TREND OF WATER BUDGET OF TURKISH REPUBLIC OF NORTHERN CYPRUS (2000 - 2012)

A THESIS SUBMITTED TO THE GRADUATE SCHOOL OF APPLIED SCIENCES OF NEAR EAST UNIVERSITY

By

ADAMU DAHIRU

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN CIVIL ENGINEERING

NICOSIA, 2014

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Adamu Dahiru:Trend of Water Budget of Turkish Republic of Northern Cyprus

Approval of Director of Graduate School of Applied Sciences

Prof. Dr. İlkay SALİHOĞLU

We certify this thesis is satisfactory for the award of the degree of Masters of Science in Civil Engineering

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name: ADAMU DAHIRU
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To my Father: Malam Dahiru Sani

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ABSTRACT

Turkish republic of North Cyprus had been in water scarcity right from 1960 to date due to limited fresh water resources, climate impact and high rate of evaporation. There exist no perennial rivers as such the Island depends largely on ground water as main source of supply. Gradual increase in water demand (domestic, industrial and irrigation) had lead to excessive extraction of fresh water from available aquifers in the past years, this leads to unexpected high water quality problem as a result of sea water intrusion making the scarcity more alarming. Though several efforts have been done to supply additional fresh water by desalinization and through water importation in large balloons from Turkey but all these attempts were not adequate, alternatively, the country is targeting and hoping to achieve water security through the ongoing water supply project of capacity 75MCM annually.

This thesis provides update on trend of water budget of North Cyprus based on available data up to year 2012. This was achieved by assessing water demand and supply for year 2011 and 2012 and then comparing the results with that of previous Ph.D research of Dr. Gozen Elkiran. The manner in which domestic water demand fluctuate over time and that of irrigation were all discussed, conveyance losses, desalination and present capacity of sanitary treatment were also investigated and provided. In addition, Assessment of Agricultural economy was conducted on 21 groups of crops that are grown in North Cyprus in terms of water consumption and incomes generated.

Finally, a general remark was provided on status of water security of the country at large, by considering the ongoing 75MCM water supply project, the extent of contamination of available aquifers as well as available supply from other sources.

Keywords: Water budget, water scarcity, water security, water demand and supply, water extraction, Agricultural Economy, TRNC

ÖZET

KKTC 1960 yılından beri kısıtlı su kaynakları, iklim etkisi ve yüksek buharlaşma oranı nedeniyle büyük su sıkıntı yaşamaktadır. Sürekli akan bir akarsuyu bulunmadığından su ihtiyacının büyük miktarını yeraltı suyundan karşılamaktadır. Tüm ülkede gittikçe artan su ihtiyacı, mevcut kaynaklardan daha fazla çekimlere sebep olmuş ve sonuç olarak su kalitesinde düşüşler ve tatlısu – deniz suyu etkileşimi yaşanmıştır. Türkiye'den balonlarla su nakli ve deniz suyundan tatlısu elde edilmesi gibi önlemlerle su sıkıntısı aşılmaya çalışılmış ancak başarılı olamamıştır. Bu nedenle alternatif su kaynağı olarak bir projeyle Türkiye'den KKTC'ye borularla yılda 75 milyon metreküp su transferi amaçlanmış ve inşaasına başlanmıştır.

Bu çalışma, KKTC'de su arz ve talebinin hangi yönde değiştiğine güncellik kazandırma amacını gütmüştür. Bu amaçla 2011-2012 yıllarına ait istatistikler kullanılarak sonuçlar alınmış ve Dr. Gözen Elkıran'ın doktora çalışmasından alınan değerlerle kıyaslanmıştır. Tüm ülke içerisinde evsel kullanım suyu ve tarımsal su ihtiyaçları dikkate alınarak; su iletim kayıpları, atıksu ve denizsuyundan elde edilen tatlısu miktarları çalışılmış ve sunulmuştur. Ayrıca, KKTC'de tarımsal alanda yetiştirilen 21 grup bitki türü için ekonomik analiz yapılmıştır.

Netice olarak, 75 milyon metreküplük su transferi, akiferlerin bugünkü durumu ve kullanılan su kaynakları dikkate alınarak KKTC'nin su güvenliği hakkında detaylı yorumlar yapılmıştır.

Anahtar kelimeler:, Su bütçesi, su kıtlığı, su güvenliği, su arzı ve talebi, su çekimi, tarımsal Ekonomi, KKTC

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LIST OF ABBREVIATIONS

TRNC	Turkish Republic of Northern Cyprus
NC	North Cyprus
MCM	Million Cubic Meter
CM	Cubic Meter
SID	Water Works Department of TRNC
DSI	State Hydraulic Works of Turkey
SPD	State Planning Department
TL	Turkish Lira
PPM	Part Per Million of Salt Concentration
IWRM	Integrated Water Resources Management
ASP	Agricultural Structure and Production
LMR	Lefkosa (Nicosia) Main Region
GMR	Girne (Kyrenia) Main Region
MMR	Magusa (Famagusta) Main Region

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CHAPTER 1

INTRODUCTION

1.1 Preamble

Cyprus is an island of total land area 9,251km^2, coastline of 1,364 km^2 and surrounded by Mediterranean Sea. It is located toward southern part of Turkey in between three continents Europe, Asia and Africa. Turkish republic of Northern Cyprus (TRNC) has land area of 3,229km^2 and was established as a republic in 1983. TRNC is divided in to three main administrative regions: Nicosia, Kyrenia and Famagusta, these three main regions are further subdivided into seventeen Agricultural sub-regions (ASP, 2012).

North Cyprus has limited surface water resources therefore depends largely on ground water as a main source for Domestic supply, Industries and Agricultural production. Gradual increase in population, impact of drought and high consumption in Agricultural sector had raised the water demand beyond available supply thereby leading to extraordinary water scarcity. Previous studies verify that, water scarcity in terms of quantity started since 1960's leading many regions to lack access to adequate fresh water supply. An effort was made by increasing rate of ground water pumping so as to meet up demand, this was the first strategy adopted over a long period of time serving all water need within the country. After a long period of time, some studies came up with update proving that, rate of pumping in Guzelyurt, Famagusta area and Kyrenia coastal area has exceeded the aquifers yield thereby leading to decline in level of water table, sea water intrusion and ground water contamination to very high salt concentration of about 5000ppm which make it neither suitable for domestic supply nor for irrigation, this make the scarcity more alarming. The following aquifers were also affected too: Incilirli, Guvercinlik and Cayonu among others (Gokchekus et al. 2002).

Generally, to deal with water problem effectively, water demand and supply characteristic of an area needs to be known. Secondly, who are the water users and how is the management strategies enforced? The above narrated problem is what prompts the need for the research in order to study water demand and supply characteristic so as to provide update on Trend of Water Budget of Northern Cyprus. The study was carried out based on approach of integrated water resources analysis through compilation and study of present and historical data. Water regulations in TRNC, relevant statistical relationships and Blaney-Criddle method were applied where relevant in processing all the data collected. A simple water budget of TRNC were prepared in form of Microsoft excel program which aid in data processing and eventually the results obtained for water budget of 2011 and 2012 were compared with that of previous studies of Dr. Gözen Elkıran. At last, updates on the water demand, water availability, over draft and trend variability were all provided.

