0	0	16432	0	76839	0	0	157383
2016-2017	0	0	181538	116373	0	107935	81766	0	487613
2017-2018	76882	51371	0	97383	0	0	0	30628	256265
2018-2019	101351	0	263543	0	Overflow	Overflow	Overflow	0	364893
2019-2020	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	-	-	-	-	0
2021-2022	-	-	-	-	-	-	-	-	0
2022-2023	-	-	-	-	-	-	-	-	0
Average	39154	32467	58041	43544	30273	21326	14216	33477	213803

Appendix I: Beşparmak-Çiftlikdere Reservoir

Beşparmak-Çiftlikdere Reservoir was constructed by the Republic of Turkey in 1992 on Çiftlikdere stream. It has an irrigation area of 67 hectares. It is the biggest water reservoir in the region in terms of catchment area surpassing Arapköy-Ayanidere Reservoir after its construction and it is fed by the peaks of Alevkayası-Beşparmak Mountains which takes lots of rainfall hence, the reservoir exposed to great runoff volumes during the wet seasons. Before the construction of tourism resorts, reservoir seems to retain water in its body permanently, however after the construction of resort next to it, post 2007, there is a significant sudden drop in water level and inconsistent water storages in the reservoir was observed. This is due to the extreme utilization of water within the reservoir by the surrounding holiday resorts (Haber Kıbrıs, 7/07/2013).

Thalweg Elevation	70	m
Bottom Elevation of Weir (Spillway)	79	m
Normal Water Level	91.50	m
Maximum Water Elevation	93	m
Crest Level	94.50	m
Maximum Active Volume Depth	12.5	m
Dead Storage	53000	m^3
Active (Live) Storage Capacity	774575	m^3
Spillway Type	Ogee	-
Catchment Area (Delineated from ArcGIS)	9.320	km^2

I1. Delineated Beşparmak-Çiftlikdere Reservoir's Catchment with Strahler's Stream Order



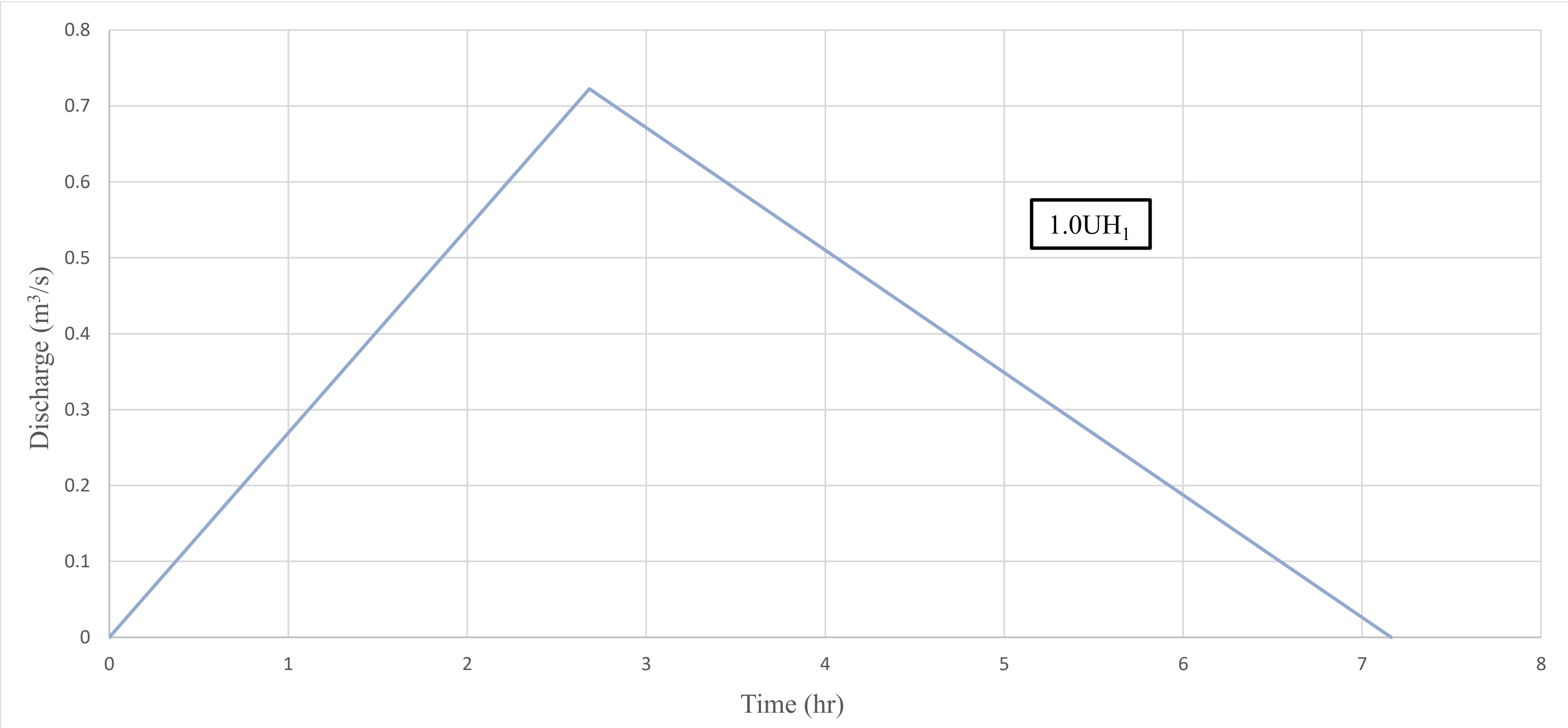
I2. Geomorphological Details of Beşparmak-Çiftlikdere Reservoir's Catchment

Name of Parameter	Unit	Catchment's Value
Stream Order	-	4
Total Number of 1st Order Stream	-	47
Total Number of 2nd Order Stream	-	6
Total Number of 3rd Order Stream	-	2
Total Number of 4th Order Stream	-	1
Total Number of All Order Streams	-	56
Basin Length	km	4.5
Basin Perimeter	km	13.8
Length of Main Channel	km	4.9
Length of Highest Order Stream	km	0.16
Length of 1st Order Stream	km	10.4
Length of 2nd Order Stream	km	6.2
Length of 3rd Order Stream	km	4.7
Length of All Order Streams	km	21.3
Basin Area	km^2	9.3
Basin Maximum Elevation	m	826
Basin Minimum Elevation	m	65
Maximum Stream Elevation	m	627
Minimum Stream Elevation	m	65
Mean Bifurcation Ratio	-	5.4
Bifurcation Ratio Order 1:2	-	7.8
Bifurcation Ratio Order 2:3	-	3.0
Circularity Ratio	-	0.617
Quadratic Harmonic Mean Slope	-	0.069

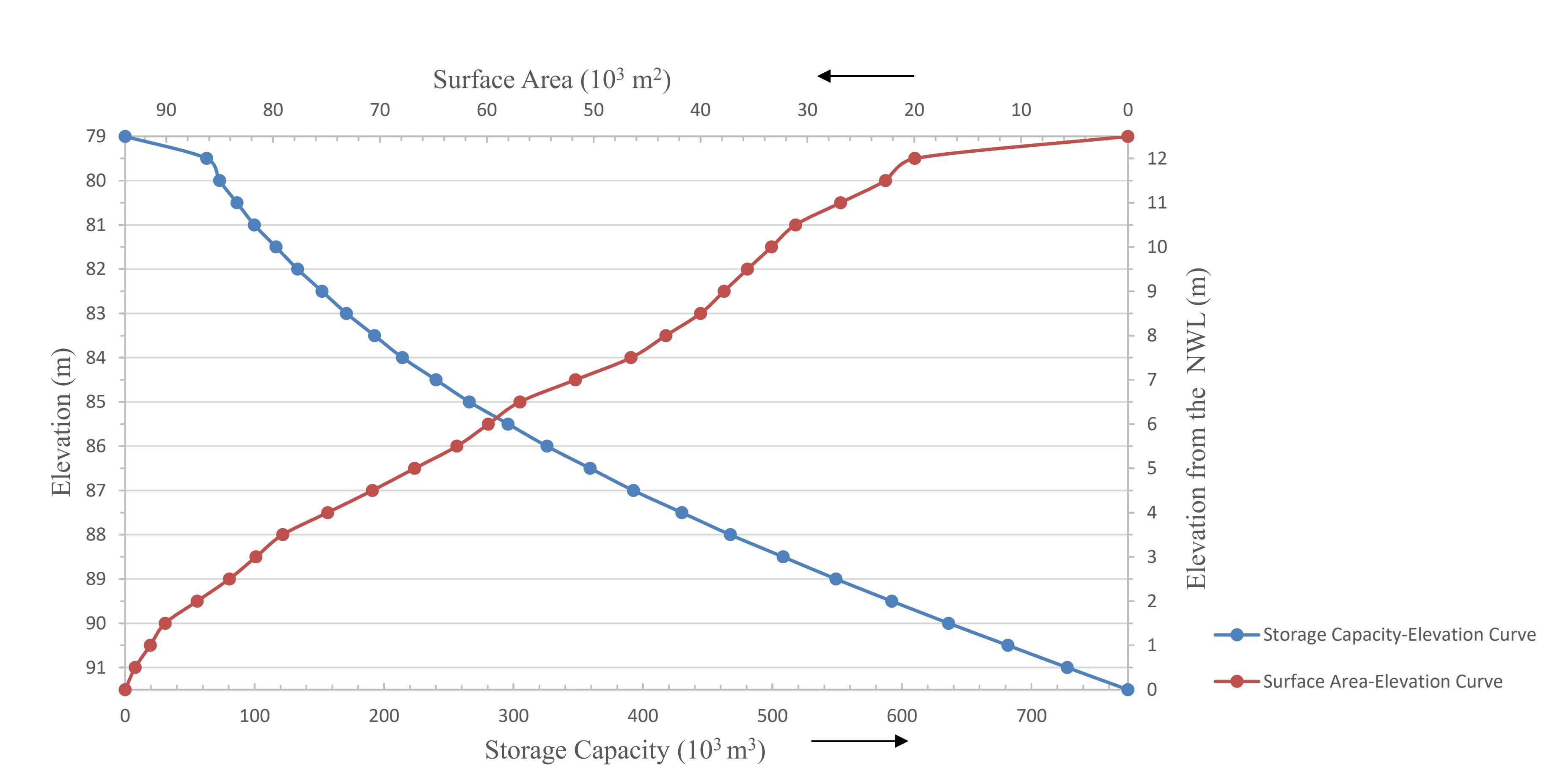
I3. Estimated Monthly Φ Index Values of Beşparmak-Çiftlikdere Reservoir's Catchment (mm/hr)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2005	-	3.79	-	-	-	-	-	-
2006	-	-	-	1.71	0.77	-	-	-
2007	-	-	-	-	4.55	-	0.38	-
2008	-	-	1.28	-	2.09	0.11	-	-
2009	-	-	3.10	0.41	-	-	0.55	-
2010	-	-	0.39	1.23	3.81	-	-	-
2011	-	5.28	2.62	-	-	-	5.31	-
2012	-	3.78	0.28	1.47	0.77	-	-	-
2013	1.42	-	3.06	3.68	-	-	-	6.35
2014	-	-	3.59	-	-	0.99	-	-
2015	0.60	-	-	-	4.17	7.95	-	-
2016	-	-	3.54	1.65	-	1.31	-	-
2017	0.11	1.70	-	0.38	-	0.17	0.96	-
2018	-	-	1.70	2.30	-	-	-	1.22
2019	-	-	-	0.86	3.92	-	0.39	-
2020	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	0.98	-	-
2022	3.30	-	1.90	-	-	-	-	-
Monthly Avg.	1.36	3.63	2.15	1.52	2.87	1.92	1.52	3.79
Total Avg.	2.34							

I4. Synthetic Unit Hydrograph of Beşparmak-Çiftlikdere Reservoir's Catchment



I5. Designed Surface Area-Storage Capacity Curve of Beşparmak-Çiftlikdere Reservoir



I6. Surface Area-Storage Capacity Details of Beşparmak-Çiftlikdere Reservoir due to Sediment Accumulation within the Active Volume at Various Sedimentation Levels

Table I6.1. Surface Area-Storage Capacity details at sedimentation level 1 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
91.5	0	93850	701625
91	0.5	92900	654700
90.5	1	91500	608950
90	1.5	90100	563200
89.5	2	87100	519100
89	2.5	84100	476100
88.5	3	81600	435300
88	3.5	79100	394500
87.5	4	74900	357050
87	4.5	70700	319600
86.5	5	66750	286225
86	5.5	62800	252850
85.5	6	59850	222925
85	6.5	56900	193000
84.5	7	51700	167150
84	7.5	46500	141300
83.5	8	43250	119675
83	8.5	40000	98050
82.5	9	37800	79150
82	9.5	35600	60250
81.5	10	33350	43575
81	10.5	31100	26900
80.5	11	26900	13450
80	11.5	0	0

Table I6.2. Surface Area-Storage Capacity details at sedimentation level 2 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
91.5	0	93850	674725
91	0.5	92900	627800
90.5	1	91500	582050
90	1.5	90100	536300
89.5	2	87100	492200
89	2.5	84100	449200
88.5	3	81600	408400
88	3.5	79100	367600
87.5	4	74900	330150
87	4.5	70700	292700
86.5	5	66750	259325
86	5.5	62800	225950
85.5	6	59850	196025
85	6.5	56900	166100
84.5	7	51700	140250
84	7.5	46500	114400
83.5	8	43250	92775
83	8.5	40000	71150
82.5	9	37800	52250
82	9.5	35600	33350
81.5	10	33350	16675
81	10.5	0	0

Table I6.3. Surface Area-Storage Capacity details at sedimentation level 3 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
91.5	0	93850	641375
91	0.5	92900	594450
90.5	1	91500	548700
90	1.5	90100	502950
89.5	2	87100	458850
89	2.5	84100	415850
88.5	3	81600	375050
88	3.5	79100	334250
87.5	4	74900	296800
87	4.5	70700	259350
86.5	5	66750	225975
86	5.5	62800	192600
85.5	6	59850	162675
85	6.5	56900	132750
84.5	7	51700	106900
84	7.5	46500	81050
83.5	8	43250	59425
83	8.5	40000	37800
82.5	9	37800	18900
82	9.5	0	0

Table I6.4. Surface Area-Storage Capacity details at sedimentation level 4 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
91.5	0	93850	603575
91	0.5	92900	556650
90.5	1	91500	510900
90	1.5	90100	465150
89.5	2	87100	421050
89	2.5	84100	378050
88.5	3	81600	337250
88	3.5	79100	296450
87.5	4	74900	259000
87	4.5	70700	221550
86.5	5	66750	188175
86	5.5	62800	154800
85.5	6	59850	124875
85	6.5	56900	94950
84.5	7	51700	69100
84	7.5	46500	43250
83.5	8	43250	21625
83	8.5	0	0

Table I6.5. Surface Area-Storage Capacity details at sedimentation level 5 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
91.5	0	93850	560325
91	0.5	92900	513400
90.5	1	91500	467650
90	1.5	90100	421900
89.5	2	87100	377800
89	2.5	84100	334800
88.5	3	81600	294000
88	3.5	79100	253200
87.5	4	74900	215750
87	4.5	70700	178300
86.5	5	66750	144925
86	5.5	62800	111550
85.5	6	59850	81625
85	6.5	56900	51700
84.5	7	51700	25850
84	7.5	0	0

Table I6.6. Surface Area-Storage Capacity details at sedimentation level 6 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
91.5	0	93850	508625
91	0.5	92900	461700
90.5	1	91500	415950
90	1.5	90100	370200
89.5	2	87100	326100
89	2.5	84100	283100
88.5	3	81600	242300
88	3.5	79100	201500
87.5	4	74900	164050
87	4.5	70700	126600
86.5	5	66750	93225
86	5.5	62800	59850
85.5	6	59850	29925
85	6.5	0	0

Table I6.7. Surface Area-Storage Capacity details at sedimentation level 7 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
91.5	0	93850	448775
91	0.5	92900	401850
90.5	1	91500	356100
90	1.5	90100	310350
89.5	2	87100	266250
89	2.5	84100	223250
88.5	3	81600	182450
88	3.5	79100	141650
87.5	4	74900	104200
87	4.5	70700	66750
86.5	5	66750	33375
86	5.5	0	0

Table I6.8. Surface Area-Storage Capacity details at sedimentation level 8 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
91.5	0	93850	382025
91	0.5	92900	335100
90.5	1	91500	289350
90	1.5	90100	243600
89.5	2	87100	199500
89	2.5	84100	156500
88.5	3	81600	115700
88	3.5	79100	74900
87.5	4	74900	37450
87	4.5	0	0

Table I6.9. Surface Area-Storage Capacity details at sedimentation level 9 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
91.5	0	93850	307125
91	0.5	92900	260200
90.5	1	91500	214450
90	1.5	90100	168700
89.5	2	87100	124600
89	2.5	84100	81600
88.5	3	81600	40800
88	3.5	0	0

Table I6.10. Surface Area-Storage Capacity details at sedimentation level 10 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
91.5	0	93850	225525
91	0.5	92900	178600
90.5	1	91500	132850
90	1.5	90100	87100
89.5	2	87100	43000
89	2.5	0	0

Table I6.11. Surface Area-Storage Capacity details at sedimentation level 11 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
91.5	0	93850	138425
91	0.5	92900	91500
90.5	1	91500	45750
90	1.5	0	0

Table I6.12. Surface Area-Storage Capacity details at sedimentation level 12 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
91.5	0	93850	46925
91	0.5	0	0

I7. Estimated Monthly Evaporation Volumes from Beşparmak-Çiftlikdere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	5339	9169	9619	11583	16767	19777	17548	15862
2005-2006	9254	5950	3518	41775	5227	8476	11178	13724	18466	19214	16870	13094
2006-2007	6522	2619	2481	15815	2906	6645	8500	4699	Dry	Dry	Dry	Dry
2007-2008	Dry	Dry	Dry	Dry	214	1043	944	Dry	Dry	Dry	Dry	Dry
2008-2009	Dry	Dry	181	1489	2719	3503	3351	4112	2791	Dry	Dry	Dry
2009-2010	Dry	Dry	815	3076	4879	7228	10671	10867	11946	11558	18305	14521
2010-2011	7706	3849	2796	2955	3957	4762	6914	3635	Dry	Dry	Dry	Dry
2011-2012	Dry	354	570	1048	4576	2761	Dry	Dry	Dry	Dry	Dry	Dry
2012-2013	Dry	943	3135	5010	5536	7753	7262	9176	13166	13587	11291	7454
2013-2014	6905	3667	4229	6490	4905	6255	8586	9401	10098	8777	7601	8135
2014-2015	5714	3505	2752	3560	4254	6975	8514	9811	12015	13499	10281	8004
2015-2016	5196	5765	3454	3844	3852	5971	3914	Dry	Dry	Dry	Dry	5047
2016-2017	Dry	Dry	2693	6919	8288	9524	12262	13282	17913	19979	17661	12547
2017-2018	12404	10703	9161	9966	6713	9927	11739	15545	17495	18385	16380	16684
2018-2019	10947	7299	5472	10620	12336	13526	15808	22167	23568	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	6450	8808	10045	14990	15070	13956	12327	8928
2021-2022	6263	2242	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2022-2023	1116	1314	2256	-	-	-	-	-	-	-		-

I8. Estimated Monthly Utilized Volumes from Beşparmak-Çiftlikdere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	38213	85228	47140	140008	0	127201	31913	0
2005-2006	130616	0	20207	0	0	0	92359	21840	10634	8109	23707	0
2006-2007	214035	31944	38531	1231	0	36329	0	284786	Dry	Dry	Dry	Dry
2007-2008	Dry	Dry	Dry	0	0	0	41706	Dry	Dry	Dry	Dry	Dry
2008-2009	Dry	Dry	0	0	3212	7258	0	0	144773	Dry	Dry	Dry
2009-2010	Dry	Dry	0	0	0	0	0	15161	12788	14099	39237	334193
2010-2011	53159	32604	0	0	0	28257	0	225192	Dry	Dry	Dry	Dry
2011-2012	Dry	0	0	0	0	241361	Dry	Dry	Dry	Dry	Dry	Dry
2012-2013	Dry	0	0	0	31403	162757	18257	0	63821	28875	29976	23351
2013-2014	0	26299	0	72142	12943	0	19284	19120	36844	58075	0	29081
2014-2015	11006	0	0	0	0	0	0	69	0	37794	36560	21274
2015-2016	0	29526	0	0	29028	0	203759	Dry	Dry	Dry	Dry	0
2016-2017	Dry	Dry	0	0	105428	0	0	101352	107891	0	76453	68107
2017-2018	0	0	54881	0	47436	77986	42942	0	0	54091	0	0
2018-2019	135942	61829	0	0	0	197962	0	0	0	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	16697	0	11036	501	11496	411	14804	19507
2021-2022	20252	132153	0	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2022-2023	0	0	0	-	-	-	-	-	-	-		-

I9. Estimated Monthly Effective Runoff Volumes of Beşparmak-Çiftlikdere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Total
2004-2005	-	-	-	-	0	0	0	0	0
2005-2006	0	217401	0	27834	15555	0	0	0	260789
2006-2007	0	0	0	0	172516	0	36988	0	209504
2007-2008	0	0	0	0	14266	29452	0	0	43718
2008-2009	0	0	11668	121193	0	0	30155	0	163016
2009-2010	0	0	71519	246122	228988	0	0	0	546628
2010-2011	0	0	40531	0	0	0	20749	0	61280
2011-2012	0	20108	23806	51531	147219	0	0	0	242664
2012-2013	0	71025	268240	71685	0	0	0	145731	556680
2013-2014	38336	0	124106	0	0	75115	0	0	237557
2014-2015	0	0	59777	0	30536	13394	0	0	103707
2015-2016	94213	0	0	25723	0	44060	0	0	163997
2016-2017	0	0	322938	51330	0	138228	98607	0	611104
2017-2018	200673	73027	0	139866	0	0	0	90740	504305
2018-2019	0	0	133547	262878	42099	0	192166	0	630690
2019-2020	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	0	24565	0	0	24565
2021-2022	0	0	0	0	0	0	0	0	0
2022-2023	46957	0	153466	-	-	-	-	-	200424
Average	23761	23848	75600	66544	38305	19107	22274	13910	253368