After all evaluations, assessment and comparison of results, it was found that the trend of domestic water demand is positive which is increasing with gradual increase in population while that of irrigation demand fluctuates depending upon size of annual cultivated area.

The findings of the research shows that, the total water demand for 2011 and 2012 were 111.8 and 125.2MCM respectively. The average annual recharge capacity of all the available aquifers including those that were contaminated is about 103.9MCM but sequel to limited supply from the other sources still ground water pumping is beyond the recharge capacity of the aquifers. Due to high consumption in irrigation sector, Ground water extraction for year 2000 was 138.5MCM while in year 2001 it was 120.7MCM and for 2002 was found to be 112.5MCM. Similarly, for 2003 was 112.2MCM while that of 2010, 2011 and 2012 were found to be 135.3, 99.9 and 115.1MCM respectively as detailed in Table 5.2 and Figure 5.6. These results justifies that there was over extraction which needs to be controlled to avoid further contamination.

There are still some uncontaminated aquifers such as Yesilirmark of recharge capacity 7MCM, Kyrenia Mountain aquifer 10MCM, Korucam 1.1MCM and Lefke 15.5MCM which are being used to provide fresh water to nearby areas. In year 2011 and 2012, the

quantity of water obtained from other sources such as dams and desalination were evaluated and found to be 11.2 and 13MCM respectively. Water demand of year 2012 was 125.2MCM unfortunately, the overall quantity of fresh water obtained from these uncontaminated aquifers, desalination and dams was far below demand proving that there was very significant imbalance between demand and fresh water supply, alternatively up to year 2014, shortage of fresh water necessitates pumping of salty water for supply to many parts of the country e.g. Nicosia.

As far as year 2012 is concerned, the total quantity of water treated from Nicosia, Famagusta, Guzelyurt and Kyrenia central sewerage treatment plants was evaluated based on their respective daily active capacities and was found to be 9.5MCM however, despite water scarcity, such quantity of water is being discharged to nearby rivers and then allowed to flow to sea without any reuse. Considering the extent of ground water contamination and the Trend of Water Budget of the Country, it could be concluded that the ongoing annual 75MCM water supply project will alleviate water scarcity significantly but might not end water problem completely, therefore to achieve water security, government need to plan more water development projects by looking at possibility of implementing more desalination plants, harvesting of rain water and also by review of existing integrated water management system and its enforcement.

Lastly, Based on the assessment of Agricultural economy performed, about 146.6 and 115.1million UDS were generated in 2011 and 2012 respectively which is a valuable income to NC but it was found that despite modernization of the irrigation methods yet there is high water consumption in Agricultural sector particularly Citrus production. Assessment indicates that cultivation of Tomato, Cucumber, Pepper, Squash, Artichoke, Strawberry, Potato, Eggplant, Cabbage, and Grapes are more profitable, check appendix iii for details. Citrus production alone consumed about 41.9MCM and 41.1MCM in 2011 and 2012 respectively but the incomes generated was not much, consequently, it is advisable to minimize irrigation water supply for citrus cultivation or its production could be reduced or replaced with new variety of crops that consume less water but generates valuable profit.

CHAPTER 2

LITERATURE REVIEW

2.1 Previous Studies on Water Problem

Research is a tool through which societal problems can be identified and assessed in order to come up with strategic measures and solution for progress and wellbeing of mankind. In order to properly assess the trend of water budget of TRNC, it was considered important to review all relevant previous research so as to have idea on general component of water cycle and climate impact in TRNC. Below are summary and synthesis of some previous studies conducted in TRNC, Turkey and some part of the world.

2.1.1 Similar Studies in North Cyprus

Gokcekus et al. (1997), Evaluation of Domestic and Agricultural Quality of Ground Water in Guzelyurt Basin, the research deals with assessment of ground water quality of Guzelyurt aquifer for domestic supply and irrigation. Water was sampled from domestic and irrigation wells for chemical analysis and physical examination. Based on the findings, the suitability of the water of various wells was interpreted for domestic supply. Similarly, the suitability of the water for irrigation was interoperated in order to prevent the use of unsuitable well for supplying water to irrigation farms. Those that were having water of good quality were recommended for continuous usage for irrigation and for optimum yield.

Gokcekus et al. (1997), Water Demand in North Cyprus, investigated impact of Kyrenia Mountain (Kyrenia range) and Torodos Mountain to climate of Cyprus. It states that these two mountain ranges are the topographical obstacles hindering most heavy cloud to reach to mesaoria plain which is considered as critical factor contributing towards decline in water level and sea water intrusion. It therefore suggested alternative ways of sourcing more fresh water to meet up demand of the Island.

Gokcekus et al. (2002), Water Management Difficulties with Limited and Contaminated Water Resources, Case study of TRNC. This research evaluated the extent of water problem in North Cyprus and discussed the elements that are contributing toward contamination of available water resources. Furthermore, evaluated water demand and supply and also reviews existing water resources projects their positive and negative impacts. In addition, it suggested possible ways to improve the productivity of available projects and prevent future contamination. Further detail, the research highlighted that the water quality problem and management difficulties arises not only due to over pumping of ground water from coastal aquifers, Geological formation, industrial waste, mining contamination and seepage of waste disposal contributed towards affecting the quality of natural resources. It suggested that better use and quality of water resources can be achieved by reducing water system losses, optimal water pricing or marketing policies, privatization, effluent discharge regulation, water quality monitoring as well as soil and water conservation measures.

Ergil (2002), Poor Management Impacts on Guzelyurt Aquifer, concerned with impact of sea water intrusion to Guzelyurt aquifer. It correlated available water level contours and salt concentration for different amount of precipitation. It also determined water demand for domestic and irrigation practices within the area. Furthermore, it recommended that, monthly estimate of direct seawater intrusion and land-wise contamination of Guzelyurt coastal aquifer should be carried out.

Gokcekus (2001), Evaluation of Water Problem in TRNC, Narrated history of water scarcity in TRNC, it evaluated extent of water problem in two different perspectives: (1) investigated the effect of drought to climate of North Cyprus. Secondly, it reviews the positive and negative impact of the various water resources projects carried out across the such as a) Yalya Irrigation project for citrus growing b) Guzelyurt Diversion Channel c) Gemikonagi Reservoir and other reservoir Projects: d) Water transportation project in Balloon from Turkey North Cyprus by Medusa.

All the above mentioned capital projects ended up below expectation. The study suggested adoption of modern irrigation methods in Yalya regions and keep pumping at safe yield through regular observation and analysis. It suggested, extra water should be provided from

elsewhere to revive aquifer in the region. It further suggested that feasibility study should be carefully done before embarking on any water resources projects. In addition, it suggested that physical planning department of TRNC should prepare and apply water master plan for Agriculture, education and tourism sector. Awareness program should be planned to educate society on how to use water effectively through seminars and conferences at educational establishment (primary, secondary and tertiary institution).

Werner et al. (2012), Sea Water Intrusion Processes, Investigation and Management: Recent advances and future challenges, deal with sea water intrusion to coastal aquifers as a global problem, it discussed and compare techniques of conducting sea water intrusion research such as laboratory and computer based techniques. The current sea water intrusion research process are based on laboratory sand tank experiment and numerical simulation in order to unveil the effect of surge, surface – ground water interaction, heterogeneity, density contrast and pumping.

Wheel Right et al. (1989), Forecasting Methods for Management. Discussed various methods of forecasting future events, time series methods, stationary time series (moving average, weighing average and exponential smoothing), Trend based time series (linear regression and double exponential smoothing), seasonal time series (CMA method and winter's methods). It also discussed how to evaluate the forecast and how to select suitable method.

Conservation Ontario (2010), Integrated Watershed Management, Water budget overview. This overview discussed concept of water budget, technical aspect of water budget assessment, and modeling. Similarly, legislative aspect of water budget was all discussed for effective management of available water resources.

Elkiran and Turkman (2008), Water Scarcity Impacts on Northern Cyprus and Alternative Mitigation Strategies, it examined the extent of water scarcity in TRNC and discussed the factors that lead to water problem as far back 1960's. Finally, suggested mitigation measures that could possibly be favorable in reviving water resources of the country.

Elkiran and Ongul (2009), Implication of Excessive Water Withdrawals to the Environment of Northern Cyprus, The research evaluated and analyzed the present and historical water budget of TRNC under drought and normal conditions. It also forecasted future demand using different scenarios; in addition, economic analysis of water resources was conducted on Agricultural economy. It's finding worth referencing for guide to engineers, scientists, and stakeholders for future studies.

Elkiran and Ergil (2002), Integrated Water Resources Planning and Management of North Cyprus: Case Study on Water Supply and Demand Including Drought Conditions. It deal with assessment of water demand and supply of TRNC year 2001. It also evaluated future water demand through optimistic and pessimistic scenario. In addition economic analysis was conducted on Agricultural economy. Based on its findings, recommends that, water use for agriculture should be reduced by enforcing farmers to cultivate not more than necessary. Another alternative is home base treatment plant and rain water harvest. It also encourages 75MCM water transportation project by undersea pipelines from Turkey to TRNC.

Hochstrat et al. (2009), Flexibility in Coping with Water Stress and Integration of Different Measures, Case Study Report on Cyprus, Investigated and recommends adaptive strategies that could be applicable to help in controlling water stress especially where impact from climate change affected the status of existing water resources e.g implementation of desalination plants, reuse of recycled water for Aquifer recharge and irrigation. Lastly development and implementation of Integrated water resources management system.

Stelio (2009), Trends of Precipitation in Cyprus, Rainfall Analysis for Agricultural Planning. The research focuses on analysis of rainfall regime and its implication for Agricultural planning in North Cyprus. Variation of rainfall intensity, period of rainy season, distribution as well as risk of drought were all studied and discussed.

Elkiran et al. (2001), Assessment of Water Budget of North Cyprus, Evaluated water demand in all sectors within the 17 sub-regions of the country, according to its findings, the water demand was found to be 103 MCM while the annual safe yield is 74.1 MCM. Water deficiencies, water losses due to old conveyance systems and the quantity of water wasted

due to low efficiency of irrigation systems were examined. The water deficit faced by the different administrative regions of NC was assessed and found to be between 3.6 and 36.6 MCM/year. It recommends that, additional Dams and underground storage facilities should be constructed for water accumulation purposes and in order to delay passage of surface water to the sea, In addition, a rainwater sewage system and desalination plant should be designed and constructed to reclaim liquid waste of each city in order to offset the increasing water deficit.

Department of Environment, Ministry of Agriculture, Natural Resources and Environment through Meteorological Service of Cyprus (2010), Impact of Climate Change in Cyprus, the research focuses on climate change and its finding states that, in 2010 precipitation had decreased by 17% (100mm) due to drought and temperature has increased by $1^{o}C$ since the beginning of the century. The changes in climate leads to severe problems in the agricultural sector, vulnerability to desertification in many areas, increased wildfires during the summer months. The research suggested not depends on rainfall as main source of freshwater, reuse of recycled water should be considered and desalination plants should be implemented.

Evrin (2012), Analysis and Water Agenda of TRNC, Deal with factors that lead to water problem in TRNC. The analysis relates impending water problem to uncontrolled use of water resources, population growth, Pollution of resources, excessive-evaporation and salinization of coastal aquifer due to over pumping. The annual water potential is 117.5 Million cubic meters with the per capita demand of 285cu.m. 79% is used for Agricultural purpose, 13% for domestic use and 8% for Industrial use. It discussed previous attempt which includes: implementation of modern irrigation techniques, sea water treatment, water transfer from Turkey to NC and construction of water storage structures. It also discussed progress of 75Million Cubic Meters of annually of annual supply via 80km under sea pipeline from Alakopru Dam (Turkey) to Gecitkoy reservoir (North Cyprus) with expected completion date fixed as early 2014.

Elkiran and Ergil (2004), Water Budget Analysis of Kyrenia Region, Case Study Report of North Cyprus, it focuses assessment of contribution of available water resources system to the water budget of TRNC. Detail result of Kyrenia region was presented. Furthermore, the

conditions of groundwater resources were also stated therein. It is considered as one of the valuable literature available for the region.

Egil (2001), Estimation of Saltwater Intrusion Through a Salt Balance Equation and its Economic Impact with Suggested Rehabilitation Scenarios It determined the amount of water used regionally by volumetric 3D approach using 20 years data of over 90 pumping wells. The storativity of the available aquifers were estimated. Water balance and salt equation balance were integrated in space and time. Based on its findings, contour lines showing variation of water table level and concentration of sodium chloride (Nacl) were clearly presented. Precautions and rehabilitation scenarios were suggested for good management of the available aquifers

Charalambous (2010), Urban Water Balance and Management, A case Study of Limassol Town. It examined level of water balance and management in urban areas. It discussed factors that contributed towards imbalance in demand and supply such as urbanization, population growth and drought. It emphasize on the need to change approach of urban water resources management in order to address current and futures sustainability problems.

Tsiourtis (1996), Water Management for Sustainable Agriculture in Cyprus: Quantity, Supply and Demand Management. The study investigated aquifer situation in NC and emphasizes on the need of water resources management in demand and supply of all regions. The following measures were suggested so as to reduce excessive extractions from ground aquifers: adoption of modern systems of irrigation, control of network losses, rational water supply and water charges.