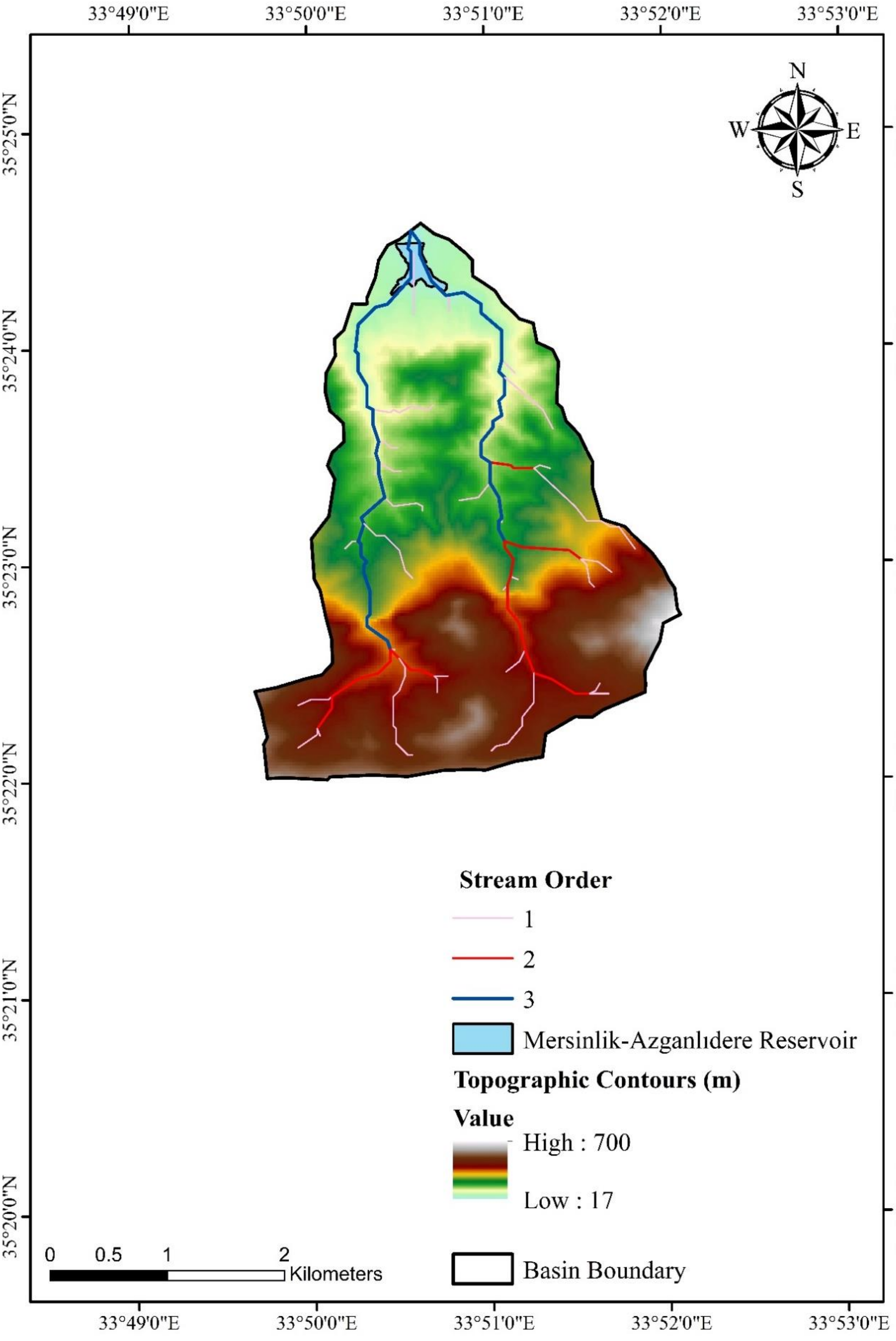
Appendix J: Mersinlik-Azganlıdere Reservoir

The Mersinlik-Azganlıdere Reservoir was constructed by the Republic of Turkey in 1989, situated within the Azganlıdere Basin of Mersinlik village, İskele region. The primary purpose of this reservoir's construction was to provide irrigation for approximately 170 hectares of land for the nearby surrounding area.

However, since 2013, the measurement of the reservoir's volume has become a challenging task due to the substantial proliferation of vegetation in its vicinity. Attempts were made by the Water Works Office to clean the vegetation surrounding the reservoir by using heavy vehicles aiming to facilitate volume readings. Unfortunately, these efforts had to be halted, as concerns arose regarding the potential damage to the dam crest's rip-rap structure during the vegetation removal process.

Thalweg Elevation	22	m
Bottom Elevation of Weir (Spillway)	27	m
Normal Water Level	42	m
Maximum Water Elevation	43.50	m
Crest Level	44.30	m
Maximum Active Volume Depth	15	m
Dead Storage	49.370	m^3
Active (Live) Storage Capacity	1145065	m^3
Spillway Type	Ogee	-
Catchment Area (Delineated from ArcGIS)	10.165	km^2

J1. Delineated Mersinlik-Azganlıdere Reservoir's Catchment with Strahler's Stream Order



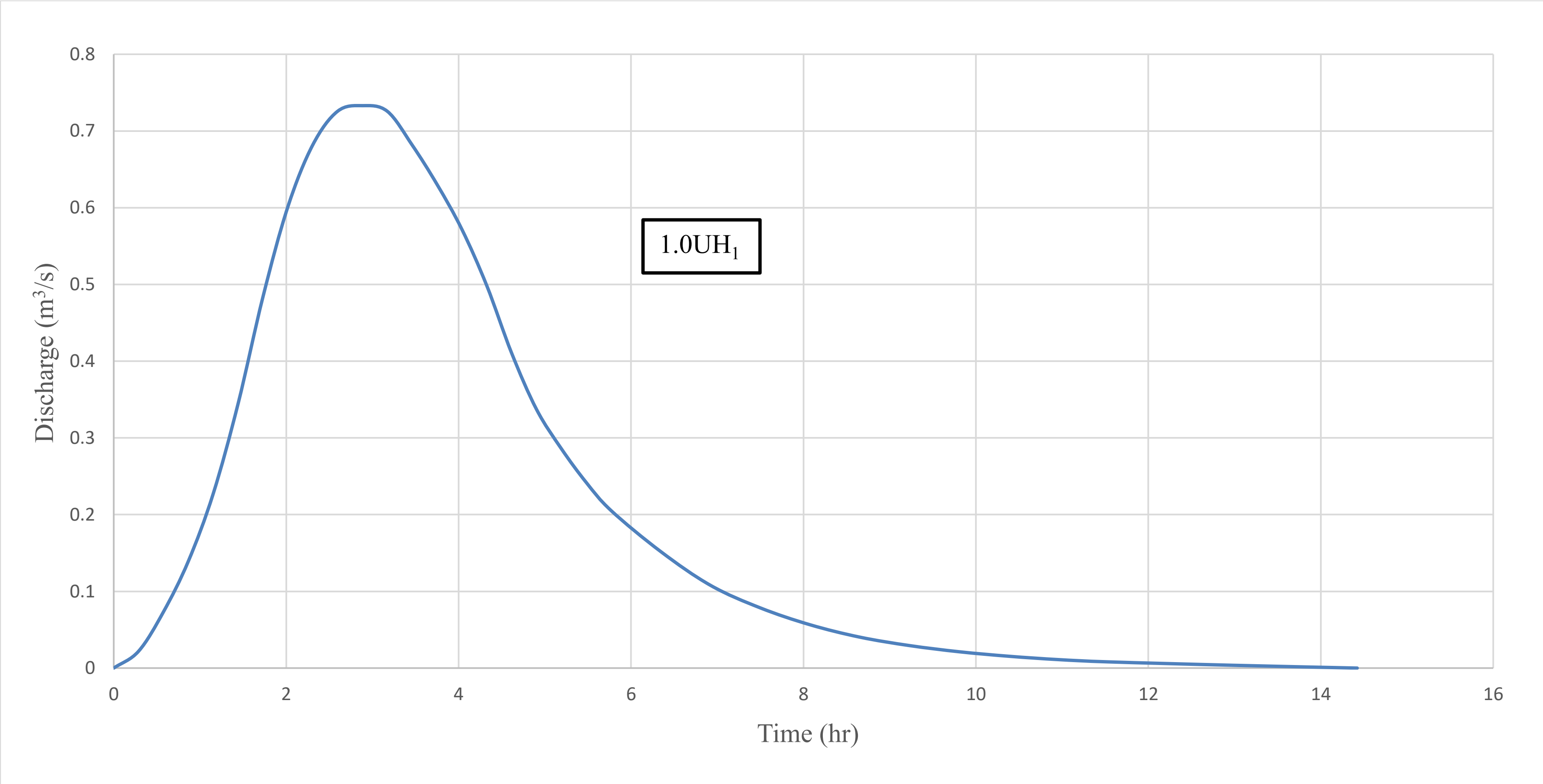
J2. Geomorphological Details of Mersinlik-Azganlıdere Reservoir's Catchment

Name of Parameter	Unit	Catchment's Value
Stream Order	-	3
Total Number of 1st Order Stream	-	31
Total Number of 2nd Order Stream	-	5
Total Number of 3rd Order Stream	-	2
Total Number of All Order Streams	-	38
Basin Length	km	4.8
Basin Perimeter	km	14.5
Length of Main Channel	km	5.4
Length of Highest Order Stream	km	7.4
Length of 1st Order Stream	km	9.3
Length of 2nd Order Stream	km	4.3
Length of All Order Streams	km	21.0
Basin Area	km^2	10.2
Basin Maximum Elevation	m	700
Basin Minimum Elevation	m	17
Maximum Stream Elevation	m	459
Minimum Stream Elevation	m	17
Mean Bifurcation Ratio	-	4.4
Bifurcation Ratio Order 1:2	-	6.2
Bifurcation Ratio Order 2:3	-	2.5
Circularity Ratio	-	0.608
Quadratic Harmonic Mean Slope	-	0.068

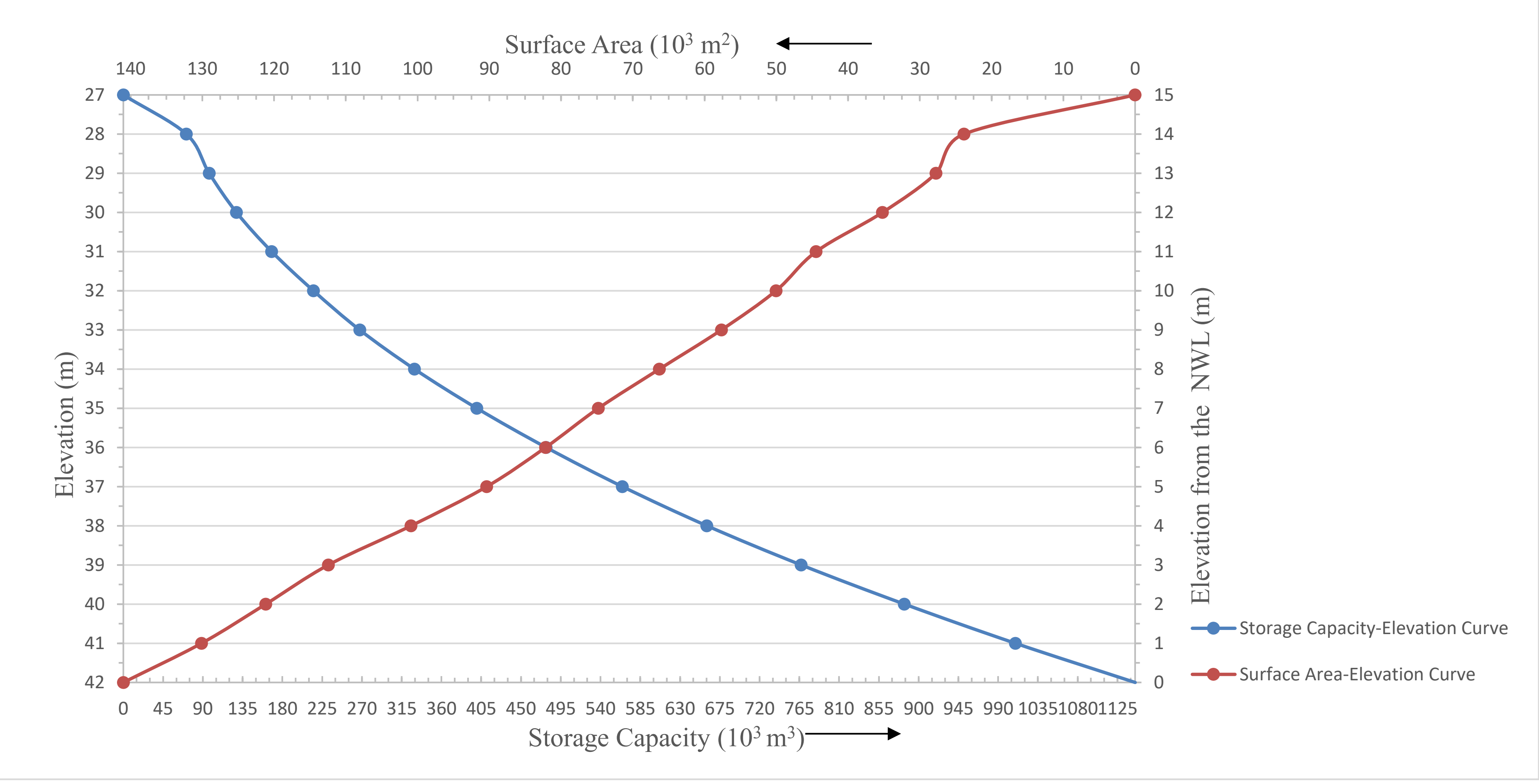
J3. Estimated Monthly Φ Index Values of Mersinlik-Azganlıdere Reservoir's Catchment (mm/hr)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2005	-	4.45	-	-	-	-	-	-
2006	1.95	-	-	1.90	-	1.78	-	-
2007	-	-	1.01	-	2.75	-	-	1.28
2008	-	2.18	2.23	-	1.61	-	-	-
2009	1.48	2.05	4.72	-	2.09	2.39	-	-
2010	4.10	-	1.34	-	-	-	-	2.71
2011	-	7.62	-	-	1.08	-	2.38	1.60
2012	-	2.99	0.62	3.02	1.07	0.92	1.86	2.52
2013	2.11	-	-	1.60	-	-	2.99	2.23
2014	-	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-	-
2019	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	-
2022	-	-	-	-	-	-	-	-
Monthly Avg.	2.41	3.86	1.98	2.17	1.72	1.70	2.41	2.07
Total Avg.	2.29							

J4. Synthetic Unit Hydrograph of Mersinlik-Azganlıdere Reservoir's Catchment



J5. Designed Surface Area-Storage Capacity Curve of Mersinlik-Azganlıdere Reservoir



J6. Surface Area-Storage Capacity Details of Mersinlik-Azganlıdere Reservoir due to Sediment Accumulation within the Active Volume at Various Sedimentation Levels

Table J6.1. Surface Area-Storage Capacity details at sedimentation level 1 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
42	0	141000	1073725
41	1	130100	938175
40	2	121150	812550
39	3	112430	695760
38	4	100900	589095
37	5	90350	493450
36	6	82150	407180
35	7	74800	328705
34	8	66300	258155
33	9	57660	196175
32	10	50050	143820
31	11	44450	96570
30	12	35200	56745
29	13	27740	25800
28	14	0	0

Table J6.2. Surface Area-Storage Capacity details at sedimentation level 2 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
42	0	141000	1047925
41	1	130100	912375
40	2	121150	786750
39	3	112430	669960
38	4	100900	563295
37	5	90350	467650
36	6	82150	381380
35	7	74800	302905
34	8	66300	232355
33	9	57660	170375
32	10	50050	118020
31	11	44450	70770
30	12	35200	30945
29	13	0	0

Table J6.3. Surface Area-Storage Capacity details at sedimentation level 3 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
42	0	141000	1016980
41	1	130100	881430
40	2	121150	755805
39	3	112430	639015
38	4	100900	532350
37	5	90350	436705
36	6	82150	350435
35	7	74800	271960
34	8	66300	201410
33	9	57660	139430
32	10	50050	87075
31	11	44450	39825
30	12	0	0

Table J6.4. Surface Area-Storage Capacity details at sedimentation level 4 m.

Elevation(m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
42	0	141000	977155
41	1	130100	841605
40	2	121150	715980
39	3	112430	599190
38	4	100900	492525
37	5	90350	396880
36	6	82150	310610
35	7	74800	232135
34	8	66300	161585
33	9	57660	99605
32	10	50050	47250
31	11	0	0

Table J6.5. Surface Area-Storage Capacity details at sedimentation level 5 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
42	0	141000	929905
41	1	130100	794355
40	2	121150	668730
39	3	112430	551940
38	4	100900	445275
37	5	90350	349630
36	6	82150	263360
35	7	74800	184885
34	8	66300	114335
33	9	57660	52355
32	10	0	0

Table J6.6. Surface Area-Storage Capacity details at sedimentation level 6 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
42	0	141000	877550
41	1	130100	742000
40	2	121150	616375
39	3	112430	499585
38	4	100900	392920
37	5	90350	297275
36	6	82150	211005
35	7	74800	132530
34	8	66300	61980
33	9	0	0

Table J6.7. Surface Area-Storage Capacity details at sedimentation level 7 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
42	0	141000	815570
41	1	130100	680020
40	2	121150	554395
39	3	112430	437605
38	4	100900	330940
37	5	90350	235295
36	6	82150	149025
35	7	74800	70550
34	8	0	0

Table J6.8. Surface Area-Storage Capacity details at sedimentation level 8 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
42	0	141000	745020
41	1	130100	609470
40	2	121150	483845
39	3	112430	367055
38	4	100900	260390
37	5	90350	164745
36	6	82150	78475
35	7	0	0

Table J6.9. Surface Area-Storage Capacity details at sedimentation level 9 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
42	0	141000	666545
41	1	130100	530995
40	2	121150	405370
39	3	112430	288580
38	4	100900	181915
37	5	90350	86270
36	6	0	0

Table J6.10. Surface Area-Storage Capacity details at sedimentation level 10 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
42	0	141000	580275
41	1	130100	444725
40	2	121150	319100
39	3	112430	202310
38	4	100900	95645
37	5	0	0

Table J6.11. Surface Area-Storage Capacity details at sedimentation level 11 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
42	0	141000	484630
41	1	130100	349080
40	2	121150	223455
39	3	112430	106665
38	4	0	0

Table J6.12. Surface Area-Storage Capacity details at sedimentation level 12 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
42	0	141000	377965
41	1	130100	242415
40	2	121150	116790
39	3	0	0

Table J6.13. Surface Area-Storage Capacity details at sedimentation level 13 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
42	0	141000	261175
41	1	130100	125625
40	2	0	0

Table J6.14. Surface Area-Storage Capacity details at sedimentation level 14 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
42	0	141000	135550
41	1	130100	0

J7. Estimated Monthly Evaporation Volumes from Mersinlik-Azganlıdere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	8453	11444	11421	14095	18680	22086	15945	15936
2005-2006	14565	8561	6151	57310	7512	10481	15267	18226	19479	18156	17344	14982
2006-2007	11699	9325	9393	51114	7795	11793	11465	14795	24347	26000	21658	16339
2007-2008	13393	8567	7783	57234	10717	12661	14183	15570	18645	19011	16391	13233
2008-2009	11805	6998	6423	5953	3590	7336	11946	16289	16696	15907	12668	9660
2009-2010	7128	5300	5322	4304	5466	8016	10873	11590	14677	15392	14770	11547
2010-2011	9204	5786	4471	5098	6213	5679	6332	9934	13246	14265	12924	9042
2011-2012	6356	5637	4252	4866	6086	10892	14015	13597	15929	16932	16180	12078
2012-2013	9170	7820	6167	9753	11287	14841	17268	21714	20717	14824	11608	9936
2013-2014	10936	-	-	-	-	-	-	-	-	-	-	-
2014-2015	-	-	-	-	-	-	-	-	-	-	-	-
2015-2016	-	-	-	-	-	-	-	-	-	-	-	-
2016-2017	-	-	-	-	-	-	-	-	-	-	-	-
2017-2018	-	-	-	-	-	-	-	-	-	-	-	-
2018-2019	-	-	-	-	-	-	-	-	-	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	-	-	-	-	-	-	-	-
2021-2022	-	-	-	-	-	-	-	-	-	-	-	-
2022-2023	-	-	-	-	-	-	-	-	-	-	-	-

J8. Estimated Monthly Utilized Volumes from Mersinlik-Azganlıdere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	34887	61507	59377	45216	0	135124	120981	0
2005-2006	90896	0	49678	0	0	0	69126	15935	54589	0	70546	70250
2006-2007	0	14214	51122	10894	0	59247	41585	0	48978	58968	55839	47004
2007-2008	6911	52123	0	39975	0	42274	29540	0	2098	2905	3195	3114
2008-2009	0	0	0	245843	0	0	23220	23348	27780	31658	29978	0
2009-2010	0	0	0	30955	0	4994	17828	0	0	22803	25354	13911
2010-2011	0	23606	0	55070	0	16500	0	0	0	20416	21489	3479
2011-2012	0	0	18291	0	0	0	0	0	23682	27875	30356	9053
2012-2013	528	0	0	0	0	0	17828	0	0	2386	3865	10432
2013-2014	0	-	-	-	-	-	-	-	-	-	-	-
2014-2015	-	-	-	-	-	-	-	-	-	-	-	-
2015-2016	-	-	-	-	-	-	-	-	-	-	-	-
2016-2017	-	-	-	-	-	-	-	-	-	-	-	-
2017-2018	-	-	-	-	-	-	-	-	-	-	-	-
2018-2019	-	-	-	-	-	-	-	-	-	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	-	-	-	-	-	-	-	-
2021-2022	-	-	-	-	-	-	-	-	-	-	-	-
2022-2023	-	-	-	-	-	-	-	-	-	-	-	-

J9. Estimated Monthly Effective Runoff Volumes of Mersinlik-Azganlıdere Reservoir (m^3)

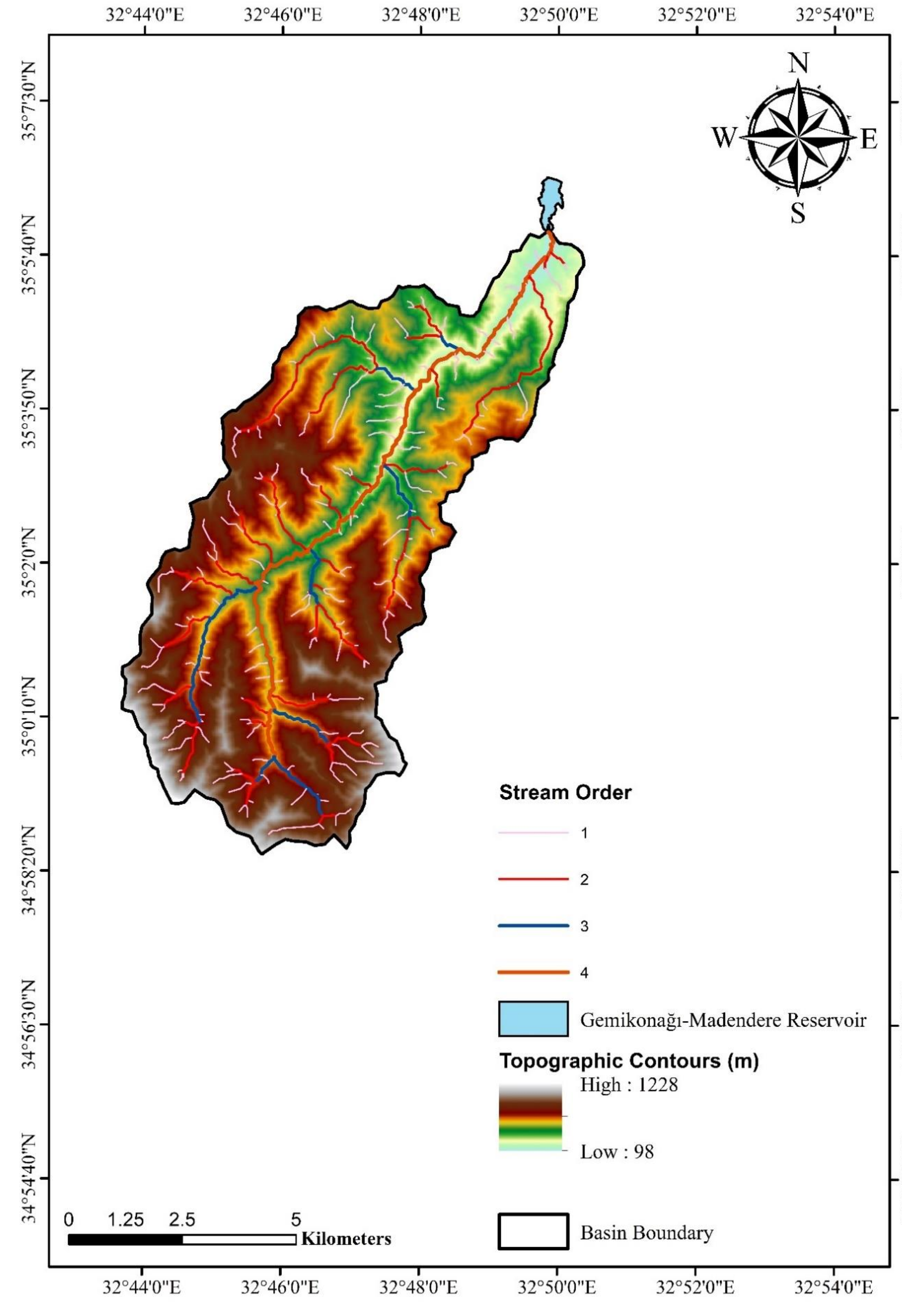
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Total
2004-2005	-	-	-	-	0	0	0	0	0
2005-2006	0	146283	0	73099	0	80076	0	0	299459
2006-2007	158645	0	0	0	172490	0	0	352635	683771
2007-2008	0	0	134623	0	78958	0	0	0	213581
2008-2009	0	26086	45811	0	88571	154765	0	0	315233
2009-2010	17964	26487	119802	0	0	0	0	73120	237373
2010-2011	21473	0	26817	0	48594	0	16151	30055	143091
2011-2012	0	26412	0	77041	59759	62111	31071	31541	287934
2012-2013	0	78584	320028	87953	0	0	129045	11955	627565
2013-2014	24057	-	-	-	-	-	-	-	24057
2014-2015	-	-	-	-	-	-	-	-	-
2015-2016	-	-	-	-	-	-	-	-	-
2016-2017	-	-	-	-	-	-	-	-	-
2017-2018	-	-	-	-	-	-	-	-	-
2018-2019	-	-	-	-	-	-	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	-	-	-	-	-
2021-2022	-	-	-	-	-	-	-	-	-
2022-2023	-	-	-	-	-	-	-	-	-
Average	24682	37981	80885	29762	49819	32995	19585	55478	283206

Appendix K: Gemikonağı-Madendere Reservoir

Gemikonağı-Madendere has the biggest volume amongst the studied reservoirs. It was constructed by Republic of Turkey in 1995. İt is fed by the Madendere river originated from the foothills of the Troodos Mountains. The reservoir was constructed to irrigate 130 hectares of the land. Due to the presence of sedimentation having 218 meters in width and 42.30 meters in depth from the talweg of the reservoir, foundation improvement became imperative. To address this geological challenge, the Frazer technique and Slurry Trench method were adopted to be the effective solutions.

Thalweg Elevation	72.50	m
Bottom Elevation of Weir (Spillway)	78.50	m
Normal Water Level	96.50	m
Maximum Water Elevation	98.70	m
Crest Level	99.50	m
Maximum Active Volume Depth	18	m
Dead Storage	156580	m^3
Active (Live) Storage Capacity	4121205	m^3
Spillway Type	Ogee	-
Catchment Area (Delineated from ArcGIS)	67.845	km^2

K1. Delineated Gemikonağı-Madendere Reservoir's Catchment with Strahler's Stream Order



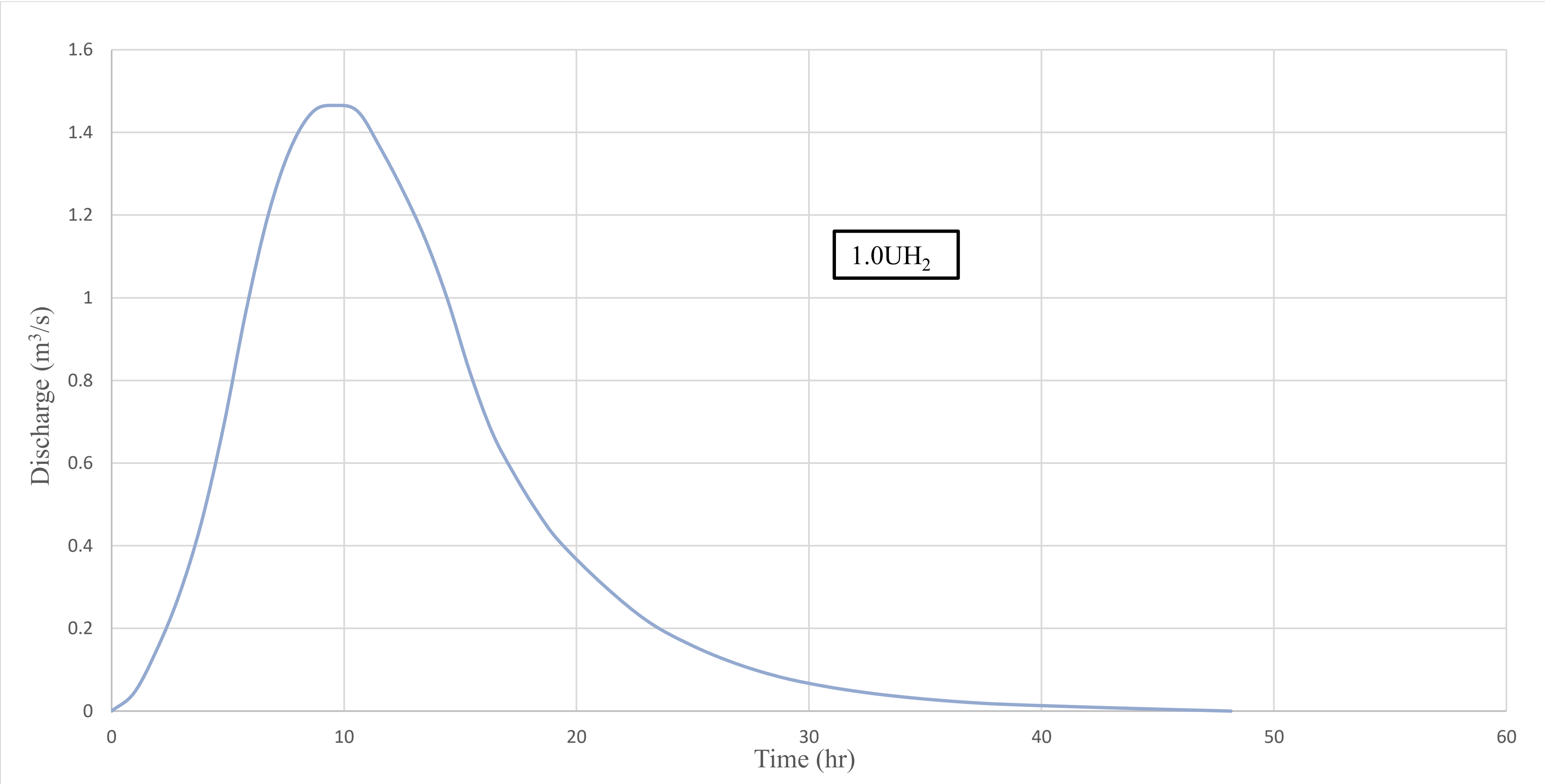
K2. Geomorphological Details of Gemikonağı-Madendere Reservoir's Catchment

Name of Parameter	Unit	Catchment's Value
Stream Order	-	4
Total Number of 1st Order Stream	-	251
Total Number of 2nd Order Stream	-	33
Total Number of 3rd Order Stream	-	8
Total Number of 4th Order Stream	-	1
Total Number of All Order Streams	-	293
Basin Length	km	15.2
Basin Perimeter	km	44.1
Length of Main Channel	km	19.8
Length of Highest Order Stream	km	16.72
Length of 1st Order Stream	km	59.8
Length of 2nd Order Stream	km	39.9
Length of 3rd Order Stream	km	12.7
Length of All Order Streams	km	129.2
Basin Area	km^2	67.8
Basin Maximum Elevation	m	1228
Basin Minimum Elevation	m	98
Maximum Stream Elevation	m	944
Minimum Stream Elevation	m	98
Mean Bifurcation Ratio	-	5.9
Bifurcation Ratio Order 1:2	-	7.6
Bifurcation Ratio Order 2:3	-	4.1
Circularity Ratio	-	0.439
Quadratic Harmonic Mean Slope	-	0.032

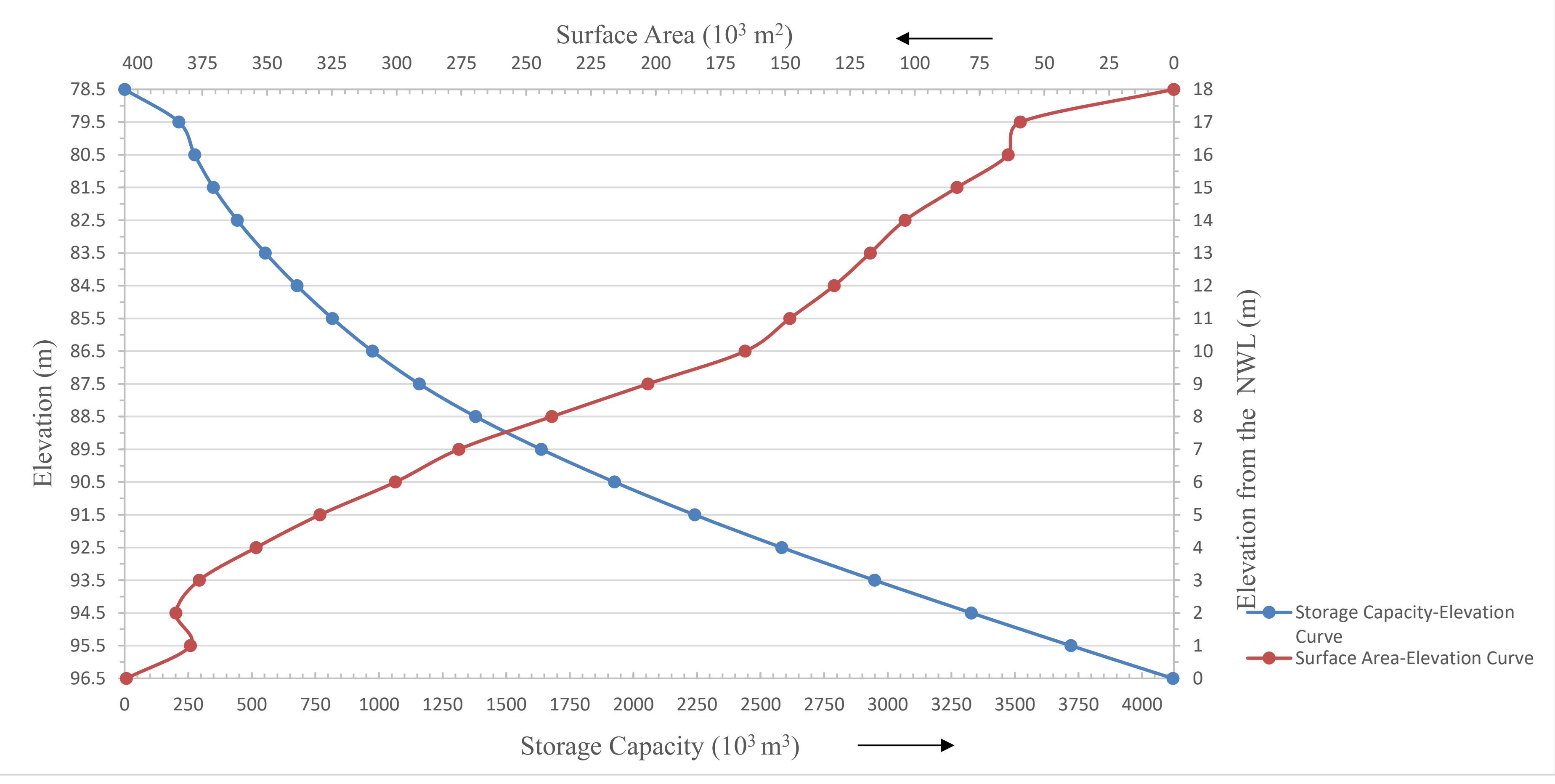
K3. Estimated Monthly Φ Index Values of Gemikonağı-Madendere Reservoir's Catchment (mm/hr)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2005	-	-	-	-	1.40	-	0.12	-
2006	0.31	-	-	0.70	0.46	0.58	-	-
2007	-	-	-	-	-	-	0.38	8.88
2008	-	-	-	-	0.70	0.17	-	-
2009	-	-	1.15	-	1.16	0.29	0.83	-
2010	-	-	-	1.67	0.64	-	-	-
2011	-	-	-	-	-	-	0.01	-
2012	1.39	1.06	0.38	0.98	0.30	-	-	-
2013	-	1.94	-	-	-	-	-	-
2014	-	1.02	0.79	-	-	-	-	-
2015	-	-	-	0.87	0.31	0.15	-	0.84
2016	-	-	-	-	-	-	-	-
2017	-	-	-	0.44	-	0.09	-	-
2018	-	-	-	1.05	1.67	0.38	-	2.52
2019	-	-	-	0.14	-	-	-	-
2020	-	-	-	-	-	-	-	-
2021	-	-	1.61	-	-	0.14	0.15	-
2022	1.97	0.57	-	0.44	0.35	0.60	-	-
Monthly Avg.	1.23	1.15	0.98	0.79	0.78	0.30	0.30	4.08
Total Avg.	1.20							

K4. Synthetic Unit Hydrograph of Gemikonağı-Madendere Reservoir's Catchment



K5. Designed Surface Area-Storage Capacity Curve of Gemikonağı-Madendere Reservoir



K6. Surface Area-Storage Capacity Details of Gemikonağı-Madendere Reservoir due to Sediment Accumulation within the Active Volume at Various Sedimentation Levels

Table K6.1. Surface Area-Storage Capacity details at sedimentation level 2 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
96.5	0	404310	3846130
95.5	1	379610	3445170
94.5	2	385210	3053760
93.5	3	376200	2673055
92.5	4	354220	2307845
91.5	5	329600	1965935
90.5	6	300500	1650885
89.5	7	276000	1362635
88.5	8	240160	1104555
87.5	9	203000	882975
86.5	10	165480	698735
85.5	11	148250	541870
84.5	12	131130	402180
83.5	13	117210	278010
82.5	14	103720	167545
81.5	15	83720	73825
80.5	16	0	0

Table K6.2. Surface Area-Storage Capacity details at sedimentation level 4 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
96.5	0	404310	3678585
95.5	1	379610	3277625
94.5	2	385210	2886215
93.5	3	376200	2505510
92.5	4	354220	2140300
91.5	5	329600	1798390
90.5	6	300500	1483340
89.5	7	276000	1195090
88.5	8	240160	937010
87.5	9	203000	715430
86.5	10	165480	531190
85.5	11	148250	374325
84.5	12	131130	234635
83.5	13	117210	110465
82.5	14	0	0

Table K6.3. Surface Area-Storage Capacity details at sedimentation level 6 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
96.5	0	404310	3443950
95.5	1	379610	3042990
94.5	2	385210	2651580
93.5	3	376200	2270875
92.5	4	354220	1905665
91.5	5	329600	1563755
90.5	6	300500	1248705
89.5	7	276000	960455
88.5	8	240160	702375
87.5	9	203000	480795
86.5	10	165480	296555
85.5	11	148250	139690
84.5	12	0	0

Table K6.4. Surface Area-Storage Capacity details at sedimentation level 8 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
96.5	0	404310	3147395
95.5	1	379610	2746435
94.5	2	385210	2355025
93.5	3	376200	1974320
92.5	4	354220	1609110
91.5	5	329600	1267200
90.5	6	300500	952150
89.5	7	276000	663900
88.5	8	240160	405820
87.5	9	203000	184240
86.5	10	0	0

Table K6.5. Surface Area-Storage Capacity details at sedimentation level 10 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
96.5	0	404310	2741575
95.5	1	379610	2340615
94.5	2	385210	1949205
93.5	3	376200	1568500
92.5	4	354220	1203290
91.5	5	329600	861380
90.5	6	300500	546330
89.5	7	276000	258080
88.5	8	0	0

Table K6.6. Surface Area-Storage Capacity details at sedimentation level 12 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
96.5	0	404310	2195245
95.5	1	379610	1794285
94.5	2	385210	1402875
93.5	3	376200	1022170
92.5	4	354220	656960
91.5	5	329600	315050
90.5	6	0	0

Table K6.7. Surface Area-Storage Capacity details at sedimentation level 14 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
96.5	0	404310	1538285
95.5	1	379610	1137325
94.5	2	385210	745915
93.5	3	376200	365210
92.5	4	0	0

Table K6.8. Surface Area-Storage Capacity details at sedimentation level 16 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
96.5	0	404310	792370
95.5	1	379610	391410
94.5	2	0	0

K7. Estimated Monthly Evaporation Volumes from Gemikonağı-Madendere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	1979	3098	13218	30888	32991	34552	33181	15769
2005-2006	1913	1832	1929	22968	5618	6794	8944	11290	11299	6059	1459	Dry
2006-2007	6083	7667	7583	51571	6887	8261	23736	40683	64290	69454	60192	49074
2007-2008	31144	17020	10097	72558	8744	19918	24356	24460	14234	Dry	Dry	Dry
2008-2009	Dry	Dry	Dry	Dry	2171	14387	29863	41947	53003	44335	24216	28006
2009-2010	24116	8112	6327	11219	26814	30427	52608	63750	77640	79061	79589	45688
2010-2011	8658	Dry	Dry	Dry	Dry	462	13876	31618	40076	37023	36299	25999
2011-2012	18065	9614	8822	11831	31384	41381	51468	60750	80324	89624	86542	56059
2012-2013	29059	19440	14735	27075	26361	48683	67455	75087	89446	91548	82988	70474
2013-2014	35970	9088	8411	6766	3740	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2014-2015	Dry	2398	2731	6883	14085	37627	50917	63797	74980	82381	81470	62725
2015-2016	30724	17280	11774	7700	9890	8292	Dry	Dry	Dry	Dry	Dry	Dry
2016-2017	Dry	Dry	Dry	3637	6546	14243	35315	36352	32426	41488	47749	34296
2017-2018	16357	6369	4931	5348	13225	31783	38316	52053	72877	80947	48430	22702
2018-2019	13091	5599	3216	10144	20158	34078	44624	77834	80540	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	6584	18375	45779	78079	72526	65065	44408	23124
2021-2022	11446	3191	2787	10444	23190	31434	66449	68491	67363	70216	50897	47487
2022-2023	36484	23302	10625	-	-	-	-	-	-	-	-	-