Charalambous (2001), Water Management under Drought Conditions, This research evaluated factors that leads to increase in water demand in Cyprus, its finding shows that, the significant increase in demand was associated with increase in population, Agriculture and industries. It also concluded that, traditional water sources could not meet the demand hence suggested need to diversify and try other sources such as desalinization. Some of the measures taken procedures adopted by water Board of Lemesos as strategies to manage potable water supply to Lemesos town and environs underway water shortage conditions and

statement of cost incurred was state. Brief information on construction process of Desalinization of plants of the Island was also outlined.

Klohn (2002), Reassessment of the Island's Water Resources and Demand: Synthesis Report. The study deal with re-assessment of water availability and water use in all main water management regions. It evaluated water demand and provided an update of Hydrology of the Island based on 2002 records. It also provided important management and adaptation policies. Furthermore, the project recommends production of intermediate outputs and collateral outputs taking in to account of improvement tools for data collection, handling, analysis, assessment of adequacy of data collection networks and review of existing institutional and legal framework.

2.1.2 Similar Studies in Turkey and Other Countries

Otelio and Atolagbe (2003), Salt Water Intrusion into Coastal Aquifers in Nigeria, This study deal with hydrogeology of Niger Delta and Benin Basins; it evaluated degree of ground water contamination due to intrusion of salty water from Atlantic Ocean to the above named basins. Finally, recommends some strategies applicable to mitigate future further intrusion within the study area.

Kumar (2000), Management of Groundwater in Salt Water Ingress Coastal Aquifers, it discussed factors that leads to seawater intrusion to coastal aquifers, Method for detecting and monitoring salt water concentration and intrusion such as geochemical techniques and geophysical methods (geological aspect of aquifer: pore water conductivity) were discussed. Furthermore, measures on how to restore groundwater systems in coastal were suggested.

Duzen et al. (2013), Sustainable Development of Water Resources in Turkey. It evaluated problems and conditions water resources in rural areas of Turkey in addition, it discovered that, precipitation regime in Turkey varies according to seasons and regions, therefore, countermeasures were designed for sustainable development.

Kanat, (2004), Watershed Resources Management in Istanbul after Drought. This research investigates recent developments of water resources of Istanbul and Urban water crisis. It also evaluates the growth in population of Istanbul and assesses water resources management after drought years. According to its findings, the main reason of severe water scarcity is associated with mismanagement of resources.

Matondo (2001), Water Resources Planning and Management for Sustainable Development, the Missing Link. This research investigated and discussed conservative and integrated water resources planning and management policies for sustainable development. The author emphasizes on the need of proper coordination within water budget monitoring authorities at all level of level of government for as an important issue for sustainable development.

FOA Water Report No. 36 (2013), Climate Change, Water and Food Security. It discussed impact of climate change on Agriculture and Agricultural water management. The publication summarizes challenges facing agriculture and water without considering climate change, it then integrate specific impact of climate at different regions of the world. It finally suggests adaptation and some mitigation measures.

Trenberth et al. (2006), Estimate of the Global Water Budget and its Annual Cycle Using Observational and Model Data. It gave brief review of climate analysis section at National Center for Atmospheric Research (NCAR) on water cycle. The results were used to estimate global Hydrological cycle for long term annual means for reservoirs and flow of water to them. It also provides information regarding Monthly precipitation, evapotranspiration, atmospheric moisture convergence of the land area. According to its findings precipitation exceed Evapotranspiration physically unrealistic, due to the fact that, evaporation mostly exceeds precipitation over land particularly in Tropic and sub-tropic regions.

Fikos et al. (2005), Water Balance Estimation in Anthemountas (Greece) River Basin and Correlation with Underground Water Level. ESRI ArcGIS 9 Environment was used to obtain several data and present detail calculation of water balance of the said study area. Correlation between flow of Anthemountas River, ground water level, precipitation, climate and evaporation were all discussed. Similarly, the relationship between demand and supply,

negative water balance and drop of underground water level was also evaluated and discussed.

Bouwer (2002), Integrated Water Management for the 21st Century-problem and Solution. It stresses the need and importance of integrated water resources management in controlling public health, environmental protection, economy and sustainability. Furthermore, it stated the importance of surface water storages, ground water resources and re-use of effluent water for their contribution in bridging the gap between demand and supply.

New Jersey Department of Environmental protection (2000), Water Budget in the Raritan River Basin. Discussed basic concept of water budget and presented the water budget of three watershed management area in Raritan River based on long term average and on annual basis. It also focuses on analysis annual precipitation received evaporation, runoff and infiltration. Finally, management strategies were developed for water security.

Myers et al. (2008), Impacts of Multiple Stresses on Water Demand and Supply Across the Southeastern United States. This research deal with budgeting of water available from various sources for supply to serve demand of the study area. Water supply stress index and supply index ratio were determined in order to evaluate water stress condition. It discovered that population growth significantly stresses water supply within metropolitan area of Florida and Piedmont. Other factors includes climate change and land cover. Land use and human population model were used to project supply stress for 2020.

Kenney et al. (2004), Use and Effectiveness of Municipal Water Restrictions During Drought in Colorado. Determined the impact of water conservation, water restriction and urban water management for effective use of domestic water use under drought condition. Other approaches were applied by 8 water providers track water saving techniques measured for comparison between 2000 and 2001 usage. Mandatory restriction was realized as the best effective way in coping with drought. 18 to 56% saving could be achieved compared to 4 - 12% saving during voluntary restriction.

Fahad University (2014), Impact of Agricultural Policy on Irrigation Water Demand: Case Study of Saudi Arabia. Deal with assessment for irrigation water need of various crops

grown in Saudi Arabia. It was realized that the country has been heavily exploiting ground water for irrigation to purposely achieved food security. Based on the assessment, cultivation of some crops including wheat was discouraged so as to limit water extraction. Similarly, a new policy was enacted to reduce over extraction and encourage importation of food.

David (2013), Regulation and Reality: Some Reflections on 50 Years of International Experience in Water and Waste Water. This article discussed important and recent development concerning level of waste water treatment for re-use. It also emphasize on regulation that are necessary to be observed prior to reuse of sanitary water.

Combalicer et al. (2010), Assessing Climate Impacts on Water Balance in the Mount Makiling Forest, Philippines. Investigated the impact of climate change on mount makiling forest watershed. The following facts were discovered on the water balance of the watershed, 42% of rainfall is converted evaporation, 40% to stream flow and 10% flows as losses due to deep seepage. It was finally concluded that the balance indicates dramatic fluctuation of hydrologic events which bring about high evaporation losses, decrease in stream flow but the subsurface flow remain unaffected, based on these development, strategic measures were provided on how to mitigate effect of climate change.

WMO (2012), Technical Material for Water Resources Assessment. This publication provide technical guide in a logical format on how to carry out water resources assessment. The guide have been developed and prepared by experienced specialist such as Dr. Annia Calver, Dr. Jeanna Balonnishniova e.t.c. details on general approach on water resources assessment such as data collection techniques and processing, rainfall analysis, impact of water extraction, land use, pollution and climate were all discussed.

Rawat et al. (2014), Poor State of Irrigation Statistics in India: The Case of Pumps, Wells and Tube wells. Investigated the impact of poor statistics on ground water extracted for irrigation, this was achieved through comparison of recorded data obtained from four government agencies, the data included are for ground water extraction through tube wells, diesel pumps and electric pumps from mid 1980s to mid 2000s. The research discovered wide divergence in data documentation! This requires urgent attention because lack of

adequate and reliable data affects realistic calculation of important information on ground water extraction.

Aqadi et al. (2013), Water Policy in Jordan. This article review past policies on water management in Jordan. The water problem in Jordan was attributed to policy and implementation failure, the effectiveness and weakness of the policies were evaluated based on which recommendations were made on how to improve management and planning process. Similarly, implementation of more desalination plants is considered as one of the viable option to be adopted so as to meet increasing demand of water.

Zekri et al. (2013), Managed Aquifer Recharge Using Quaternary Treated Wastewater: An Economic Perspective. This article investigated the possibility of recharging aquifers using treated. About 31 million cubic meter of sanitary water will be produced annually from Muscat and Oman. It focuses on health and economic aspect of adopting this artificial recharge after reverse osmosis treatment, but considering health risk, the project face rejection from domestic users of not willing to mixing treated sanitary water with domestic supply.

Omar (2013), Water Demand versus Supply in Saudi Arabia: Current and Future Challenges. Deal with analysis of demand and supply. It was realized that Saudi Arabia is sourcing water to meet up demand through conventional and non conventional water resources along with excessive extraction of ground water. The research forecasted possible gap between demand and supply for the next 20 years through 3 different scenarios: Pessimistic, moderate and optimistic. The study predicted that Saudi Arabia will experience gab between demand and supply, hence conservation and management plans are needed to tackle future scarcity.

Dessu et al. (2013), Assessment of Water Resources Availability and Demand in the Mara River Basin. It deal with assessment of availability of fresh water and demand within entire Mara River Basin. Twelve sub basins were defined and their water availability was assessed based on long term precipitation – runoff simulation with the aid of soil and water assessment tool (SWAT). A model was customized and used in evaluating the status of water resources of the basin along with anticipated demand, space time matrix was used to

show the result of the model for easy comprehension and decision making. The outcome of the research shows considerable variability of water availability and demand within the basin.

Anghileri et al. (2014), Trend Detection in Seasonal Data: From Hydrology to Water Resources. This paper investigates the relationship between hydro climatic trend and its impacts on water resources at a basin scale comparison of Swiss and Italian catchment for the period between 1974 - 2010. Data analysis was carried out using moving average over shifting horizon (MASH) which allow simultaneous investigation of seasonal data and filter out effect of inter annual variability therefore facilitate trend analysis and detection. The analysis shows that there are statistically considerable changes in hydro climatic record but had limited impact on water resources.

J. Gupta et al. (2007), Inter-basin Water Transfer and Integrated Water Resources Management: Where Engineering, Science and Politics Interlock. This article assess situation of inter basins water transfer from multi-displanary perspective and also discussed whether such transfer are compatible with concept of integrated water resources management. The criteria for inter basin transfer was proposed by international commission, scientist and policy communities so as to serve as guide for evaluation. The criteria were applied to some river linking project within India for preliminary assessment, finally conclusion were drawn on required institutional capacity for controlling water and also to adopt changes of environmental policy.

Cheng Fu et al. (2012), Cropping Pattern Modification Changes Water Resources Demand in the Beijing Metropolitan Area. This research investigated the impact of changes in cropping pattern and demand variability, it also discuss how recent changes in cropping affects water resources in Beijing metropolis. It was discovered that, there is significant increase in irrigation water need as a result of changes in cropping pattern from cereal to vegetable crops which greatly affects domestic supply. Finally, concluded on the need to develop integrated water resources policy.

Fenghua et al. (2012), Impact of Climate Change on Water Resources at Local Area in Anhui Province. Investigated the correlation between climate change and water resources and its impact on natural ecosystem, Agricultural production and human life. 50 years hydrological and climatic data of Anhui province were analyzed by using linear trend variation and statistical method. The finding shows that precipitation and temperature have been increasing in Chaochu and Ninggou basin while slight decrease was observed in Chuzhou.

Shangwei Qu et al. (2012), A Water Management Strategy Based on Efficient Prediction and Resource Allocation. This research deal with development of water distribution programming system, aimed at ensuring that the available water resources could be utilized to meet demand of China from 2013 to 2025. Based on the second exponential soothing method, the demand was evaluated to be 616 billion cubic meter while the water resources is nearly 531 billion cubic meter for the year 2013. The findings indicate that, Guangdang and Jiansu will experience serious water shortage. Therefore, water resource allocation model (WRAM) should be applied to minimize expenses on water allocation and also for conservation.

Kim-Poh et al. (2013), Using System Dynamics for Sustainable Water Resources Management in Singapore. In an effort to achieved water security, Singapore invested significantly in desalination, water catchment management, waste reclamation and many other related projects. Among the alternatives ways to augment the water scarcity problem, decision and law makers are interested in knowing which methods is efficient and sustainable plan to adopt. This research develop System Dynamic (SD) model of title Singapore water which were used to analyzed long term impact of different investment plans. The finding of the research indicates that investing on underground water storage only is not sufficient. It is therefore concluded that, if desalination infrastructures are implemented after there is shortage, then it will result in getting to 5 years of water scarcity before balance could be attained, hence there is need to build desalination infrastructures in advance so as to tackle future water scarcity.

CHAPTER 3

CONCEPT OF WATER RESOURCES AND WATER MANAGEMENT IN TRNC

3.1 Concept of Integrated Water Resources Management

Integrated water resources management is a systematic process for achieving sustainable development through appropriate allocation and proper monitoring of available water resources taken into account economic, social and environmental goals. It deals with challenges of sectorial management where responsibility of drinking water supply is controlled by one Agency, for Irrigation water with another agency and for environment also with yet another. Lack of co-ordination and linkage mostly leads to uncoordinated management and defragmentation of development effort thereby leading to contamination of resources, conflict and unsustainable development. Therefore, to achieve sustainable development and water security, it is imperative to have linkage among water governing agencies that control sectorial water uses as shown in Figure 3.1 (Ontario, 2010).