K8. Estimated Monthly Utilized Volumes from Gemikonağı-Madendere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	0	140314	0	131417	0	0	0	777355
2005-2006	19730	0	17846	0	0	0	32576	0	81187	87717	47279	0
2006-2007	0	11819	41221	0	63313	113395	0	0	82167	95006	92392	82134
2007-2008	598846	0	0	615492	0	0	121239	92076	542443	Dry	Dry	Dry
2008-2009	Dry	Dry	Dry	0	0	0	0	0	116092	636575	232790	0
2009-2010	732437	302350	0	0	0	0	30555	36860	42674	45624	46644	0
2010-2011	691890	0	0	Dry	Dry	0	0	42801	57983	63464	71423	57398
2011-2012	148812	0	56773	0	0	0	317046	319385	0	307280	275105	1739730
2012-2013	0	0	0	0	0	0	0	0	771453	0	18770	16449
2013-2014	2510817	0	0	325001	232498	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2014-2015	Dry	0	0	0	0	0	201084	0	281950	236334	249062	0
2015-2016	2002185	61984	39897	694559	0	546048	Dry	Dry	Dry	Dry	Dry	Dry
2016-2017	Dry	Dry	Dry	0	558571	0	305666	242110	388746	0	44318	36876
2017-2018	760870	0	105725	0	0	0	583623	0	0	118530	1224580	39608
2018-2019	138800	29527	169627	0	0	0	0	0	0	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	518198	0	0	71974	600637	572798	517729	362580
2021-2022	71150	310965	0	0	0	0	652891	63661	273589	329708	298880	0
2022-2023	0	0	1311766	-	-	-	-	-	-	-	-	-

K9. Estimated Monthly Effective Runoff Volumes of Gemikonağı-Madendere Reservoir (m^3)

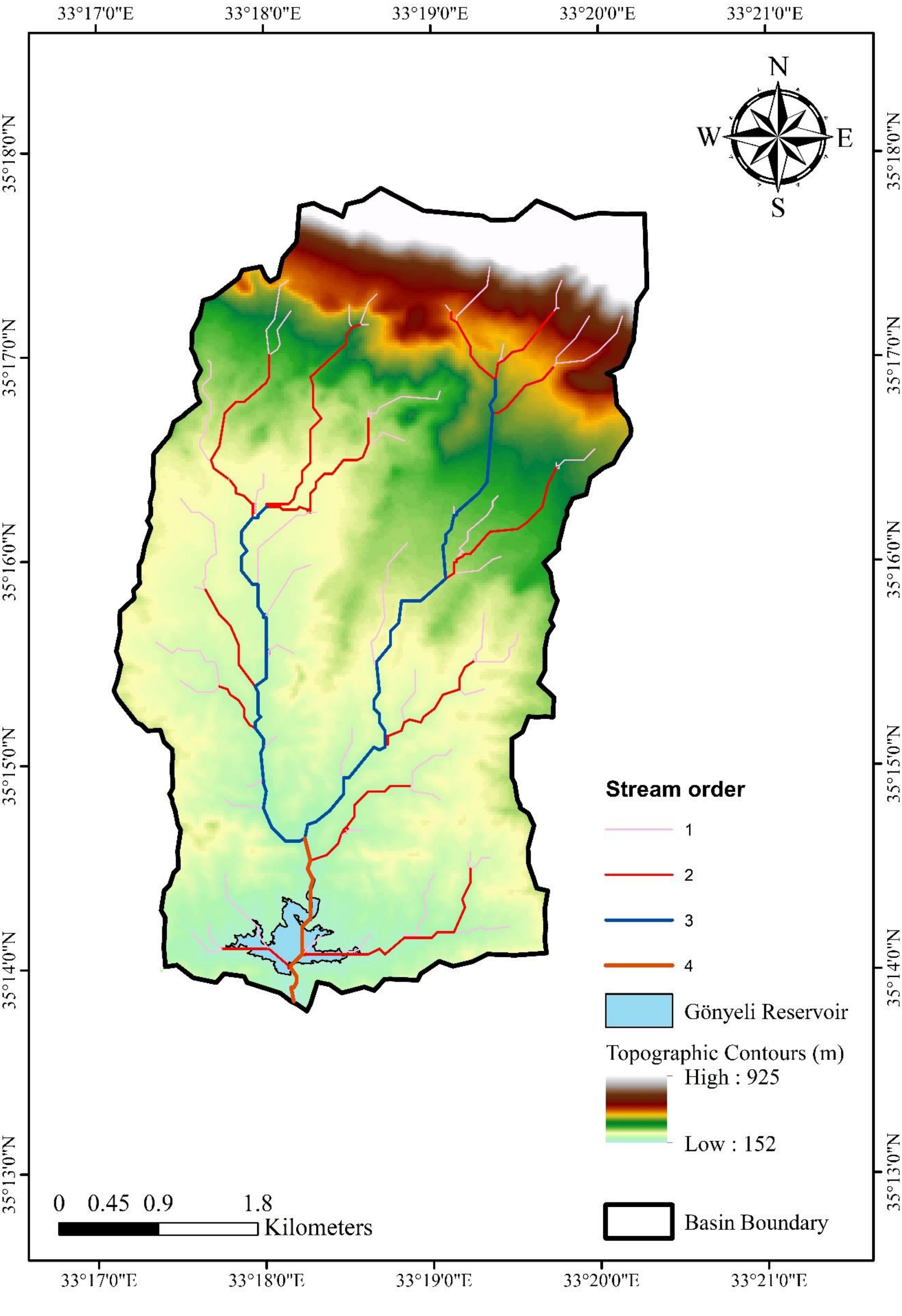
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Total
2004-2005	-	-	-	-	169682	0	1046753	0	1216435
2005-2006	0	0	0	156310	0	0	0	0	156310
2006-2007	477701	0	0	0	0	0	1374752	531047	2383499
2007-2008	0	0	0	0	141982	374346	0	0	516328
2008-2009	0	0	0	0	217047	1231806	85310	0	1534162
2009-2010	0	0	321654	1281760	2255574	0	0	0	3858988
2010-2011	0	0	0	0	0	0	1188750	0	1188750
2011-2012	0	0	0	1111176	2406039	0	0	0	3517215
2012-2013	206788	144764	2319006	Overflow	Overflow	Overflow	Overflow	Overflow	2670559
2013-2014	0	91043	0	0	0	0	0	0	91043
2014-2015	0	219776	219285	561417	1562160	1573679	0	292945	4429261
2015-2016	0	0	0	0	0	0	0	0	0
2016-2017	0	0	0	698850	0	1541926	0	0	2240776
2017-2018	0	0	0	461294	149854	707137	0	1201386	2519671
2018-2019	0	0	0	3978824	Overflow	Overflow	Overflow	0	3978824
2019-2020	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	0	1478988	1000611	0	2479600
2021-2022	0	0	510145	2239128	240859	125679	0	0	3115811
2022-2023	187502	116215	0	-	-	-	-	-	303717
Average	54499	35737	210631	749197	476213	468904	313078	126586	2011164

Appendix L: Gönyeli Reservoir

The Gönyeli Reservoir, constructed in 1962 by the Water Division Department of Cyprus to irrigate 85 hectares of land, underwent a significant transformation when its irrigation system was removed following the events of 1974. As a result, the reservoir ceased its agricultural function and has since been repurposed for fishing and recreational activities(Şener, 1997). DSİ conducted research about Gönyeli Reservoir and found out that reservoir's current active storage capacity had reduced significantly to 453 857 cubic meters from 1 MCM due to sedimentation.

Thalweg Elevation	148.19	m
Bottom Elevation of Weir (Spillway)	155	m
Normal Water Level	164	m
Maximum Water Elevation	166.65	m
Crest Level	166.65	m
Maximum Active Volume Depth	9	m
Total Storage Capacity	1045000	m^3
Active (Live) Storage Capacity	1000000	m^3
Spillway Type	Ogee	-
Catchment Area (Delineated from ArcGIS)	25.144	km^2

L1. Delineated Gönyeli Reservoir's Catchment with Strahler's Stream Order



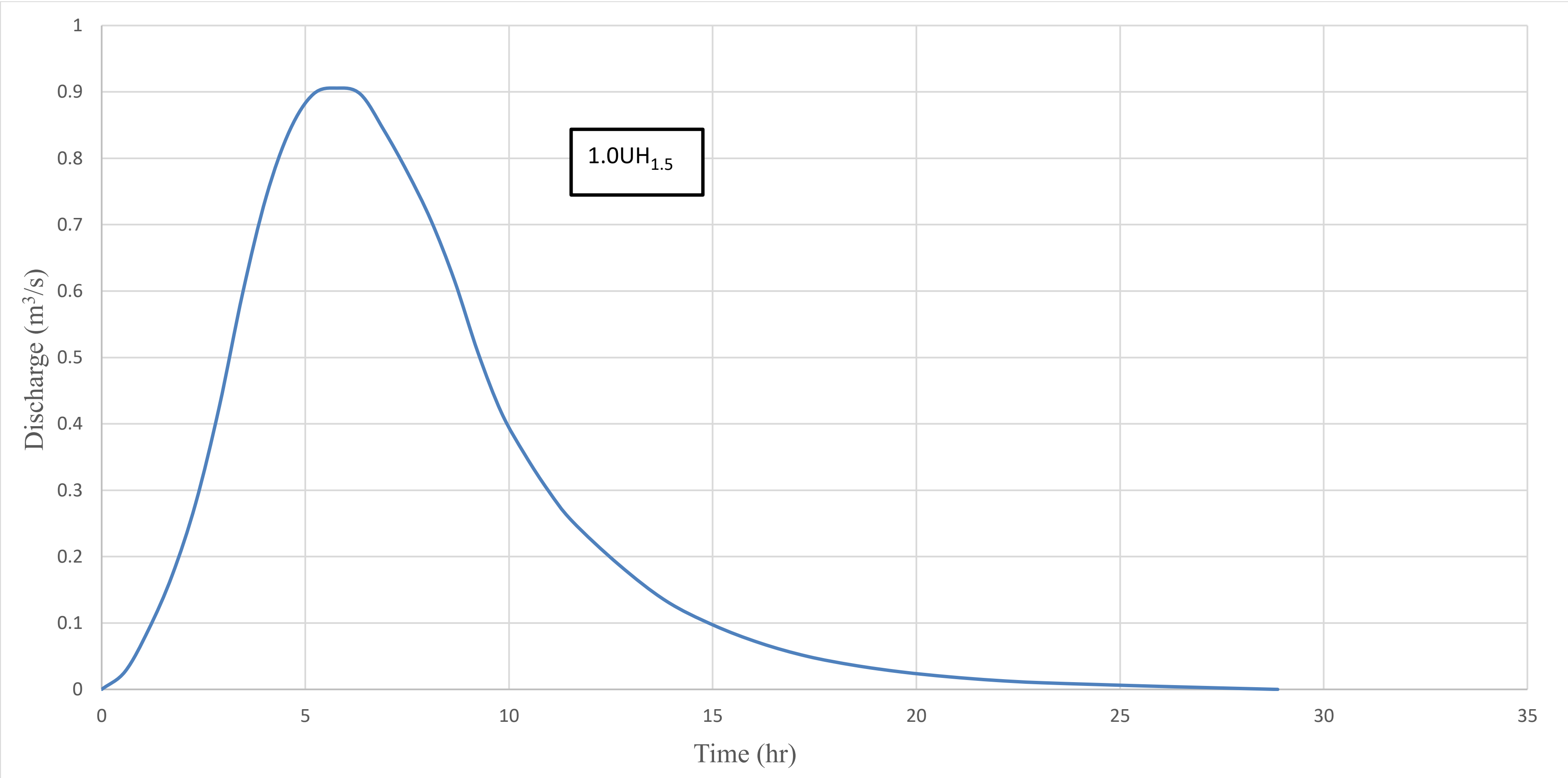
L2. Geomorphological Details of Gönyeli Reservoir's Catchment

Name of Parameter	Unit	Catchment's Value
Stream Order	-	4
Total Number of 1st Order Stream	-	104
Total Number of 2nd Order Stream	-	13
Total Number of 3rd Order Stream	-	2
Total Number of 4th Order Stream	-	1
Total Number of All Order Streams	-	120
Basin Length	km	7.8
Basin Perimeter	km	23.6
Length of Main Channel	km	8.0
Length of Highest Order Stream	km	1.7
Length of 1st Order Stream	km	22.9
Length of 2nd Order Stream	km	16.8
Length of 3rd Order Stream	km	9.0
Length of All Order Streams	km	50.4
Basin Area	km^2	25.1
Basin Maximum Elevation	m	925
Basin Minimum Elevation	m	152
Maximum Stream Elevation	m	507
Minimum Stream Elevation	m	152
Mean Bifurcation Ratio	-	7.3
Bifurcation Ratio Order 1:2	-	8.0
Bifurcation Ratio Order 2:3	-	6.5
Circularity Ratio	-	0.565
Quadratic Harmonic Mean Slope	-	0.022

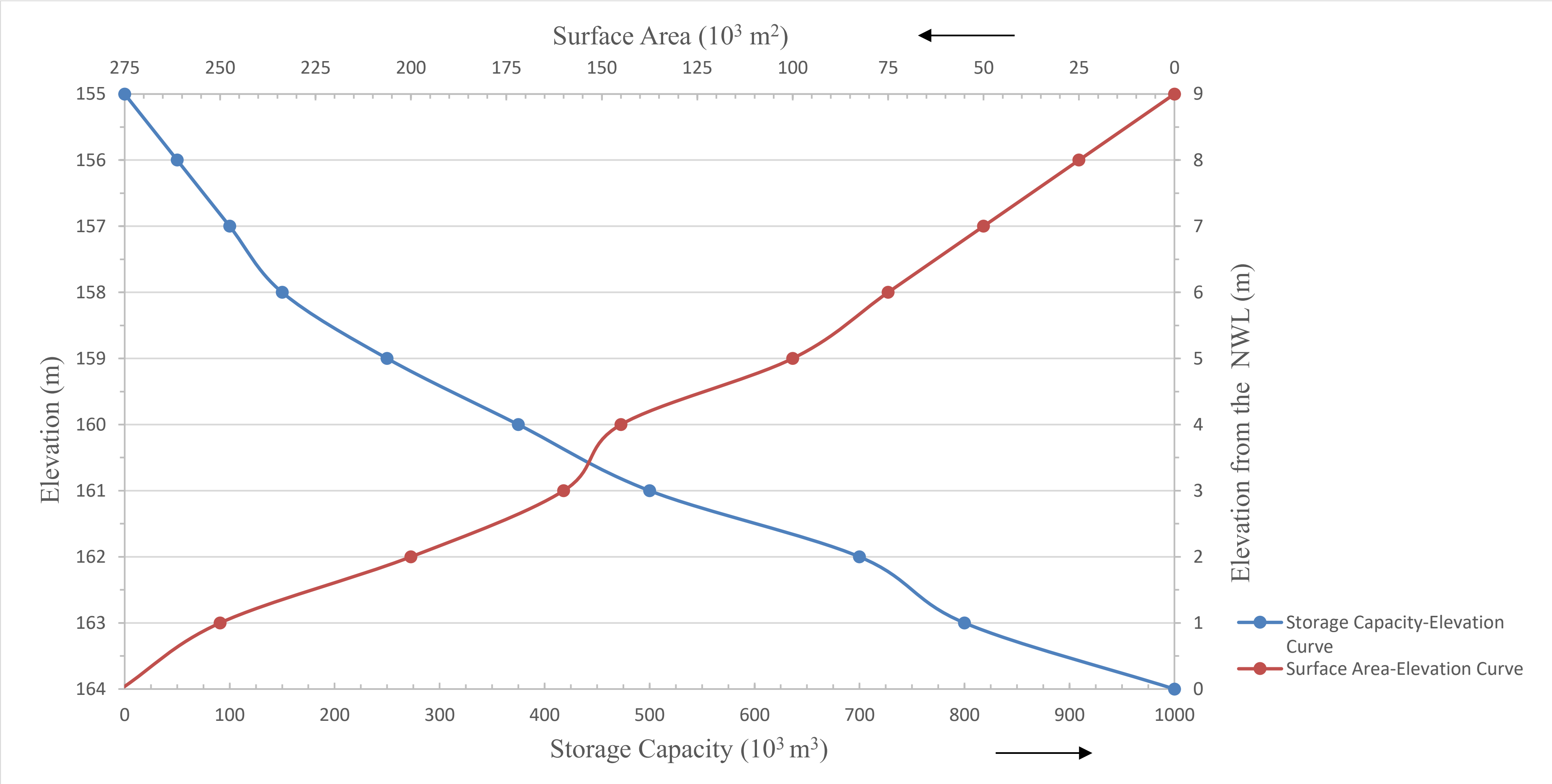
L3. Estimated Monthly Φ Index Values of Gönyeli Reservoir's Catchment (mm/hr)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2005	-	2.40	-	-	3.30	-	0.71	2.69
2006	-	-	-	0.77	-	-	-	-
2007	-	-	0.84	2.52	2.22	-	-	2.86
2008	-	-	1.27	-	1.38	-	-	-
2009	-	-	1.87	-	-	-	0.28	0.10
2010	-	-	-	1.86	4.23	1.89	0.09	0.37
2011	-	9.05	-	4.47	-	-	-	0.96
2012	-	6.34	1.16	2.70	-	0.70	-	3.19
2013	-	-	1.41	-	-	-	-	-
2014	-	-	1.99	-	-	-	0.29	-
2015	-	-	2.00	2.40	6.41	5.82	2.22	-
2016	-	-	12.95	-	-	7.96	-	-
2017	-	1.64	-	2.09	-	0.85	2.16	-
2018	-	-	8.08	5.38	-	-	1.80	-
2019	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	-
2022	-	-	-	1.61	0.76	2.12	-	-
Monthly Avg.	-	4.86	3.51	2.65	3.05	3.22	1.08	1.69
Total Avg.	2.87							

L4. Synthetic Unit Hydrograph of Gönyeli Reservoir's Catchment



L5. Designed Surface Area-Storage Capacity Curve of Gönyeli Reservoir



L6. Surface Area-Storage Capacity Details of Gönyeli Reservoir due to Sediment Accumulation within the Active Volume at Various Sedimentation Levels

Table L6.1. Surface Area-Storage Capacity details at sedimentation level 1 m.

Elevation(m)	Elevation from NWL (m)	Area(m^2)	Storage Capacity (m^3)
164	0	276000	950000
163	1	250000	750000
162	2	200000	650000
161	3	160000	450000
160	4	145000	325000
159	5	100000	200000
158	6	75000	100000
157	7	50000	50000
156	8	0	0

Table L6.2. Surface Area-Storage Capacity details at sedimentation level 2 m.

Elevation(m)	Elevation from Crest	Area(m^2)	Storage Capacity (m^3)
164	0	276000	900000
163	1	250000	700000
162	2	200000	600000
161	3	160000	400000
160	4	145000	275000
159	5	100000	150000
158	6	75000	50000
157	7	0	0

Table L6.3. Surface Area-Storage Capacity details at sedimentation level 3 m.

Elevation(m)	Elevation from NWL (m)	Area(m^2)	Storage Capacity (m^3)
164	0	276000	850000
163	1	250000	650000
162	2	200000	550000
161	3	160000	350000
160	4	145000	225000
159	5	100000	100000
158	6	0	0

Table L6.4. Surface Area-Storage Capacity details at sedimentation level 4 m.

Elevation(m)	Elevation from NWL (m)	Area(m^2)	Storage Capacity (m^3)
164	0	276000	750000
163	1	250000	550000
162	2	200000	450000
161	3	160000	250000
160	4	145000	125000
159	5	0	0

Table L6.5. Surface Area-Storage Capacity details at sedimentation level 5 m.

Elevation(m)	Elevation from NWL (m)	Area(m^2)	Storage Capacity (m^3)
164	0	276000	625000
163	1	250000	425000
162	2	200000	325000
161	3	160000	125000
160	4	0	0

Table L6.6. Surface Area-Storage Capacity details at sedimentation level 6 m.

Elevation(m)	Elevation from NWL (m)	Area(m^2)	Storage Capacity (m^3)
164	0	276000	500000
163	1	250000	300000
162	2	200000	200000
161	3	0	0

Table L6.7. Surface Area-Storage Capacity details at sedimentation level 7 m.

Elevation(m)	Elevation from NWL (m)	Area(m^2)	Storage Capacity (m^3)
164	0	276000	300000
163	1	250000	100000
162	2	0	0

Table L6.8. Surface Area-Storage Capacity details at sedimentation level 8 m.

Elevation(m)	Elevation from NWL (m)	Area(m^2)	Storage Capacity (m^3)
164	0	276000	200000
163	1	0	0

L7. Estimated Monthly Evaporation Volumes from Gönyeli Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	23398	40531	51438	62569	68198	67853	56649	49315
2005-2006	34100	19782	13323	146701	18329	31108	44956	57037	74308	67838	70708	51703
2006-2007	27091	18804	16631	117070	16006	25610	43668	44519	68802	73225	63210	54612
2007-2008	40878	25635	14916	156592	25811	41417	46114	46898	60078	58045	46486	30714
2008-2009	23391	12664	9776	14221	17995	21924	37685	48083	69723	64119	49985	32972
2009-2010	18262	4898	6832	12127	24086	33413	47832	53052	49024	48117	48875	56271
2010-2011	39551	27537	18596	17981	23058	27094	34800	46873	63866	68754	68148	47657
2011-2012	35387	21018	13631	14103	19273	26928	40896	44107	61955	68574	68977	48727
2012-2013	22987	14440	13002	12310	15900	35717	45880	56531	68901	72712	72460	52063
2013-2014	43277	19620	15707	14440	24554	36121	43325	44028	68150	59412	55629	48246
2014-2015	31033	14996	11836	11845	18154	30829	42766	55643	64066	71173	66904	50162
2015-2016	31051	23548	15755	14008	21873	30699	23408	Dry	Dry	Dry	Dry	22795
2016-2017	Dry	Dry	6813	15031	19240	28797	45567	52886	51937	62917	60955	46878
2017-2018	33223	19017	14560	11965	17293	33130	47881	51474	51391	62332	52549	38905
2018-2019	24824	13345	14271	13541	17123	25348	28309	58271	61339	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	19451	24517	34951	57988	60562	69111	54921	37061
2021-2022	30688	19289	11676	14232	19073	26056	47923	56237	62776	79718	57291	40111
2022-2023	19312	11158	7850	-	-	-	-	-	-	-	-	-

L8. Estimated Monthly Effective Runoff Volumes of Gönyeli Reservoir (m^3)

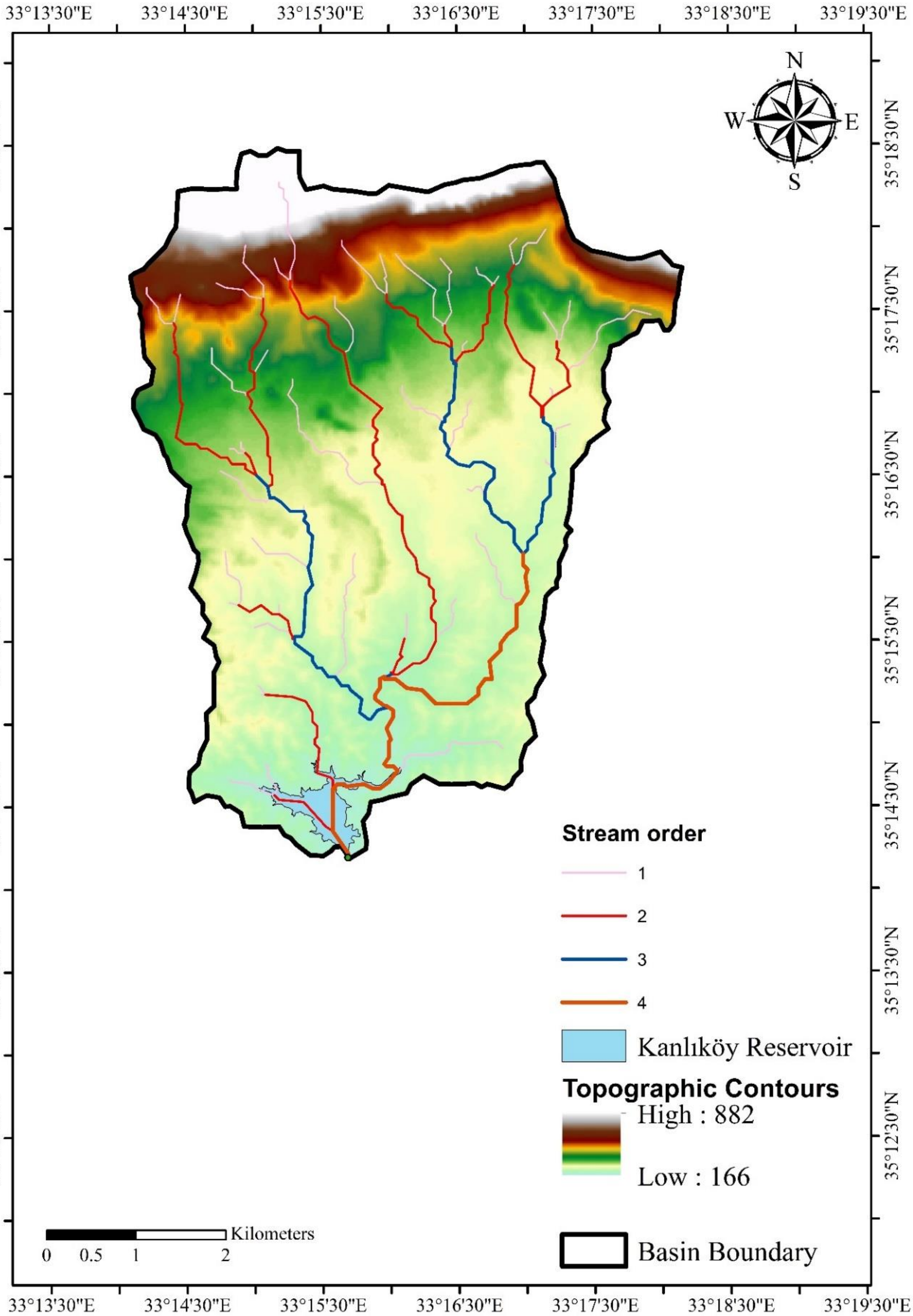
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Total
2004-2005	-	-	-	-	28215	0	43641	76559	148415
2005-2006	0	99936	0	325107	0	0	0	0	425044
2006-2007	0	0	0	119923	206245	0	0	52411	378578
2007-2008	88764	0	61991	0	117838	0	0	0	268593
2008-2009	0	0	55219	50348	0	0	61115	89377	256060
2009-2010	0	0	80349	255934	38780	26513	45624	50127	497327
2010-2011	0	0	0	57056	0	0	0	85576	142632
2011-2012	0	47575	0	38054	0	50810	0	46150	182588
2012-2013	0	163872	139338	0	0	0	0	0	303210
2013-2014	0	0	235612	0	0	0	45002	0	280614
2014-2015	0	0	44499	31339	51082	47707	71598	0	246226
2015-2016	0	0	66270	0	0	38011	0	0	104281
2016-2017	0	0	255369	58914	0	123774	35297	0	473354
2017-2018	0	37853	0	98890	0	0	32587	0	169330
2018-2019	0	0	255909	Overflow	Overflow	Overflow	Overflow	0	255909
2019-2020	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	0	0	0	0	0
2021-2022	0	0	0	57538	39876	45342	0	0	142756
2022-2023	0	0	0	-	-	-	-	-	0
Average	5548	21827	74660	78079	30127	20760	20929	23541	237495

Appendix M: Kanlıköy Reservoir

Kanlıköy Reservoir was constructed by Water Division Department of Cyprus in December 1963 over the Çınar (Jinar) tributary of Kanlıdere. Irrigated land by using this reservoir is estimated to be 400 hectares. Like the other two reservoirs which existed before the declaration of TRNC, it underwent sedimentation and its live storage capacity reduced from 1 MCM to 730 294 cubic meters.

Thalweg Elevation	180	m
Bottom Elevation of Weir (Spillway)	184	m
Normal Water Level	191	m
Maximum Water Elevation	192.36	m
Crest Level	192.36	m
Maximum Active Volume Depth	7	m
Total Storage Capacity	1130000	m^3
Active (Live) Storage Capacity	1000000	m^3
Spillway Type	Ogee	-
Catchment Area (Delineated from ArcGIS)	31.364	km^2

M1. Delineated Kanlıköy Reservoir's Catchment with Strahler's Stream Order



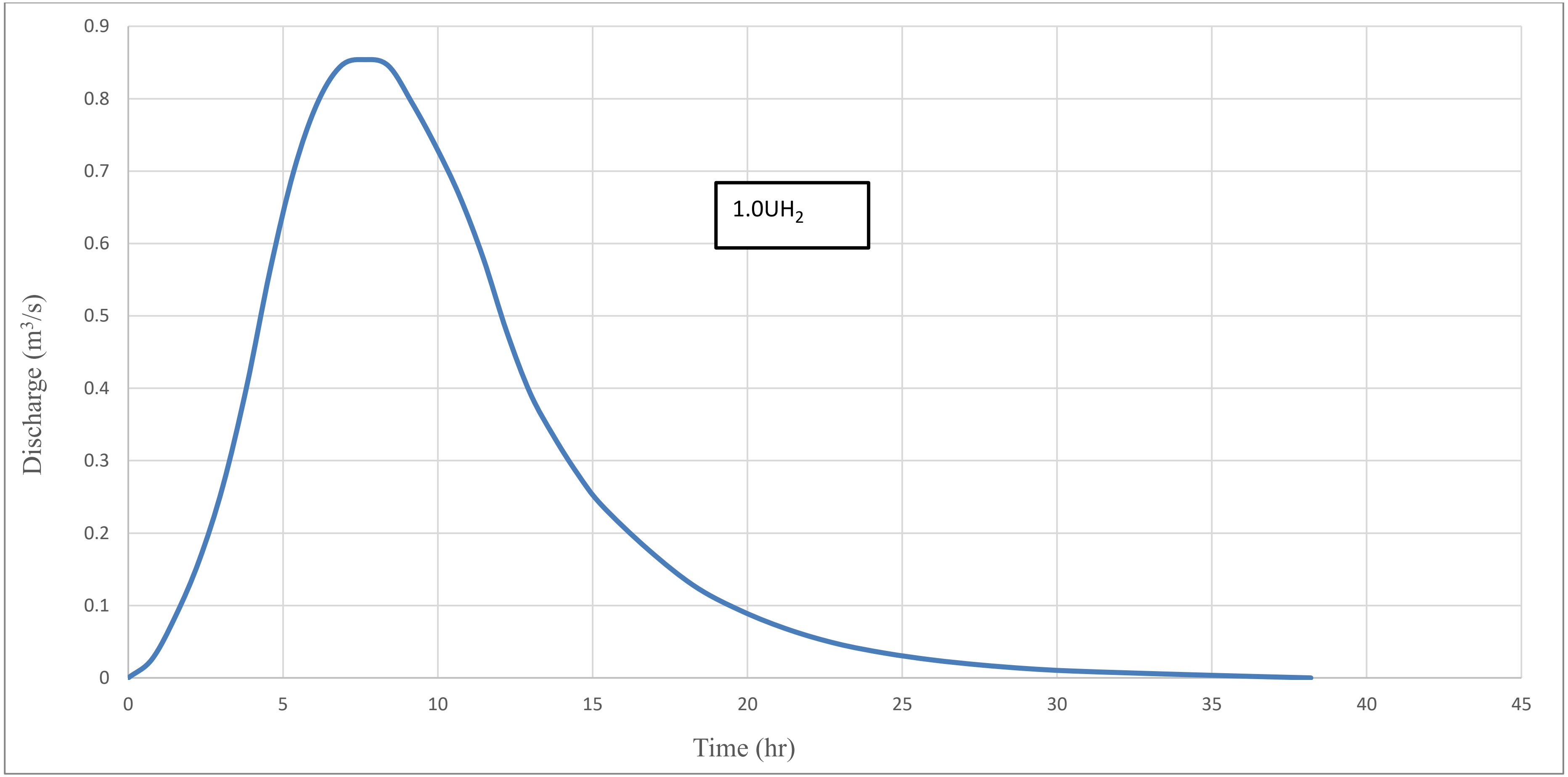
M2. Geomorphological Details of Kanlıköy Reservoir's Catchment

Name of Parameter	Unit	Catchment's Value
Stream Order	-	4
Total Number of 1st Order Stream	-	67
Total Number of 2nd Order Stream	-	13
Total Number of 3rd Order Stream	-	3
Total Number of 4th Order Stream	-	1
Total Number of All Order Streams	-	84
Basin Length	km	8.1
Basin Perimeter	km	26.7
Length of Main Channel	km	9.9
Length of Highest Order Stream	km	6.1
Length of 1st Order Stream	km	25.8
Length of 2nd Order Stream	km	20.1
Length of 3rd Order Stream	km	9.1
Length of All Order Streams	km	61.3
Basin Area	km^2	31.4
Basin Maximum Elevation	m	882
Basin Minimum Elevation	m	166
Maximum Stream Elevation	m	769
Minimum Stream Elevation	m	166
Mean Bifurcation Ratio	-	4.7
Bifurcation Ratio Order 1:2	-	5.2
Bifurcation Ratio Order 2:3	-	4.3
Circularity Ratio	-	0.551
Quadratic Harmonic Mean Slope	-	0.016

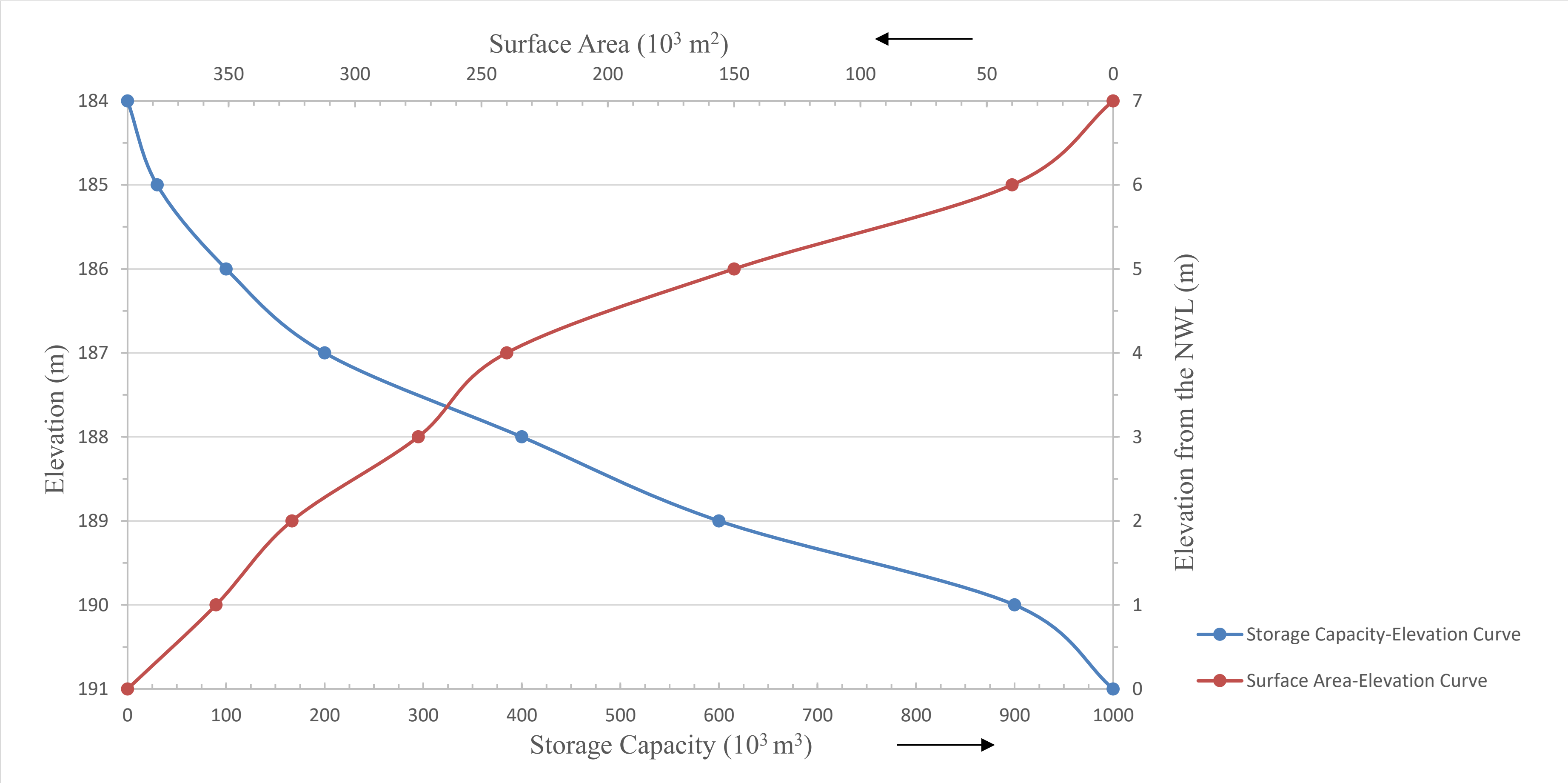
M3. Estimated Monthly Φ Index Values of Kanlıköy Reservoir's Catchment (mm/hr)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2005	-	2.68	-	-	3.23	-	0.64	2.69
2006	-	-	-	1.00	0.78	-	-	0.28
2007	-	-	-	2.47	-	-	0.16	2.82
2008	-	-	1.32	-	-	-	-	-
2009	-	-	1.88	0.51	-	-	-	-
2010	-	-	-	1.81	3.97	0.80	0.08	0.35
2011	-	8.97	3.68	3.99	-	2.75	-	0.85
2012	-	6.03	1.13	2.57	-	0.66	-	3.08
2013	-	-	1.88	-	-	-	-	-
2014	-	-	1.97	-	-	-	0.28	-
2015	0.37	-	1.89	2.36	6.49	-	2.18	-
2016	-	-	13.57	-	-	-	-	-
2017	-	1.63	-	1.13	-	0.82	2.18	0.002
2018	-	-	7.10	5.50	-	-	1.78	-
2019	-	-	-	4.01	7.35	-	-	-
2020	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	-
2022	1.05	0.63	-	-	0.70	1.97	-	-
Monthly Avg.	0.71	3.99	3.82	2.53	3.75	1.40	1.04	1.44
Total Avg.	2.34							

M4. Synthetic Unit Hydrograph of Kanlıköy Reservoir's Catchment



M5. Designed Surface Area-Storage Capacity Curve of Kanlıköy Reservoir



M6. Surface Area-Storage Capacity Details of Kanlıköy Reservoir due to Sediment Accumulation within the Active Volume at Various Sedimentation Levels

Table M6.1. Surface Area-Storage Capacity details at sedimentation level 1 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
191	0	390000	970000
190	1	355000	870000
189	2	325000	570000
188	3	275000	370000
187	4	240000	170000
186	5	150000	70000
185	6	0	0

Table M6.2. Surface Area-Storage Capacity details at sedimentation level 2 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
191	0	390000	900000
190	1	355000	800000
189	2	325000	500000
188	3	275000	300000
187	4	240000	100000
186	5	0	0

Table M6.3. Surface Area-Storage Capacity details at sedimentation level 3 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
191	0	390000	800000
190	1	355000	700000
189	2	325000	400000
188	3	275000	200000
187	4	0	0

Table M6.4. Surface Area-Storage Capacity details at sedimentation level 4 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
191	0	390000	600000
190	1	355000	500000
189	2	325000	200000
188	3	0	0

Table M6.5. Surface Area-Storage Capacity details at sedimentation level 5 m.

Elevation (m)	**Elevation from NWL (m)**	**Area (m^2)**	**Storage Capacity (m^3)**
191	0	390000	400000
190	1	355000	300000
189	2	0	0

Table M6.6. Surface Area-Storage Capacity details at sedimentation level 6 m.

Elevation (m)	**Elevation from NWL (m)**	**Area (m^2)**	**Storage Capacity (m^3)**
191	0	390000	100000
190	1	0	0

M7. Estimated Monthly Evaporation Volumes from Kanlıköy Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	30896	53534	68210	83227	90728	91057	80274	69181
2005-2006	48593	28159	17786	187368	22472	38424	55845	71981	95039	86985	90474	67220
2006-2007	36138	25029	22969	167787	20110	28909	49755	51736	81097	86616	75011	66530
2007-2008	42776	11016	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2008-2009	Dry	Dry	3451	13913	23336	28102	46574	27598	Dry	Dry	Dry	Dry
2009-2010	Dry	Dry	7498	15916	30614	44957	67589	74965	67680	64349	64930	74673
2010-2011	52412	36569	24989	24177	30830	36363	46758	63595	86714	92501	91417	63818
2011-2012	50299	30103	18518	19655	26548	35615	54107	58398	82129	92459	87750	65138
2012-2013	40817	23479	17935	17394	22467	50470	64831	79881	95908	97526	95006	68286
2013-2014	58992	27977	20878	18436	32173	47364	56877	58028	90859	84178	77710	65840
2014-2015	44971	22129	15881	15902	23643	39499	54148	70495	82312	92730	88931	66858
2015-2016	41033	32313	21475	18970	31037	43333	32366	Dry	Dry	Dry	Dry	31519
2016-2017	Dry	Dry	8340	18882	24984	37381	58610	71009	84422	96885	78255	60304
2017-2018	43765	25326	19511	15837	22215	42387	60943	67521	68361	84906	73324	54211
2018-2019	17570	Dry	10689	16990	22925	35817	40002	82339	84938	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	26316	33454	47858	81567	85632	96843	79407	55014
2021-2022	46540	29528	17694	20210	25597	34975	64322	77135	86822	108440	78443	66767
2022-2023	41089	22413	17744	-	-	-	-	-	-	-	-	-

M8. Estimated Monthly Utilized Volumes from Kanlıköy Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	0	26336	0	0	0	22582	24026	0
2005-2006	38593	0	6503	0	0	0	46629	0	0	0	0	0
2006-2007	0	0	14125	0	4981	0	0	0	0	0	0	0
2007-2008	80384	95754	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2008-2009	Dry	Dry	0	0	0	0	0	116172	Dry	Dry	Dry	Dry
2009-2010	Dry	Dry	0	0	0	0	0	0	8077	22439	25678	0
2010-2011	57906	61181	5164	0	0	0	0	0	0	0	0	0
2011-2012	339	0	0	0	244362	0	26820	0	0	0	139	0
2012-2013	87802	0	0	25428	0	0	0	0	0	0	0	0
2013-2014	47612	0	0	0	0	5913	0	0	0	20295	0	47365
2014-2015	1673	0	0	0	0	0	0	16728	0	0	0	0
2015-2016	0	47449	0	70886	17389	0	260889	Dry	Dry	Dry	Dry	0
2016-2017	Dry	Dry	0	0	112607	0	0	0	44204	0	0	0
2017-2018	3912	0	3272	0	0	77183	0	8078	0	0	0	0
2018-2019	139229	Dry	0	0	0	28221	0	0	0	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	0	0	0	0	0	0	0	0
2021-2022	0	0	0	0	0	0	49554	0	0	0	0	74314
2022-2023	0	0	151904	-	-	-	-	-	-	-	-	-

M9. Estimated Monthly Effective Runoff Volumes of Kanlıköy Reservoir (m^3)