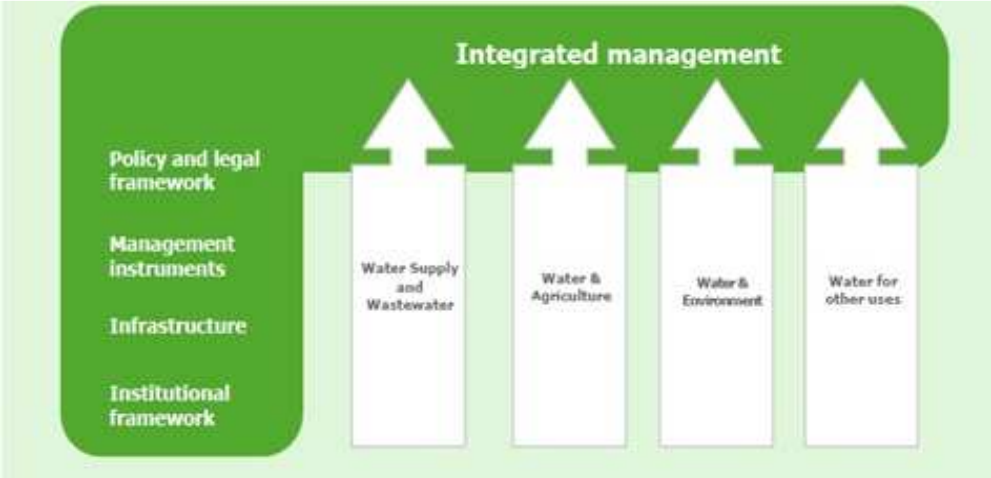


Figure 3.1: IWRM and its Linkage to Other Sub-Sectors (GWP, 2000)

In recent years 2011 and 2012, the water resources of TRNC comprises of precipitation, Dams, Ponds and ground water, other sources include desalinization and water recycled through sanitary plants. These resources are limited due to the fact that there exist no perennial rivers except some ephemeral streams that flow for short while during rainy season contributing minor quantity of water for domestic and irrigation demand. With all the above resources at its disposal, the country have been experiencing water scarcity right from 1960 to date, this is associated with scarce water resources, growth in population, urbanization, impact of drought, high consumption by old irrigation system and above all conventional water management (Gokcekus et al. 2002).

3.2 Natural Water Budget and Water Balance

Water budget is a scientific term which basically means technical information on how water naturally occurs and flow in and out of a catchment area, Lake or any geographic area of interest. Water budget of a catchment area has two components: input and output. The input component includes precipitation, surface runoff and groundwater inflow. The output component covers evaporation, transpiration, surface water outflow, ground water outflow and demand for Domestic use, Industrial use and Agricultural production as shown in Figure 3.2 (New Jersey, 2000).

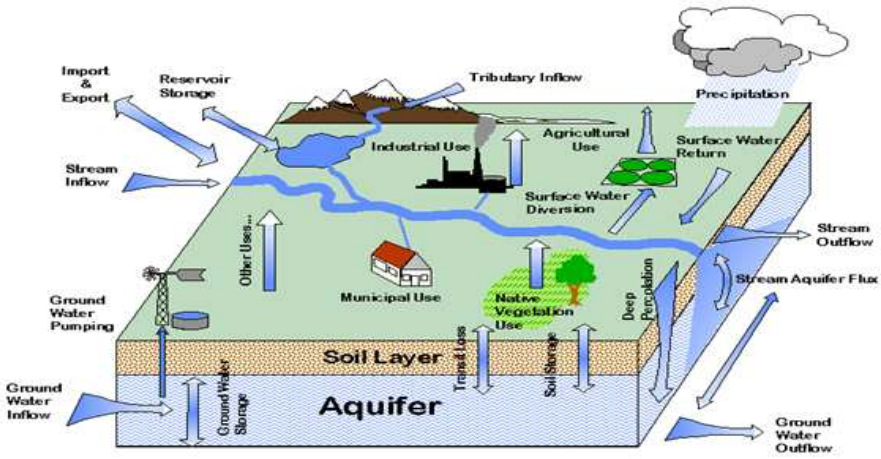


Figure 3.2: Conceptual Water Budget of a Watershed

Assessment of water budget refers to evaluation of water available from various sources, study of rainfall/runoff relationship as well as demand and supply for a variety of uses. It also deal with impact of climate change, Urbanization and human interactions which can significantly alter natural supply of water especially if there are nearby Sea, Ponds or Wetlands. Assessment of water budget is needed to determine possible changes in storage so as to plan mitigation measures for sound water management.

Mathematically, water budget equation can be expressed based on the components outlined below:

$$\pm\Delta S = P - E - ET \pm SRO \pm GF \quad \text{..... 1}$$

Where:

ΔS: Change in Storage

P: Precipitation

E: Evaporation

ET: Evapotranspiration

SRO: Surface Runoff

GF: Ground flow

If the value of the expression on the right-hand side of the equation is positive, the storage will increase and water level in the study area will rise. Positive change in storage is often termed a surplus, while a decrease in storage is generally termed as deficit (New Jersey, 2000).

3.3 Biophysical Information

3.3.1 Topography and Drainage/Streams Characteristics

Cyprus is an Island which is merely dominated by two Mountain ranges: Troodos and Kyrenia Mountain with Mesaria central plain situated in between. Troodos Mountain of altitude 1,952m covers significant part of west and south of the Island nearly half of its area. Kyrenia Mountain is narrow in shape extending along northern coastline but has less altitude and occupies less area compared to Troodos as shown in Figure 3.3 (Wikipedia, 2012).

Fig 3.3: Topographic Map of Cyprus, Troodos Mountain (1,952m) and Kyrenia Mountain range (Wikipedia, 2012)

Sequel to arid climate impact and mountainous nature of North Cyprus, access to adequate supply of fresh water had been difficult. There exist no perennial rivers in the whole Island except some network of ephemeral streams that naturally originates from Troodos Mountain and flows to different direction as shown in Figure 3.3. All the streams become dry during summer, Pedhieos and Yialias Rivers flow eastward through Mesaria to Famagusta Bay as

shown in Figure 3.3 while Serraghis River flows northwest across Morphou plain. Various dams and water ways have been constructed to store and divert water to farming areas (Wikipedia, 2012).

Kanlidere and Yalya are the main streams in TRNC in addition, there are ten ephemeral rivers that originated from Troodos mountain of south Cyprus discharging about 43MCM of water yearly but nowadays the rivers have been Dammed upstream in southern part of the Island (Wikipedia, 2012).

3.3.2 Land Use and Vegetation Cover

Land use such as Urbanization contribute toward generating large quantity of surface runoff during winter period alternatively forest and grass land retain runoff and thereby delaying and allowing significant part of the water to infiltrate to the ground. As it was previously discussed that the total land area of TRNC is 3,229km^2, Table 3.1 provides distribution of land resources across the country (ASP, 2012; Wikipedia, 2012).

Table 3.1: Land Use in TRNC (ASP, 2012)

Land Use	Area (Donum)	(%)
Agriculture	1,398,123	56.7
Forest	480,740	19.5
Grassing	122,157	5.0
Towns, Villages, Rivers and Dams	263,471	10.7
Unused Land/Bare soil	201,061	8.1
Total	2,465,552	100

Cyprus has variety of natural vegetations comprising of forests and grasses covering 19.5% and 4.95% respectively. Broad-leave trees and Forest conifers such as Cypresses, Pinus Brutia, Cedar and Oaks are the main types of tree plants that are in Cyprus. Mesaria was densely forested and still there are considerable forests on Kyrenia and Troodos ranges

particularly at lower altitudes which delay flow of runoff and increase infiltration as well as ground recharge. In vegetal cover area where there is no forest it will be found that tall shrub communities such as strawberry tree, Golden oak, Olive exist and grow at different altitude as shown in Figure 3.4 (Wikipedia, 2012).