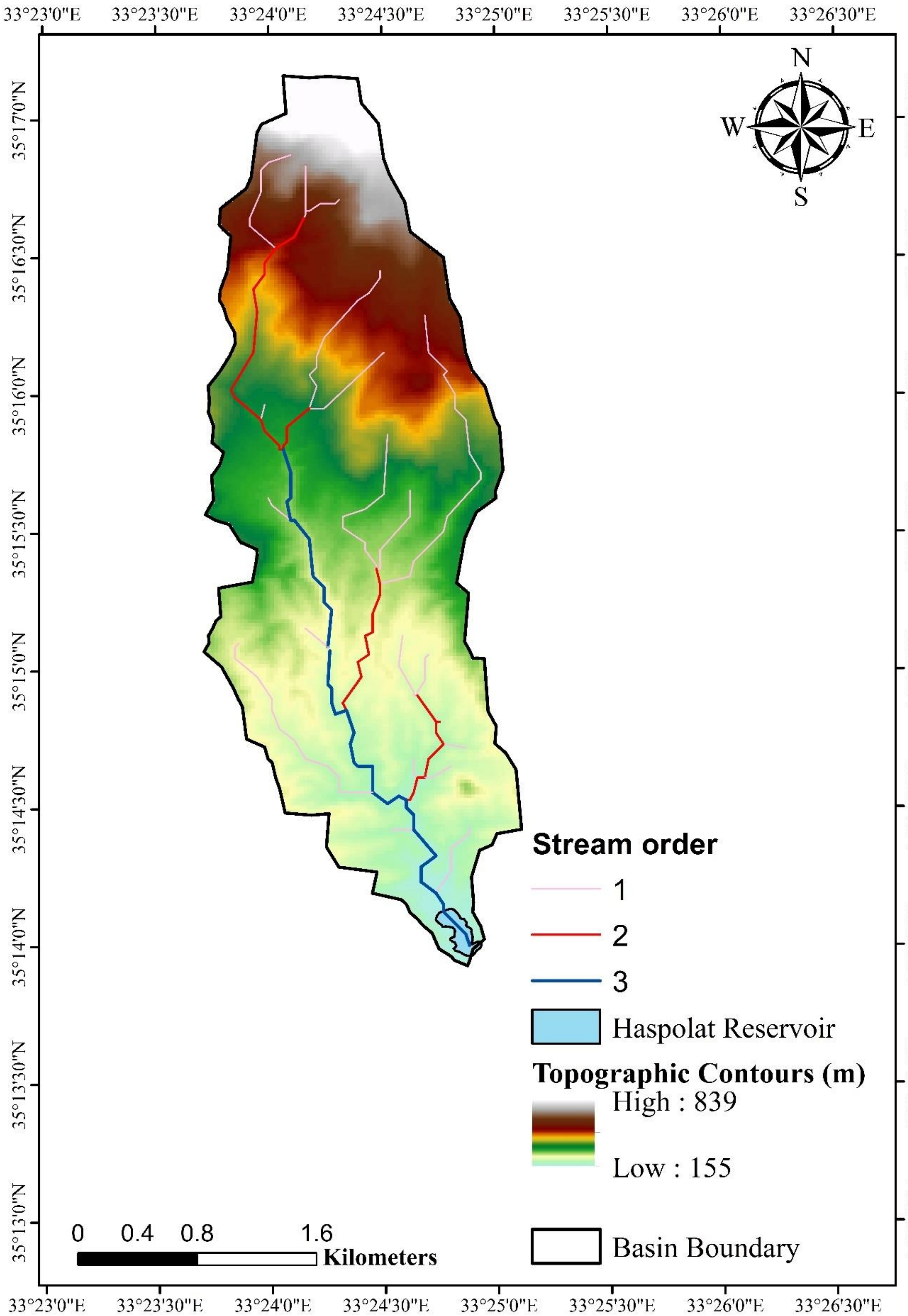
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Total
2004-2005	-	-	-	-	42451	0	81382	109186	233019
2005-2006	0	98951	0	187852	62601	0	0	74253	423657
2006-2007	0	0	0	160860	0	0	50254	71559	282674
2007-2008	0	0	0	0	0	0	0	0	0
2008-2009	0	0	43384	92952	0	0	0	0	136336
2009-2010	0	0	95722	339476	112547	158489	64469	70831	841534
2010-2011	0	0	0	124898	0	32956	0	149878	307733
2011-2012	0	79509	34108	67367	0	76070	0	64292	321346
2012-2013	0	263177	191814	0	0	0	0	0	454991
2013-2014	0	0	150577	0	0	0	63098	0	213675
2014-2015	0	0	60873	42819	58912	0	96396	0	259001
2015-2016	44364	0	99885	0	0	0	0	0	144248
2016-2017	0	0	231653	186026	0	160114	42849	41688	662329
2017-2018	0	50197	0	114493	0	0	41955	0	206644
2018-2019	0	0	472663	36541	114033	0	0	0	623237
2019-2020	0	0	0	-	-	-	-	-	-
2020-2021	-	-	-	-	0	0	0	0	0
2021-2022	0	0	0	0	67915	75688	0	0	143603
2022-2023	32809	47591	0	-	-	-	-	-	80400
Average	4540	31731	81216	90219	26968	29607	25906	34217	296357

Appendix N: Haspolat Reservoir

Haspolat Reservoir was constructed by Water Division Department of Cyprus in 1964 to irrigate 130 hectares of land. As a reservoir, it occupies a small surface area of 6.8 hectares. However, at the initial years of operation it had water depth of 12 meters. It is fed by Symeas, a tributary of the Kanlıdere. Currently the reservoir has a storage capacity of 117 390 cubic meters which was reduced from 340 000 cubic meters.

Thalweg Elevation	-	m
Bottom Elevation of Weir (Spillway)	153	m
Normal Water Level	165	m
Maximum Water Elevation	-	m
Crest Level	166.44	m
Maximum Active Volume Depth	12	m
Total Storage Capacity	350000	m^3
Active (Live) Storage Capacity	340000	m^3
Spillway Type	Ogee	-
Catchment Area (Delineated from ArcGIS)	8.052	km^2

N1. Delineated Haspolat Reservoir's Catchment with Strahler's Stream Order



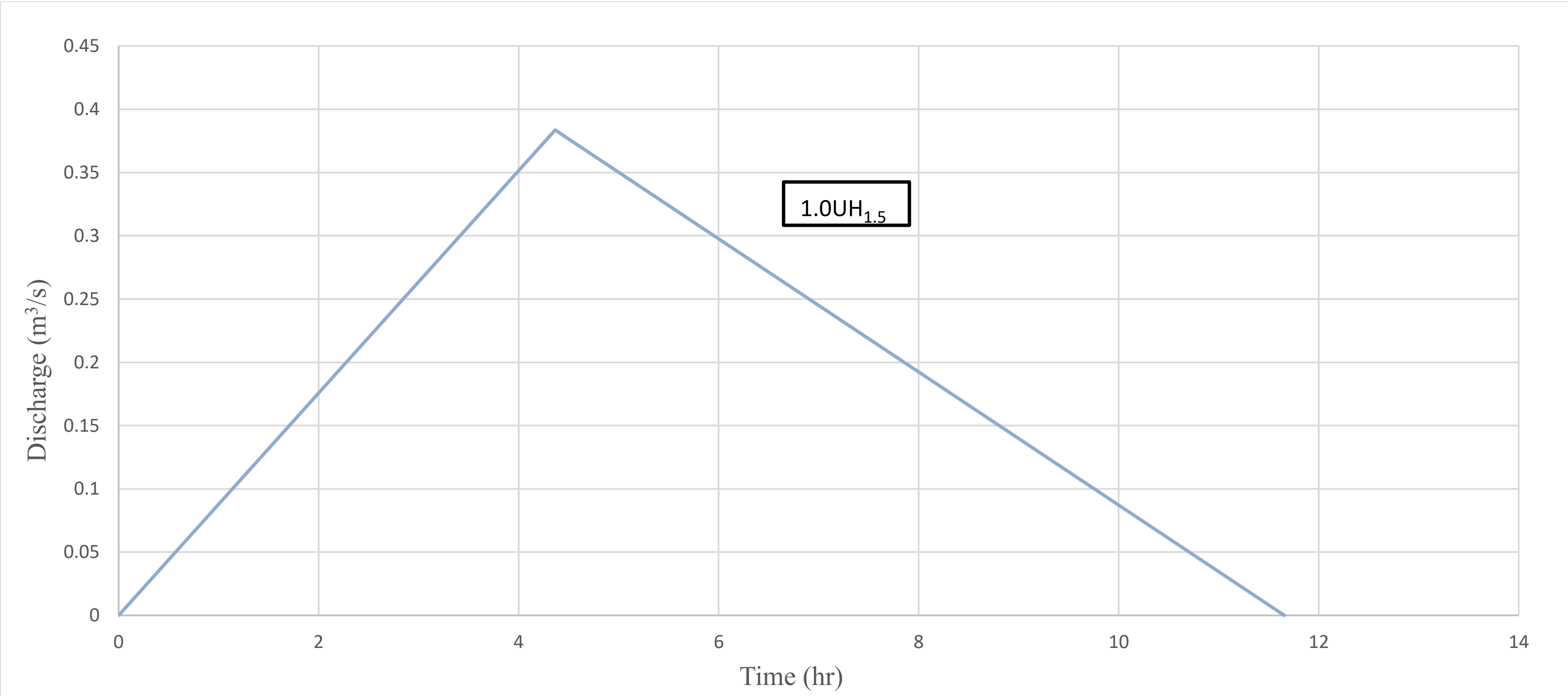
N2. Geomorphological Details of Haspolat Reservoir's Catchment

Name of Parameter	Unit	Catchment's Value
Stream Order	-	3
Total Number of 1st Order Stream	-	32
Total Number of 2nd Order Stream	-	4
Total Number of 3rd Order Stream	-	1
Total Number of All Order Streams	-	37
Basin Length	km	6.1
Basin Perimeter	km	15.2
Length of Main Channel	km	6.6
Length of Highest Order Stream	km	4.2
Length of 1st Order Stream	km	11.3
Length of 2nd Order Stream	km	4.2
Length of All Order Streams	km	19.7
Basin Area	km^2	8.1
Basin Maximum Elevation	m	839
Basin Minimum Elevation	m	155
Maximum Stream Elevation	m	553
Minimum Stream Elevation	m	155
Mean Bifurcation Ratio	-	6.0
Bifurcation Ratio Order 1:2	-	8.0
Bifurcation Ratio Order 2:3	-	4.0
Circularity Ratio	-	0.438
Quadratic Harmonic Mean Slope	-	0.035

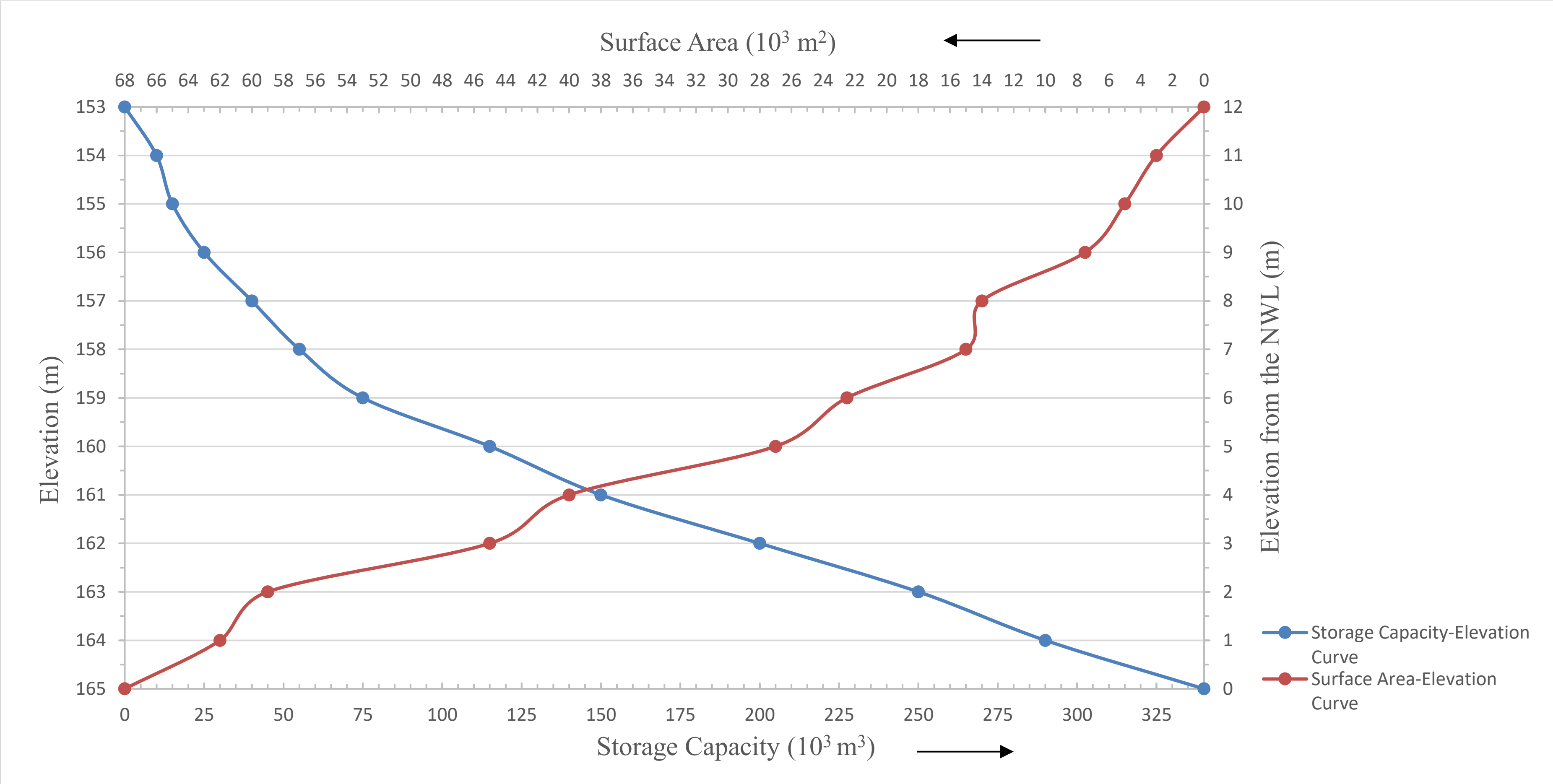
N3. Estimated Monthly Φ Index Values of Haspolat Reservoir's Catchment (mm/hr)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2005	-	10.40	-	-	-	-	-	-
2006	-	-	-	2.53	-	-	-	-
2007	-	-	-	-	6.47	-	-	-
2008	-	-	-	-	-	-	-	-
2009	-	-	2.88	-	-	-	-	-
2010	-	-	-	3.10	5.14	1.65	-	-
2011	-	-	-	-	-	-	-	-
2012	-	-	-	-	-	-	-	-
2013	-	-	-	2.22	-	0.12	0.61	2.02
2014	-	-	1.70	-	-	-	-	-
2015	-	-	-	-	3.18	-	1.77	-
2016	-	-	9.36	-	-	3.36	-	-
2017	-	-	-	-	-	-	-	-
2018	-	-	5.46	-	-	-	-	-
2019	-	-	-	-	5.76	-	-	-
2020	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	-
2022	-	-	-	-	-	-	-	-
Monthly Avg.	-	10.40	4.85	2.61	5.14	1.71	1.19	2.02
Total Avg.	3.99							

N4. Synthetic Unit Hydrograph of Haspolat Reservoir's Catchment



N5. Designed Surface Area-Storage Capacity Curve of Haspolat Reservoir



N6. Surface Area-Storage Capacity Details of Haspolat Reservoir due to Sediment Accumulation within the Active Volume at Various Sedimentation Levels

Table N6.1. Surface Area-Storage Capacity details at sedimentation level 1 m.

Elevation (m)	**Elevation from NWL (m)**	**Area (m^2)**	**Storage Capacity (m^3)**
165	0	68000	330000
164	1	62000	280000
163	2	59000	240000
162	3	45000	190000
161	4	40000	140000
160	5	27000	105000
159	6	22500	65000
158	7	15000	45000
157	8	14000	30000
156	9	7500	15000
155	10	5000	5000
154	11	0	0

Table N6.2. Surface Area-Storage Capacity details at sedimentation level 2 m.

Elevation (m)	**Elevation from NWL (m)**	**Area (m^2)**	**Storage Capacity (m^3)**
165	0	68000	325000
164	1	62000	275000
163	2	59000	235000
162	3	45000	185000
161	4	40000	135000
160	5	27000	100000
159	6	22500	60000
158	7	15000	40000
157	8	14000	25000
156	9	7500	10000
155	10	0	0

Table N6.3. Surface Area-Storage Capacity details at sedimentation level 3 m.

Elevation (m)	**Elevation from NWL (m)**	**Area (m^2)**	**Storage Capacity (m^3)**
165	0	68000	315000
164	1	62000	265000
163	2	59000	225000
162	3	45000	175000
161	4	40000	125000
160	5	27000	90000
159	6	22500	50000
158	7	15000	30000
157	8	14000	15000
156	9	0	0

Table N6.4. Surface Area-Storage Capacity details at sedimentation level 4 m.

Elevation (m)	**Elevation from NWL (m)**	**Area (m^2)**	**Storage Capacity (m^3)**
165	0	68000	300000
164	1	62000	250000
163	2	59000	210000
162	3	45000	160000
161	4	40000	110000
160	5	27000	75000
159	6	22500	35000
158	7	15000	15000
157	8	0	0

Table N6.5. Surface Area-Storage Capacity details at sedimentation level 5 m.

Elevation (m)	**Elevation from NWL (m)**	**Area (m^2)**	**Storage Capacity (m^3)**
165	0	68000	285000
164	1	62000	235000
163	2	59000	195000
162	3	45000	145000
161	4	40000	95000
160	5	27000	60000
159	6	22500	20000
158	7	0	0

Table N6.6. Surface Area-Storage Capacity details at sedimentation level 6 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
165	0	68000	265000
164	1	62000	215000
163	2	59000	175000
162	3	45000	125000
161	4	40000	75000
160	5	27000	40000
159	6	0	0

Table N6.7. Surface Area-Storage Capacity details at sedimentation level 7 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
165	0	68000	225000
164	1	62000	175000
163	2	59000	135000
162	3	45000	85000
161	4	40000	35000
160	5	0	0

Table N6.8. Surface Area-Storage Capacity details at sedimentation level 8 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
165	0	68000	190000
164	1	62000	140000
163	2	59000	100000
162	3	45000	50000
161	4	0	0

Table N6.9. Surface Area-Storage Capacity details at sedimentation level 9 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
165	0	68000	140000
164	1	62000	90000
163	2	59000	50000
162	3	0	0

Table N6.10. Surface Area-Storage Capacity details at sedimentation level 10 m.

Elevation (m)	Elevation from NWL(m)	Area (m^2)	Storage Capacity (m^3)
165	0	68000	90000
164	1	62000	40000
163	2	0	0

Table N6.11. Surface Area-Storage Capacity details at sedimentation level 11 m.

Elevation (m)	**Elevation from NWL (m)**	**Area (m^2)**	**Storage Capacity (m^3)**
165	0	68000	50000
164	1	0	0

N7. Estimated Monthly Evaporation Volumes from Haspolat Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2005-2006	Dry	1916	2044	26592	2095	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2006-2007	Dry	Dry	Dry	Dry	1975	5705	5618	697	Dry	Dry	Dry	Dry
2007-2008	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2008-2009	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2009-2010	Dry	Dry	961	2564	5538	7963	5892	Dry	Dry	Dry	Dry	Dry
2010-2011	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2011-2012	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2012-2013	Dry	Dry	Dry	645	1443	5212	9881	12288	14980	7934	Dry	Dry
2013-2014	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2014-2015	Dry	Dry	524	1360	3353	7073	9637	12577	14724	8351	Dry	Dry
2015-2016	Dry	Dry	Dry	Dry	Dry	3122	4649	Dry	Dry	Dry	Dry	Dry
2016-2017	Dry	Dry	1608	3503	4528	6735	5185	Dry	Dry	Dry	Dry	Dry
2017-2018	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2018-2019	Dry	Dry	2026	3200	4136	6245	6975	14357	15071	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	8	9	12	20	20	21	16	10
2021-2022	8	3	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2022-2023	Dry	Dry	Dry	-	-	-	-	-	-	-	-	-

N8. Estimated Monthly Utilized Volumes from Haspolat Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2005-2006	Dry	0	4308	0	75156	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2006-2007	Dry	Dry	Dry	Dry	0	0	23739	3303	Dry	Dry	Dry	Dry
2007-2008	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2008-2009	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2009-2010	Dry	Dry	0	0	0	0	111691	Dry	Dry	Dry	Dry	Dry
2010-2011	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2011-2012	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2012-2013	Dry	Dry	Dry	0	2774	0	0	0	0	26548	Dry	Dry
2013-2014	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2014-2015	Dry	Dry	0	0	0	0	0	0	0	40836	Dry	Dry
2015-2016	Dry	Dry	Dry	Dry	Dry	0	16693	Dry	Dry	Dry	Dry	Dry
2016-2017	Dry	Dry	0	0	6962	0	34364	Dry	Dry	Dry	Dry	Dry
2017-2018	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2018-2019	Dry	Dry	Dry	499	0	1660	0	0	0	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	0	0	0	0	0	0	0	0
2021-2022	0	0	25	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2022-2023	Dry	Dry	Dry	-	-	-	-	-	-	-	-	-

N9. Estimated Monthly Effective Runoff Volumes of Haspolat Reservoir (m^3)

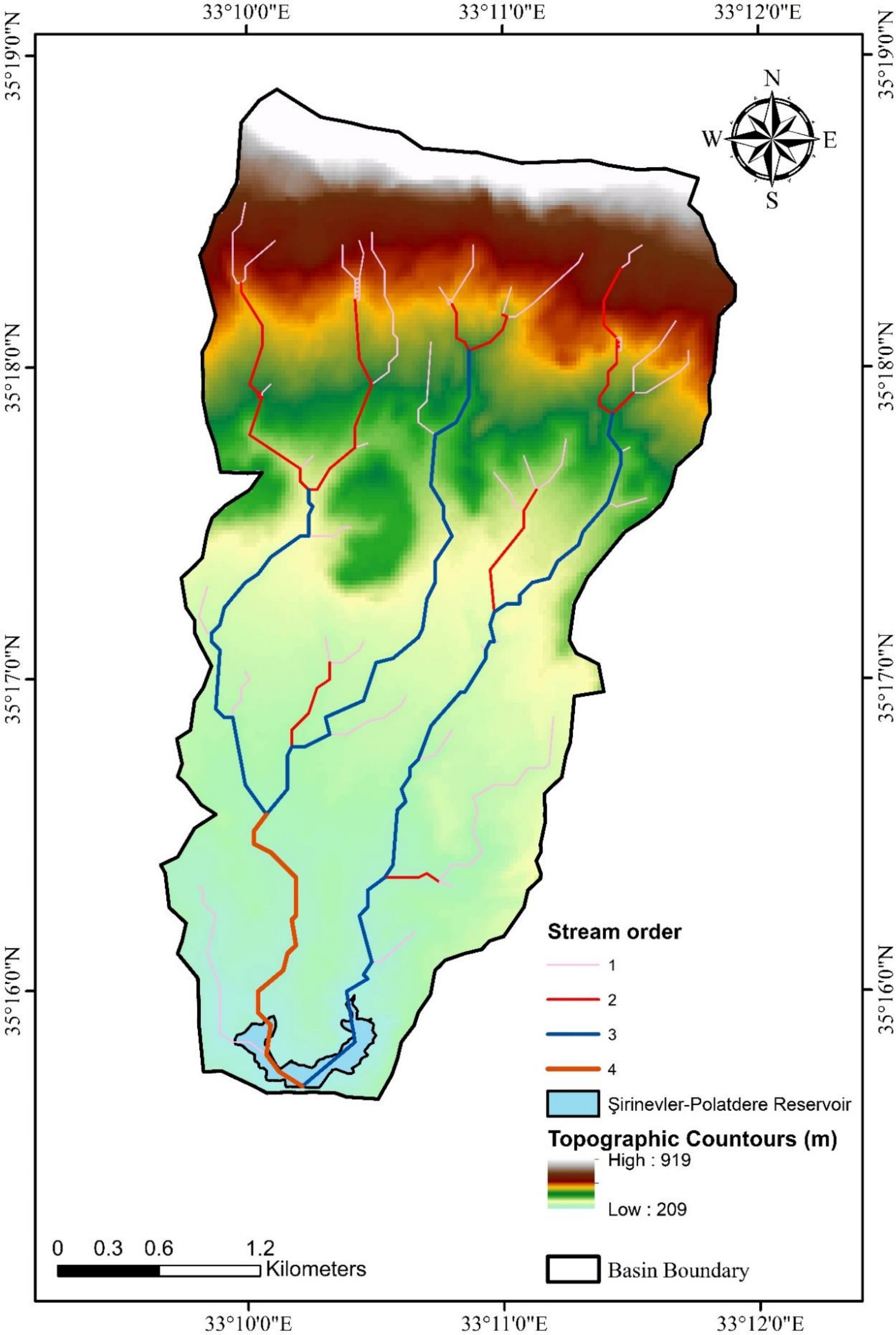
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Total
2004-2005	-	-	-	-	0	0	0	0	0
2005-2006	0	18642	0	78159	0	0	0	0	96802
2006-2007	0	0	0	0	29513	0	0	0	29513
2007-2008	0	0	0	0	0	0	0	0	0
2008-2009	0	0	0	0	0	0	0	0	0
2009-2010	0	0	11500	41781	12453	42453	0	0	108187
2010-2011	0	0	0	0	0	0	0	0	0
2011-2012	0	0	0	0	0	0	0	0	0
2012-2013	0	0	0	11906	0	27467	9611	20803	69787
2013-2014	0	0	0	0	0	0	0	0	0
2014-2015	0	0	9450	0	30540	0	11062	0	51052
2015-2016	0	0	0	0	0	23216	0	0	23216
2016-2017	0	0	38602	0	0	0	0	0	38602
2017-2018	0	0	0	0	0	0	0	0	0
2018-2019	0	0	87664	0	17118	Overflow	Overflow	0	104782
2019-2020	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	0	0	0	0	0
2021-2022	0	0	0	0	0	0	0	0	0
2022-2023	0	0	0	-	-	-	-	-	0
Average	0	1165	9201	8790	5272	5821	1292	1224	28997

Appendix O: Şirinevler-Polatdere Reservoir

The Şirinevler-Polatdere Reservoir was constructed by the Republic of Turkey on the Çalı Stream and was first put into operation in 1994 to facilitate irrigation for 40 hectares of land.

Thalweg Elevation	197	m
Bottom Elevation of Weir (Spillway)	200	m
Normal Water Level	207	m
Maximum Water Elevation	208	m
Crest Level	209	m
Maximum Active Volume Depth	7	m
Dead Storage	47050	m^3
Active (Live) Storage Capacity	517167	m^3
Spillway Type	Ogee	-
Catchment Area (Delineated from ArcGIS)	13.140	km^2

O1. Delineated Şirinevler-Polatdere Reservoir's Catchment with Strahler's Stream Order



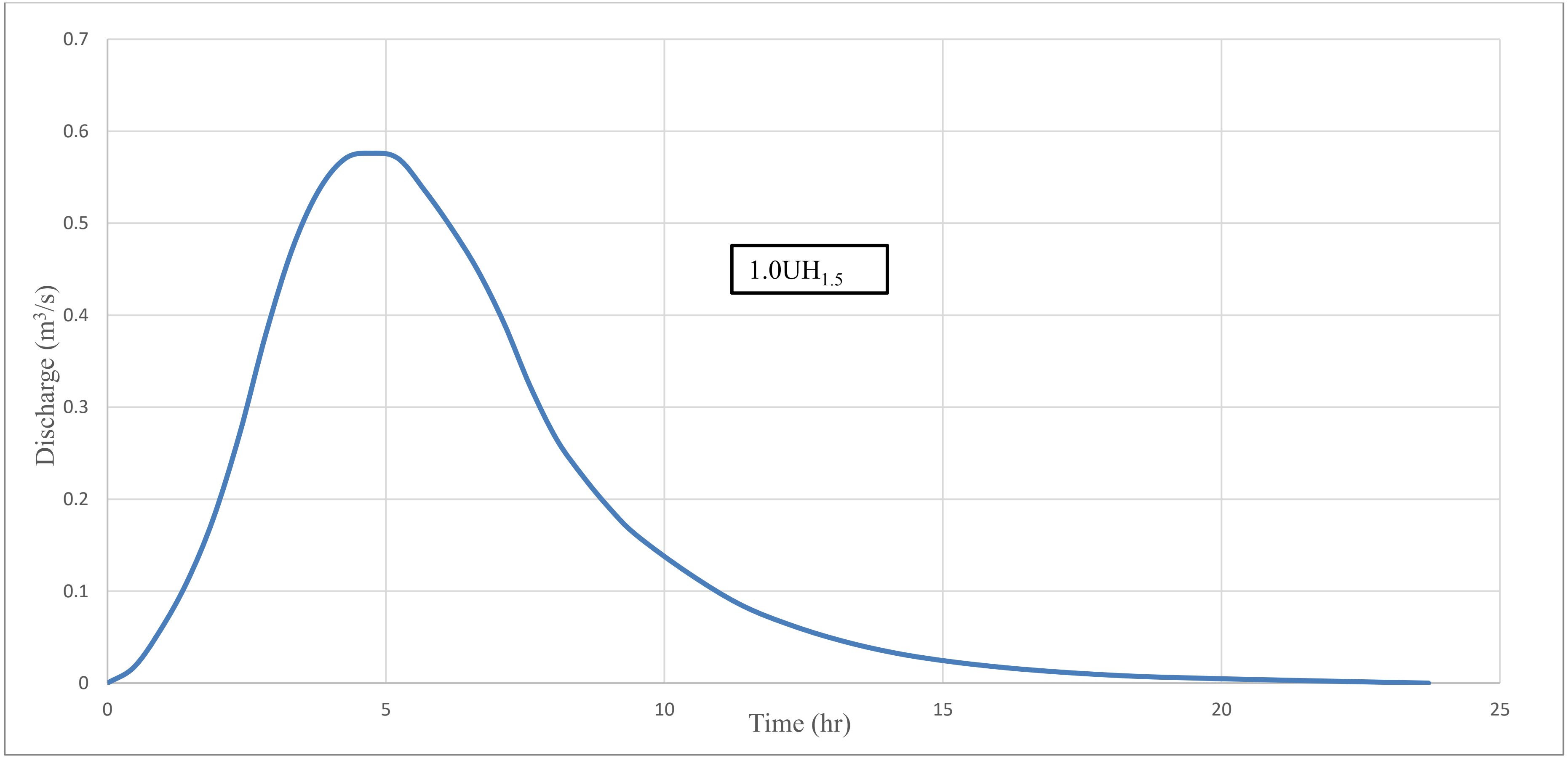
O2. Geomorphological Details of Şirinevler-Polatdere Reservoir's Catchment

Name of Parameter	Unit	Catchment's Value
Stream Order	-	4
Total Number of 1st Order Stream	-	56
Total Number of 2nd Order Stream	-	9
Total Number of 3rd Order Stream	-	3
Total Number of 4th Order Stream	-	1
Total Number of All Order Streams	-	69
Basin Length	km	5.9
Basin Perimeter	km	17.3
Length of Main Channel	km	6.4
Length of Highest Order Stream	km	2.0
Length of 1st Order Stream	km	12.8
Length of 2nd Order Stream	km	6.5
Length of 3rd Order Stream	km	10.8
Length of All Order Streams	km	32.0
Basin Area	km^2	13.1
Basin Maximum Elevation	m	919
Basin Minimum Elevation	m	209
Maximum Stream Elevation	m	571
Minimum Stream Elevation	m	209
Mean Bifurcation Ratio	-	4.6
Bifurcation Ratio Order 1:2	-	6.2
Bifurcation Ratio Order 2:3	-	3.0
Circularity Ratio	-	0.555
Quadratic Harmonic Mean Slope	-	0.025

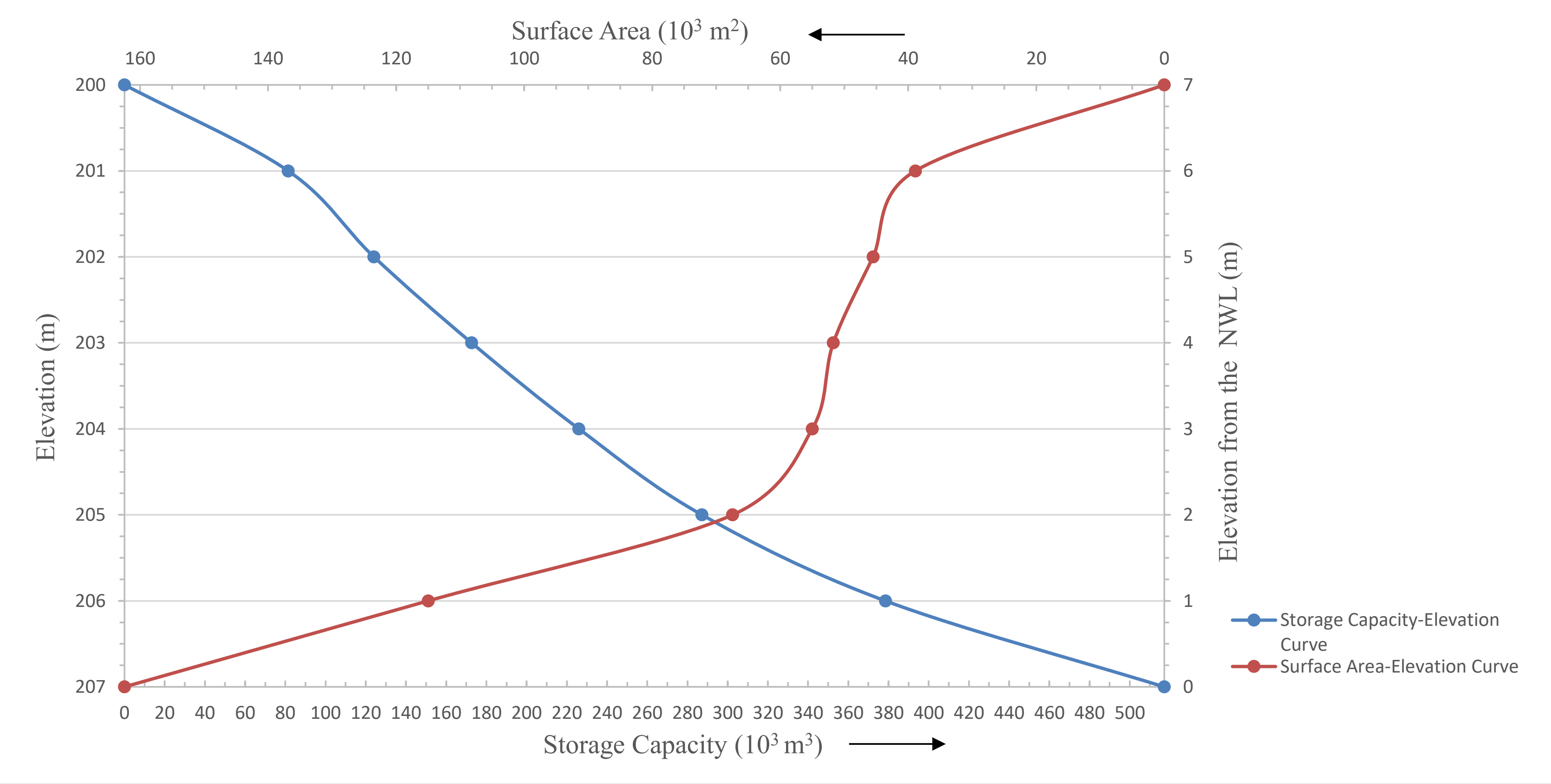
O3. Estimated Monthly Φ Index Values of Şirinevler-Polatdere Reservoir's Catchment (mm/hr)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2005	-	5.00	-	-	2.72	-	0.83	-
2006	-	-	-	1.62	0.83	-	-	-
2007	-	0.94	1.00	3.68	2.85	-	0.34	2.85
2008	-	-	-	-	1.42	-	-	-
2009	-	-	1.74	-	-	-	-	-
2010	-	-	-	1.76	4.43	1.21	-	0.27
2011	-	9.47	2.91	2.89	0.79	3.03	-	0.47
2012	-	5.57	1.21	2.33	-	0.58	-	3.26
2013	-	-	-	1.35	-	-	-	-
2014	-	-	1.87	-	-	-	-	-
2015	-	-	2.02	2.19	3.63	4.81	1.87	-
2016	-	-	-	-	-	7.62	-	-
2017	-	-	-	0.39	-	-	-	-
2018	-	-	2.58	7.25	-	0.84	-	-
2019	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	-
2022	-	-	-	-	-	-	-	-
Monthly Avg.	-	5.24	1.90	2.61	2.38	3.01	1.02	1.71
Total Avg.	2.55							

O4. Synthetic Unit Hydrograph of Şirinevler-Polatdere Reservoir's Catchment



O5. Designed Surface Area-Storage Capacity Curve of Şirinevler-Polatdere Reservoir



O6. Surface Area-Storage Capacity Details of Şirinevler-Polatdere Reservoir due to Sediment Accumulation within the Active Volume at Various Sedimentation Levels

Table O6.1. Surface Area-Storage Capacity details at sedimentation level 1 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
207	0	162433	435767
206	1	115000	297050
205	2	67450	205825
204	3	55000	144600
203	4	51700	91250
202	5	45500	42650
201	6	0	0

Table O6.2. Surface Area-Storage Capacity details at sedimentation level 2 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
207	0	162433	393117
206	1	115000	254400
205	2	67450	163175
204	3	55000	101950
203	4	51700	48600
202	5	0	0

Table O6.3. Surface Area-Storage Capacity details at sedimentation level 3 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
207	0	162433	344517
206	1	115000	205800
205	2	67450	114575
204	3	55000	53350
203	4	0	0

Table O6.4. Surface Area-Storage Capacity details at sedimentation level 4 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
207	0	162433	291167
206	1	115000	152450
205	2	67450	61225
204	3	0	0

Table O6.5. Surface Area-Storage Capacity details at sedimentation level 5 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
207	0	162433	229942
206	1	115000	91225
205	2	0	0

Table O6.6. Surface Area-Storage Capacity details at sedimentation level 6 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
207	0	162433	138717
206	1	0	0

O7. Estimated Monthly Evaporation Volumes from Şirinevler-Polatdere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	4952	8610	10784	13074	14419	14716	12989	10114
2005-2006	4874	2811	2238	31176	4873	8347	10820	12330	15666	14162	14617	10684
2006-2007	5721	3926	3427	24376	3300	5218	8987	10505	17437	17590	14485	12223
2007-2008	8554	5033	2971	27728	4015	5993	5648	5331	3394	Dry	Dry	Dry
2008-2009	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2009-2010	Dry	Dry	1323	4935	13093	19664	24449	23012	20567	17400	13809	17323
2010-2011	12413	6677	4259	4750	7811	11018	13870	18621	25525	23669	19649	12354
2011-2012	8769	5077	3433	4590	6103	6635	9801	10091	14123	7933	Dry	Dry
2012-2013	Dry	1128	2045	2611	3560	10094	16291	22569	22941	15983	15057	10595
2013-2014	8716	1970	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2014-2015	Dry	30	568	1507	3631	8834	14073	16687	17387	18439	15840	11511
2015-2016	6645	4673	3147	2975	4893	6895	5277	Dry	Dry	Dry	Dry	Dry
2016-2017	Dry	Dry	Dry	1594	4034	5757	8525	10222	6272	Dry	Dry	Dry
2017-2018	Dry	Dry	Dry	603	1618	4363	8120	8835	8573	5232	Dry	Dry
2018-2019	Dry	126	5166	7969	10077	14918	16661	34294	34923	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	4322	5317	7505	12586	13047	14401	11470	7771
2021-2022	3252	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2022-2023	Dry	Dry	Dry	-	-	-	-	-	-	-	-	-

O8. Estimated Monthly Utilized Volumes from Şirinevler-Polatdere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	0	21308	0	0	0	15461	14707	51058
2005-2006	59205	0	15122	0	0	2361	43687	2658	15581	0	15783	9444
2006-2007	0	8004	28964	0	0	17709	0	0	9240	0	10430	10170
2007-2008	47672	0	0	81063	0	22184	8886	0	45741	Dry	Dry	Dry
2008-2009	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2009-2010	Dry	Dry	0	0	0	0	102477	0	4566	32364	38146	0
2010-2011	48747	46456	0	0	0	0	21620	0	3359	8912	13232	0
2011-2012	87701	0	0	0	100261	0	30944	0	0	227867	Dry	Dry
2012-2013	Dry	0	0	0	21370	0	0	0	107341	13624	15165	11594
2013-2014	45206	128514	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2014-2015	Dry	0	0	0	0	0	0	22165	0	19032	21177	0
2015-2016	77771	37284	0	0	21018	0	165699	0	Dry	Dry	Dry	Dry
2016-2017	Dry	Dry	Dry	0	42040	16252	5435	0	141106	Dry	Dry	Dry
2017-2018	Dry	Dry	Dry	0	829	0	3118	7056	0	73420	Dry	Dry
2018-2019	Dry	0	0	0	0	0	0	0	0	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	12415	3167	14037	5625	861	5303	0	5747
2021-2022	128143	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2022-2023	Dry	Dry	Dry	-	-	-	-	-	-	-	-	-

O9. Estimated Monthly Effective Runoff Volumes of Şirinevler-Polatdere Reservoir (m^3)

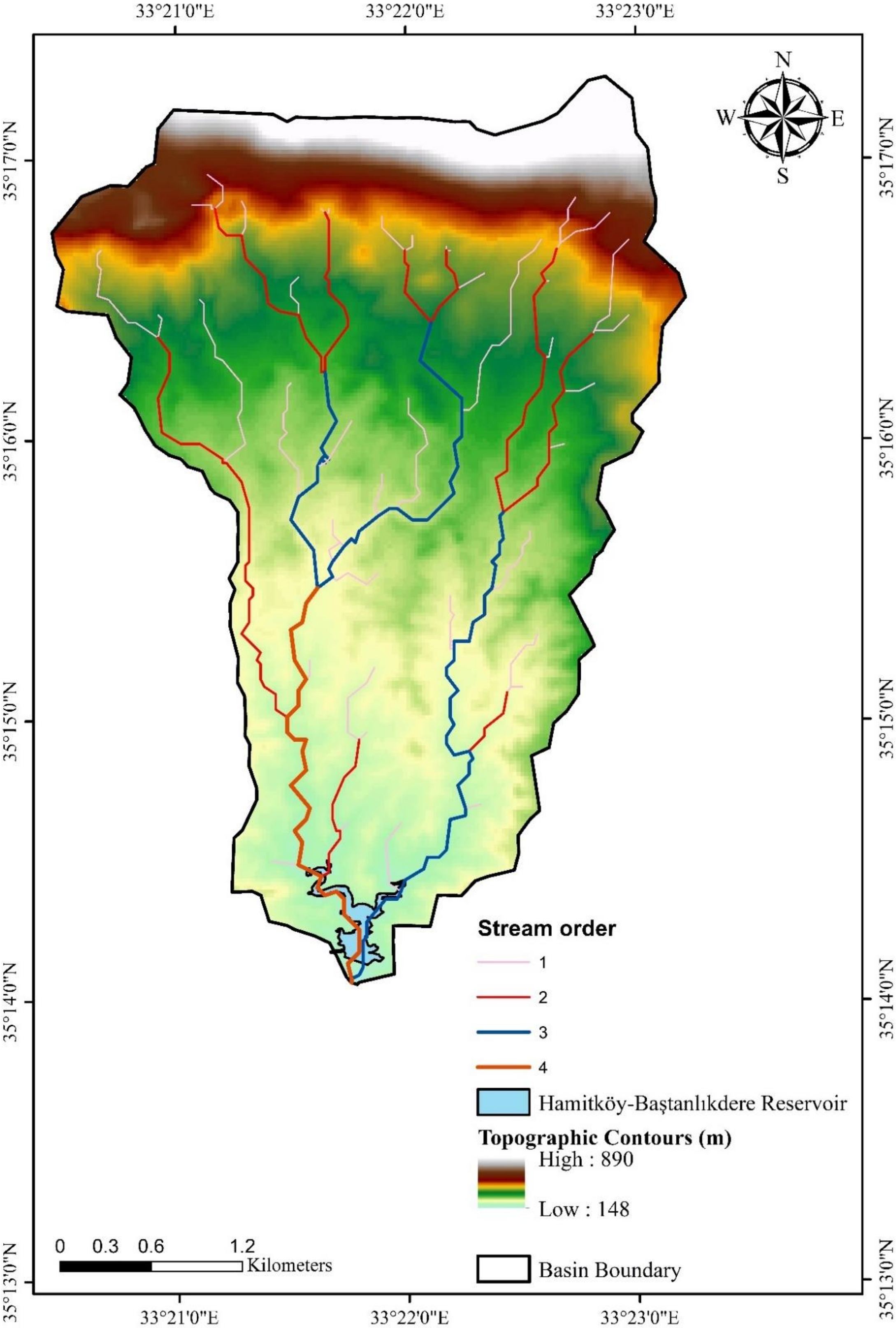
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Total
2004-2005	-	-	-	-	25839	0	22710	0	48550
2005-2006	0	61462	0	222429	0	0	0	0	283891
2006-2007	0	0	0	29231	107109	0	20457	80242	237038
2007-2008	0	13190	17669	0	24799	0	0	0	55657
2008-2009	0	0	0	0	0	0	0	0	0
2009-2010	0	0	76949	342361	67792	16659	0	22050	525811
2010-2011	0	0	0	61827	47494	26861	0	49033	185215
2011-2012	0	73611	20887	59024	0	25291	0	15368	194180
2012-2013	0	62200	126630	71762	0	0	0	0	260593
2013-2014	0	0	0	0	0	0	0	0	0
2014-2015	0	0	46086	30151	185074	55857	16834	0	334002
2015-2016	0	0	52864	0	0	25622	0	0	78486
2016-2017	0	0	0	225461	0	0	0	0	225461
2017-2018	0	0	0	50124	0	63365	0	0	113489
2018-2019	0	0	491333	Overflow	Overflow	Overflow	Overflow	0	491333
2019-2020	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	0	0	0	0	0
2021-2022	0	0	0	0	0	0	0	0	0
2022-2023	0	0	0	-	-	-	-	-	0
Average	0	13154	52026	78026	28632	13353	3750	9805	168539

Appendix P: Hamitköy-Baştanlıkdere Reservoir

Hamitköy-Baştanlıkere Reservoir constructed by the Republic of Turkey in 1992 for irrigating 95 hectares of land.