(a) Urbanization (b) Agriculture (c) Vegetation Cover

Figure 3.4: Land Use in TRNC

3.3.3 Geology and Ground Water

Going by opinion of geologist, extraction of ground water in whole Cyprus had becomes dangerously lawless therefore requires severe enforcement of new and existing regulations. Normal salt concentration in potable water is less than 400ppm but Guzelyurt aquifers and some others had becomes completely saline to a concentration of about 5000 ppm of salt. These aquifers will definitely require long time of rainy seasons or decades to replenish themselves to fresh water status and also to fill up to normal water level. In reality, is very possible that most of these wonderful resources could be lost completely for ever if extraction continues beyond safe yield (Ellis, 2009).

Geological investigations show that there exist several types of water table and aquifers (confined unconfined and patched aquifers). These aquifers are recharged in different

manners some by rivers that originate from Troodos and Kyrenia Mountain range while others by ground water inflow.

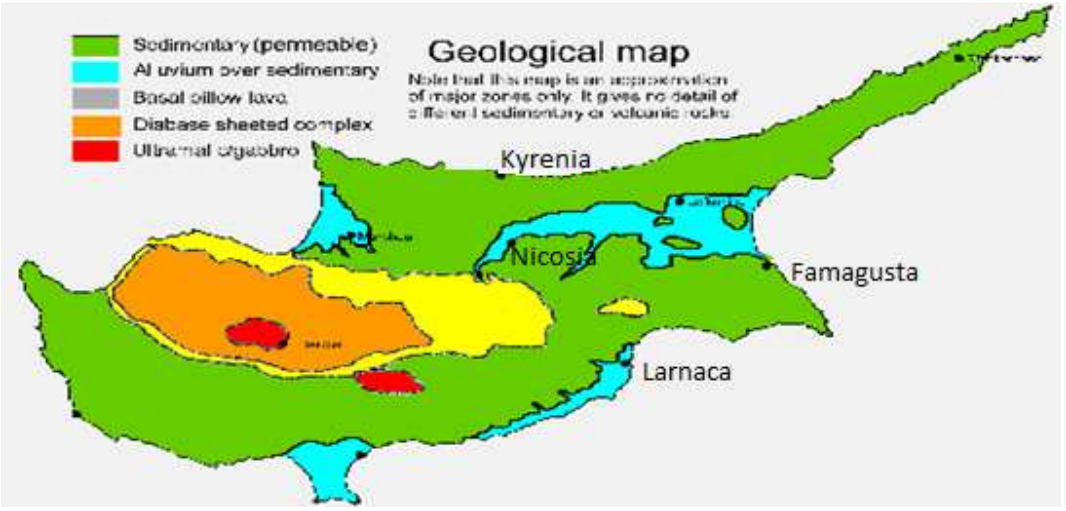


Figure 3.5: Geological Map of Cyprus (Ellis, 2009)

Figure 3.5 display a minimal detail of geologic formation of the whole Island, Kyrenia Mountain (Besparmak) is permeable sedimentary rocks extending 160km along Kyrenia coastline. It significantly consists of lime and sandstones of different types formed by seismic activity in sea. During winter, significant percentage of rainfall infiltrate into the rocks and flows downhill percolating different layers as far as the layers remain porous. Considering southern slopes, the porous layer extend very well up to many kilometers towards south of the foothills up to Mesaria and convey water to e.g. Nicosia septic area. Similarly, there was no Vadose water in the region but several Phreatic aquifers exist from which fresh water were being extracted at different level. The quality of the ground water is generally fair due to the fact that it contains dissolved calcium salts of limestone (Ellis, 2009).

Besparmak Mountain is translated as five finger mountain due to it five raised sections near Kyrenia. Geologically, it consists of sedimentary formation and some metamorphic as well as igneous rock. The mountain has many historic structures such as Kantara castle and

monasteries including St. Hilarion Castle. A harmful wild fire in July 1995 leads to burning of significant parts of these mountains which bring about loss of large natural habitat and forest land (Ellis, 2009).

It was scientifically observed that, in many places, there exist sedimentary formation overlaid by recent geological alluvial deposits conveyed and brought down by very old natural river systems flowing from Troodos massif and nearly cover about half eastern part of Mesaria, northwest of Famagusta, as well as southwest of Nicosia. In addition, it exist in Larnaka and Guzelyurt stretching to Zygi. Akrotiri peninsula is nearly all alluvial formation in the region. Alluvium consists of unconsolidated sedimentary rock (marl) and clays which normally forms an impervious layer over the existing underlying rock formations (Ellis, 2009).

Troodos Mountain is impermeable metamorphosed volcanic rock. Rainfall is absorbed into the formation through openings called honeycomb of seismic faults and other available structural cracks. There is no aquifer or water table in the formation but the water is in the form of Vadose which is relatively soft in quality being there is little sedimentary calcic formation with variety of dissolved mineral salts depending on the rock formation through which it percolates. Where such Vadose water reaches the surface it flows and forms spring which is exploited and packaged as bottle water (Ellis, 2009).

Due to high altitude, the water flows with a pressure provided there is rainfall. In many cases, nearly all the water flows from volcanic regions through cracks and opening and then enters more porous formation in the area of Mesaria and coastal plain below sea level from which it eventually discharges into sea, the pressure of the water prevent its contamination by sea water as the direction of the flow goes to towards the sea (Ellis, 2009).

Within plain areas, large quantity of water were previously extracted through boreholes beyond yield capacity which leads to drying of some the available Phreatic aquifers along with drastic dropping of water level especially in agricultural regions. On the other hand, Pyrga area have unlimited supply, its water table is available just few 10 meters below ground level (Ellis, 2009).

In Troodos massif region and around foothills e.g. Stavrovouni, ground water supply had becomes less reliable due to the fact that wells and boreholes have to penetrate up water carrying cracks or faults so as to be recharging e.g. Mosfiloti area. In July 2008, a borehole was drilled in the area but due to decline in water level the hydrostatic pressure has fallen allowing infiltration of sea water to the aquifers particularly in agricultural zones. This case is very alarming in south eastern part of e.g. Famagusta, Dhekelia and Cape Greco where brackish water was noticed in pumping wells. The contaminated aquifers in these regions may remain unusable for decade even if replenished with fresh water after adequate rainfall, this is because of the time lag between precipitation falling on Mountains reaching the lower levels and also because flushing the salt out of the contaminated aquifers is a long process of continuous successive dilution. Some other regions, including market gardens around Maroni, with important tomato and cucumber production have also experienced similar problems (Ellis, 2009).

3.4 Characteristic of Input and Output Components of Water Resources in TRNC

Considering year 2011 and 2012, the input components of water resources of North Cyprus comprises of precipitation, Ground water, ephemeral spring, Dams, Ponds, desalinization and recycled sanitary water. Previously, water was imported in medusa bags between 1998 to 2002. Similarly, in an attempt to meet up water demand of the country another capital project was designed and is expected to start to supplying 75MCM yearly to TRNC by September 2014. The output of the water budget constitutes supply of water for domestic, Agricultural, industrial needs, Evaporation and network losses.