Thalweg Elevation	155	m
Bottom Elevation of Weir (Spillway)	158.80	m
Normal Water Level	169	m
Maximum Water Elevation	170	m
Crest Level	171	m
Maximum Active Volume Depth	10.2	m
Dead Storage	49425	m^3
Active (Live) Storage Capacity	529125	m^3
Spillway Type	Ogee	-
Catchment Area (Delineated from ArcGIS)	14.699	km^2

P1. Delineated Hamitköy-Baştanlıkdere Reservoir's Catchment with Strahler's Stream Order



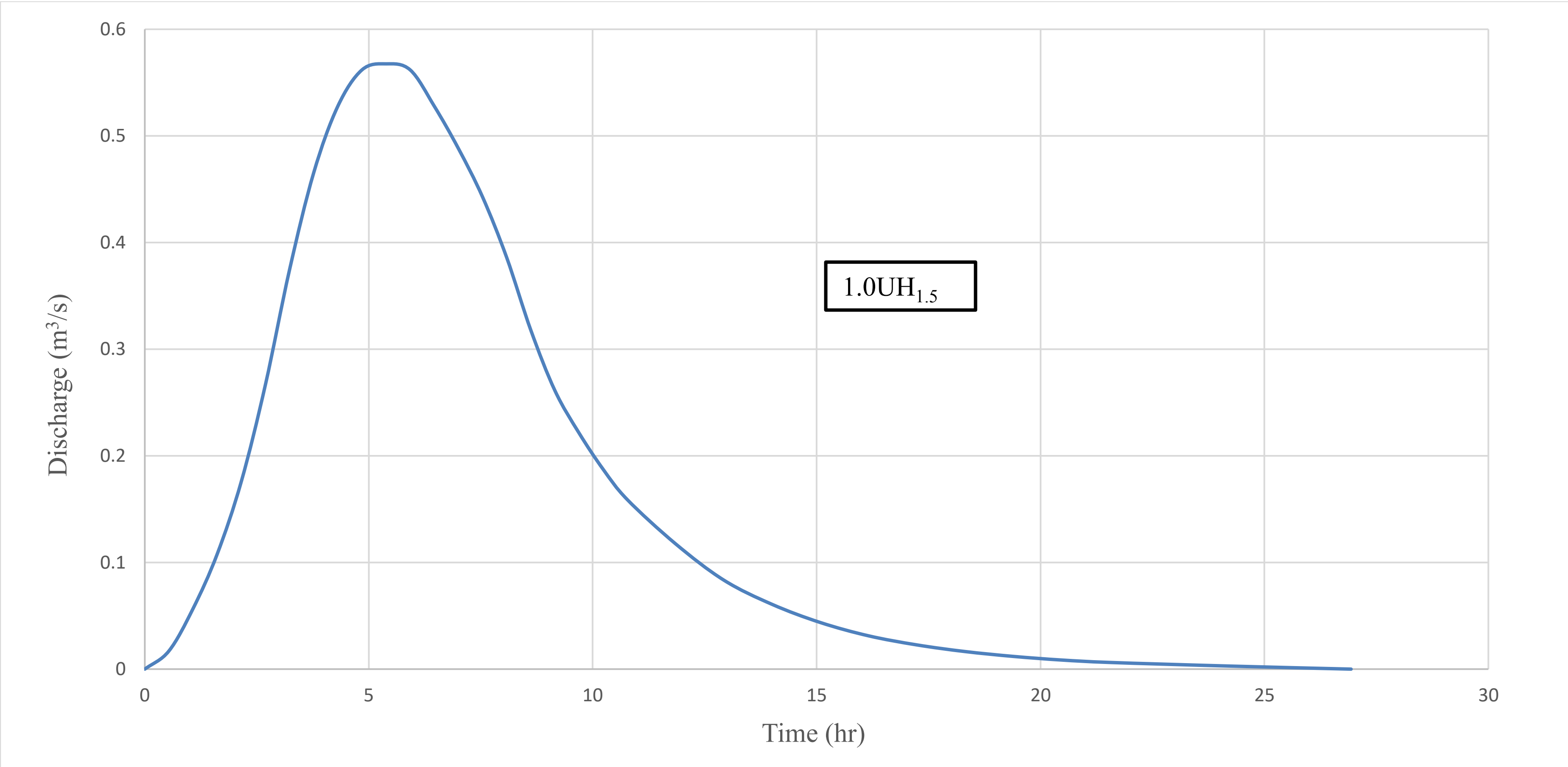
P2. Geomorphological Details of Hamitköy-Baştanlıkdere Reservoir's Catchment

Name of Parameter	Unit	Catchment's Value
Stream Order	-	4
Total Number of 1st Order Stream	-	52
Total Number of 2nd Order Stream	-	9
Total Number of 3rd Order Stream	-	3
Total Number of 4th Order Stream	-	1
Total Number of All Order Streams	-	65
Basin Length	km	6.2
Basin Perimeter	km	18.4
Length of Main Channel	km	6.7
Length of Highest Order Stream	km	3.3
Length of 1st Order Stream	km	14.0
Length of 2nd Order Stream	km	11.8
Length of 3rd Order Stream	km	8.3
Length of All Order Streams	km	37.3
Basin Area	km^2	14.7
Basin Maximum Elevation	m	890
Basin Minimum Elevation	m	148
Maximum Stream Elevation	m	419
Minimum Stream Elevation	m	148
Mean Bifurcation Ratio	-	4.4
Bifurcation Ratio Order 1:2	-	5.8
Bifurcation Ratio Order 2:3	-	3.0
Circularity Ratio	-	0.547
Quadratic Harmonic Mean Slope	-	0.018

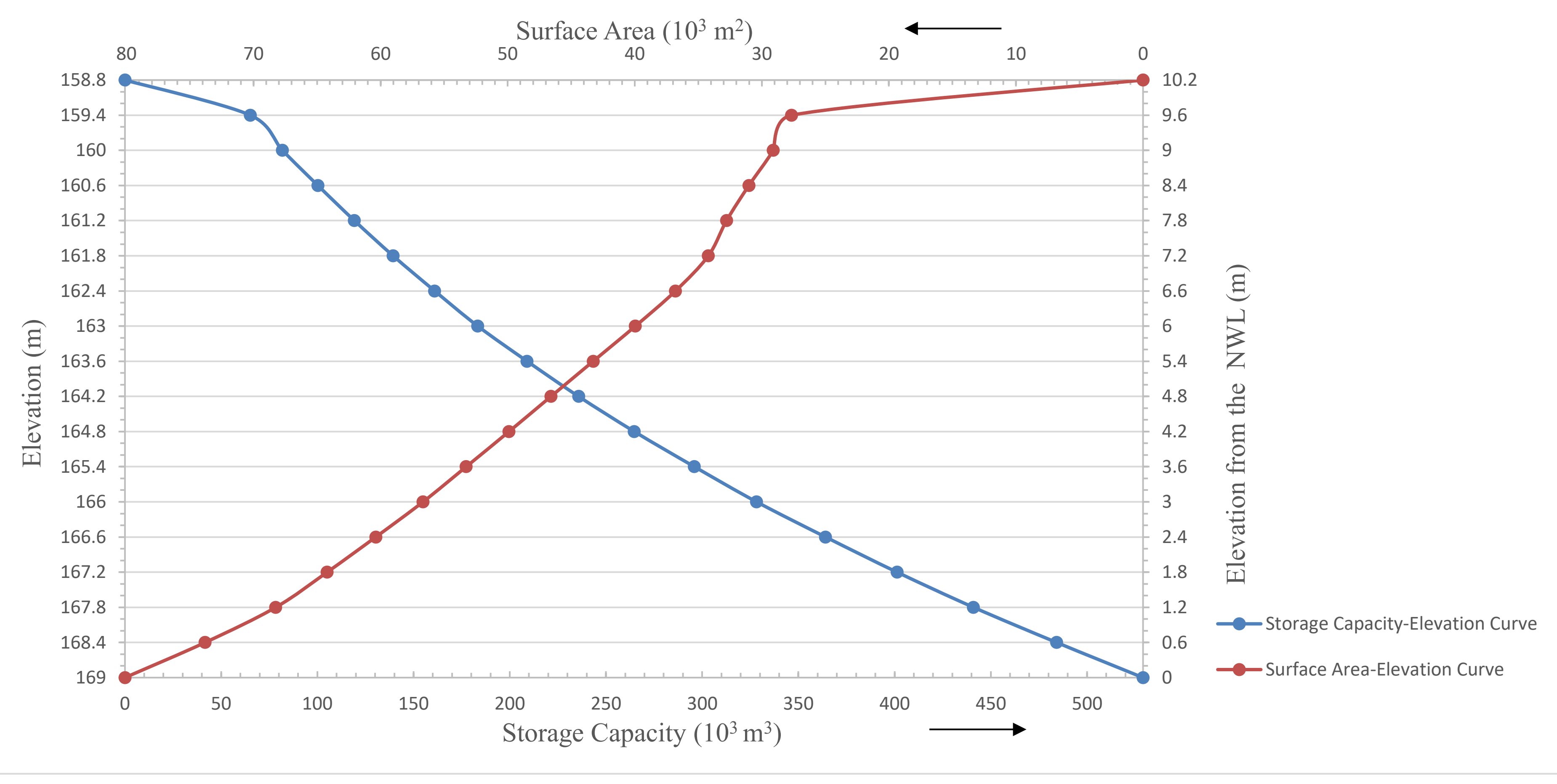
P3. Estimated Monthly Φ Index Values of Hamitköy-Baştanlıkdere Reservoir's Catchment (mm/hr)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2005	-	3.63	-	-	2.15	-	0.87	-
2006	0.91	-	-	1.27	0.73	-	-	-
2007	-	0.84	0.76	3.37	2.17	-	0.22	2.65
2008	-	-	-	-	1.12	-	-	0.28
2009	-	-	1.43	-	-	-	-	-
2010	-	-	-	1.14	-	1.24	0.22	0.23
2011	-	8.91	2.68	2.53	0.43	2.56	-	0.32
2012	-	4.47	1.06	2.02	-	0.50	-	2.79
2013	-	1.76	1.44	1.06	-	-	-	-
2014	-	-	1.60	-	0.88	-	0.26	-
2015	-	-	1.32	1.79	2.14	3.25	1.66	-
2016	-	-	-	4.13	-	4.63	-	-
2017	-	-	-	0.21	-	0.64	-	0.08
2018	-	-	2.50	6.14	-	0.36	-	-
2019	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	-
2022	-	-	-	-	-	-	-	-
Monthly Avg.	0.91	3.92	1.60	2.37	1.38	1.88	0.65	1.06
Total Avg.	1.72							

P4. Synthetic Unit Hydrograph of Hamitköy-Baştanlıkdere Reservoir's Catchment



P5. Designed Surface Area-Storage Capacity Curve of Hamitköy-Baştanlıkdere Reservoir



P6. Surface Area-Storage Capacity Details of Hamitköy-Baştanlıkdere Reservoir due to Sediment Accumulation within the Active Volume at Various Sedimentation Levels

Table P6.1. Surface Area-Storage Capacity details at sedimentation level 1.2 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
169	0	80120	447250
168.4	0.6	73808	402334
167.8	1.2	68252	359144
167.2	1.8	64208	319406
166.6	2.4	60380	282256
166	3	56660	246400
165.4	3.6	53264	214077
164.8	4.2	49898	182867
164.2	4.8	46592	153893
163.6	5.4	43274	127147
163	6	39950	101515
162.4	6.6	36794	79123
161.8	7.2	34212	57500
161.2	7.8	32778	37400
160.6	8.4	31020	18420
160	9	0	0

Table P6.2. Surface Area-Storage Capacity details at sedimentation level 2.4 m.

Elevation (m)	Elevation from NWL (m)	Area (m^2)	Storage Capacity (m^3)
169	0	80120	409850
168.4	0.6	73808	364934
167.8	1.2	68252	321744
167.2	1.8	64208	282006
166.6	2.4	60380	244856
166	3	56660	209000
165.4	3.6	53264	176677
164.8	4.2	49898	145467
164.2	4.8	46592	116493
163.6	5.4	43274	89747
163	6	39950	64115
162.4	6.6	36794	41723
161.8	7.2	34212	20100
161.2	7.8	0	0

Table P6.3. Surface Area-Storage Capacity details at sedimentation level 3.6 m.

Elevation (m)	**Elevation from NWL (m)**	**Area (m^2)**	**Storage Capacity (m^3)**
169	0	80120	368127
168.4	0.6	73808	323211
167.8	1.2	68252	280021
167.2	1.8	64208	240283
166.6	2.4	60380	203133
166	3	56660	167277
165.4	3.6	53264	134954
164.8	4.2	49898	103744
164.2	4.8	46592	74770
163.6	5.4	43274	48024
163	6	39950	22392
162.4	6.6	0	0

Table P6.4. Surface Area-Storage Capacity details at sedimentation level 4.8 m.

Elevation (m)	**Elevation from NWL (m)**	**Area (m^2)**	**Storage Capacity (m^3)**
169	0	80120	320103
168.4	0.6	73808	275187
167.8	1.2	68252	231997
167.2	1.8	64208	192259
166.6	2.4	60380	155109
166	3	56660	119253
165.4	3.6	53264	86930
164.8	4.2	49898	55720
164.2	4.8	46592	26746
163.6	5.4	0	0

Table P6.5. Surface Area-Storage Capacity details at sedimentation level 6 m.

Elevation (m)	**Elevation from NWL (m)**	**Area (m^2)**	**Storage Capacity (m^3)**
169	0	80120	264383
168.4	0.6	73808	219467
167.8	1.2	68252	176277
167.2	1.8	64208	136539
166.6	2.4	60380	99389
166	3	56660	63533
165.4	3.6	53264	31210
164.8	4.2	0	0

Table P6.6. Surface Area-Storage Capacity details at sedimentation level 7.2 m.

Elevation (m)	**Elevation from NWL (m)**	**Area (m^2)**	**Storage Capacity (m^3)**
169	0	80120	200850
168.4	0.6	73808	155934
167.8	1.2	68252	112744
167.2	1.8	64208	73006
166.6	2.4	60380	35856
166	3	0	0

Table P6.7. Surface Area-Storage Capacity details at sedimentation level 8.4 m.

Elevation (m)	**Elevation from NWL (m)**	**Area (m^2)**	**Storage Capacity (m^3)**
169	0	80120	127844
168.4	0.6	73808	82928
167.8	1.2	68252	39738
167.2	1.8	0	0

Table P6.8. Surface Area-Storage Capacity details at sedimentation level 9.6 m.

Elevation (m)	**Elevation from NWL (m)**	**Area (m^2)**	**Storage Capacity (m^3)**
169	0	80120	44916
168.4	0.6	0	0

P7. Estimated Monthly Evaporation Volumes from Hamitköy-Baştanlıkdere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	5595	9545	12195	14041	15502	16271	13611	11402
2005-2006	7050	4290	2992	37248	5283	8910	11802	14532	19447	16581	15627	11535
2006-2007	6929	4847	4037	27547	4286	7243	12069	13150	20240	19765	15750	13032
2007-2008	9266	5448	3179	35248	5794	8670	9418	9974	12950	12638	10754	7467
2008-2009	5511	3413	2569	2545	2558	3025	4941	2920	Dry	Dry	Dry	Dry
2009-2010	Dry	Dry	1034	2661	6030	9289	13635	15123	14105	13164	12350	13887
2010-2011	9362	5846	3890	4119	5559	6431	8292	11255	14831	15117	13807	9120
2011-2012	7397	4662	2918	3142	4170	5367	7714	8623	13230	14326	15226	11062
2012-2013	5988	3829	3103	3314	4383	9845	13319	16410	20001	20254	18597	12491
2013-2014	9721	3946	3280	3240	5427	7989	9312	9271	14012	11678	10452	8151
2014-2015	4824	2361	2136	2194	4043	7702	10647	13744	15438	16327	14160	10168
2015-2016	6380	4855	3189	2873	4513	6283	4796	Dry	Dry	Dry	Dry	Dry
2016-2017	Dry	Dry	1278	3095	4019	5985	9965	11688	13301	14374	10962	8042
2017-2018	5267	3050	2628	2402	3606	6127	7541	8158	7930	9043	8121	3259
2018-2019	Dry	Dry	2008	3512	4925	7358	8218	16915	17806	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	4439	5631	7954	13208	13618	15273	12211	8128
2021-2022	6664	4069	2251	2379	1461	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2022-2023	Dry	Dry	Dry	-	-	-	-	-	-	-	-	-

P8. Estimated Monthly Utilized Volumes from Hamitköy-Baştanlıkdere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2004-2005	-	-	-	-	0	31968	0	78154	0	64473	9301	0
2005-2006	90314	0	39170	0	0	10531	103094	0	26227	34633	61588	0
2006-2007	0	47923	62730	0	0	64124	0	0	33204	34050	35883	33374
2007-2008	0	24426	0	9292	0	54271	20264	5347	0	4019	6265	0
2008-2009	70037	1802	0	64775	0	2370	1061	82354	Dry	Dry	Dry	Dry
2009-2010	Dry	Dry	0	0	0	0	7345	0	9012	48021	51528	0
2010-2011	79137	61642	0	0	0	17789	0	0	15712	35159	36931	1781
2011-2012	0	0	0	0	98557	0	41958	0	0	46990	0	152959
2012-2013	0	0	0	0	56163	0	0	0	0	39908	42816	32597
2013-2014	89898	54115	0	39093	0	0	25457	0	41920	51621	0	94338
2014-2015	10968	1050	0	0	0	2828	0	29845	0	52450	53784	0
2015-2016	0	55226	0	24996	27333	0	232729	Dry	Dry	Dry	Dry	Dry
2016-2017	Dry	Dry	0	0	98328	0	8114	13526	35774	0	10899	18515
2017-2018	54530	0	0	0	2703	108271	10468	4724	10290	39809	0	129604
2018-2019	Dry	Dry	0	0	0	1956	0	0	0	-	-	-
2019-2020	-	-	-	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	0	0	9880	4252	0	0	12658	13067
2021-2022	6568	16357	32456	9238	173510	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2022-2023	Dry	Dry	Dry	-	-	-	-	-	-	-	-	-

P9. Estimated Monthly Effective Runoff Volumes of Hamitköy-Baştanlıkdere Reservoir (m^3)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Total
2004-2005	-	-	-	-	17521	0	46012	0	63532
2005-2006	0	137685	0	241602	0	0	0	66096	445383
2006-2007	67485	0	0	15179	265602	0	39213	49865	437343
2007-2008	0	0	47613	0	30583	0	0	0	78196
2008-2009	0	0	56396	0	0	0	0	0	56396
2009-2010	0	0	80333	299928	84687	54862	0	34577	554387
2010-2011	0	0	25127	92052	0	0	26231	0	143409
2011-2012	35072	29849	0	57857	0	0	0	78074	200852
2012-2013	0	115668	96059	78309	0	67812	0	0	357848
2013-2014	0	0	178787	0	0	0	0	0	178787
2014-2015	0	0	84064	49667	171777	0	34911	0	340419
2015-2016	17813	0	54747	0	0	23037	0	0	95598
2016-2017	0	0	242573	102747	0	101655	0	0	446975
2017-2018	0	58996	20406	94799	0	0	0	0	174202
2018-2019	0	0	398988	111542	0	Overflow	Overflow	0	510530
2019-2020	-	-	-	-	-	-	-	-	-
2020-2021	-	-	-	-	0	0	0	0	0
2021-2022	0	0	0	0	0	0	0	0	0
2022-2023	0	0	0	-	-	-	-	-	0
Average	7523	21387	80318	76246	33539	15460	9148	13448	226881