3.4.1 Precipitation and Climate

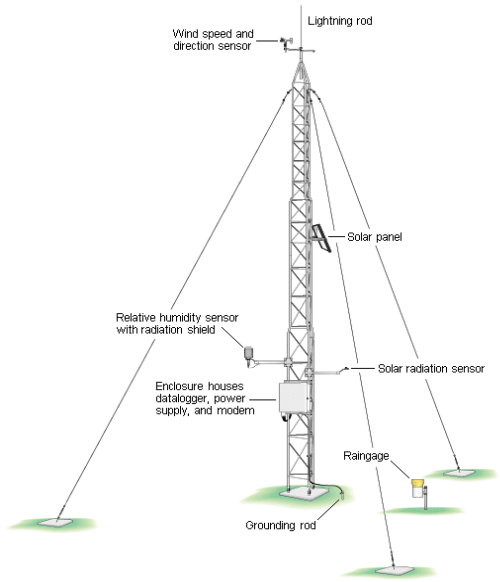


Figure 3.6 Cyprus Automated Weather Stations (AWS) and Meteorological Instruments

The weather of Cyprus is characterized by hot dry summer and cool wet winter. Precipitation is being recorded annually mostly from October to April. Rainfall and other meteorological data are recorded at the following metrological regions: Besparmak, west Mesaria, central Mesaria, east Mesaria, east Seaside/Coast and Karpaz station. Figure 3.7 shows variation of average monthly rainfall for year 2011 and 2012 (ASP, 2011; ASP, 2012).

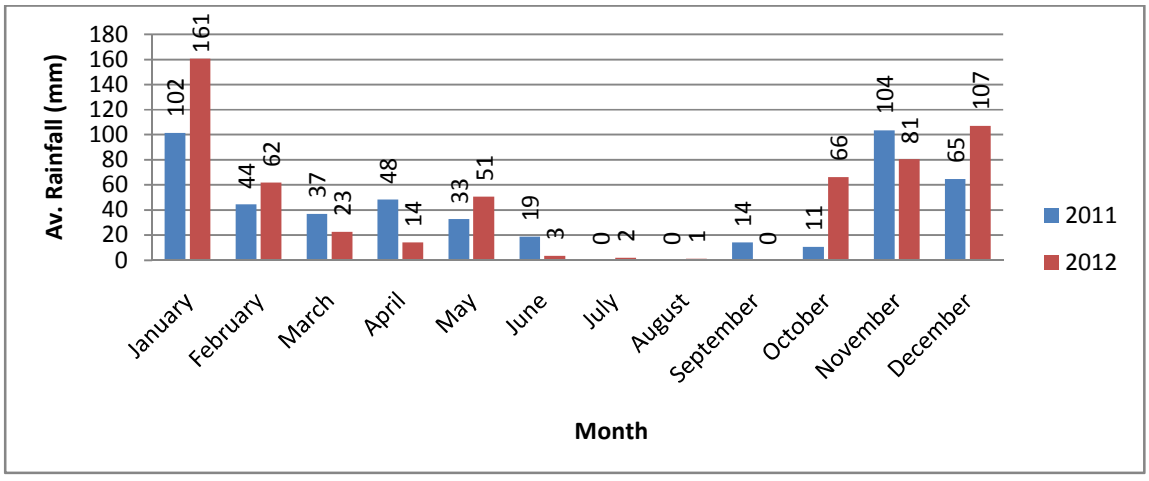


Figure 3.7: Rainfall Pattern in TRNC Year 2011- 2012 (ASP, 2011; ASP, 2012)

Based on record obtained from department of meteorology, North Sea side and Besparmak Mountain recorded highest rainfall intensity of 165mm in November 2011 while the monthly average was 40mm. The average temperature was about 19.2^0 but as low as below 0^0 C in winter. Similarly, the average monthly regional relative humidity was about 63.8 but it falls to 61mm (ASP, 2011; ASP, 2012).

Similarly, for 2012, North Sea side and Besparmak Mountain recorded highest rainfall intensity of 191mm in January while the monthly average was 48mm. The average temperature was about 19.6^0 but drop to 10^0 C in winter. Similarly, the average monthly relative humidity by regions was found to be 64.3 however it goes decreases to 52mm (ASP, 2011; ASP, 2012).

During summer period, temperature in N.C rises to 30°C and some time even up to 40°C thereby leading high rate of evaporation and transpiration, only 20% of the total rainfall received contributes to the water budget while 80% returns to atmosphere by Evapotranspiration and some part drained as runoff to Mediterranean (Elkiran and Ergil, 2004). According to previous studies, drought had significantly influence water scarcity and has been jeopardizing water sustainability particularly in North Cyprus. Analysis of long term rainfall data base on long term annual average shows that, there was 1.68mm/year reduction in precipitation between 1975 and 2004 as shown in Figure 3.8 (Sharif, 2006).

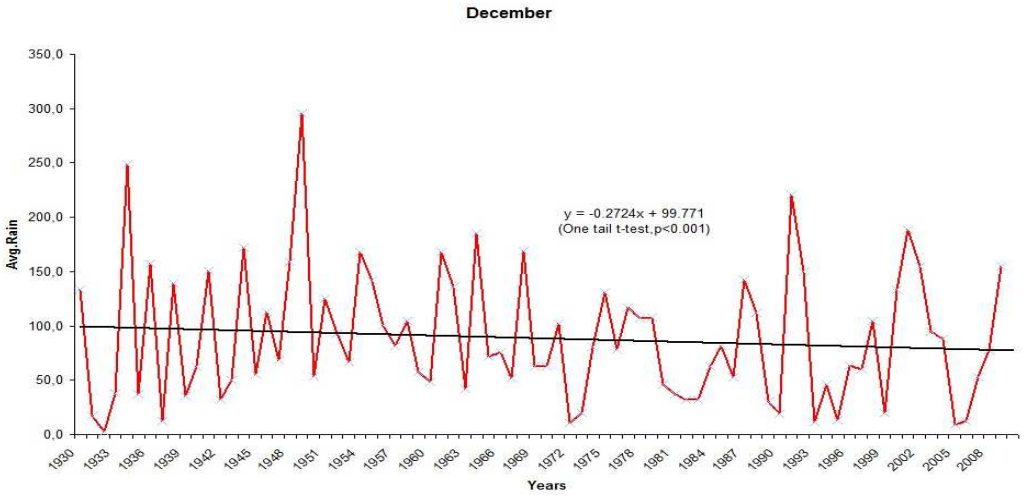


Figure 3.8: Rainfall Pattern in TRNC 1974 to 2008 (Sharif, 2006)

3.4.2 Dams and Ponds

Generally Dams are constructed across rivers to store surface runoff for future use during dry season, for aquifer recharge and in some cases to control dangerous flooding. In TRNC the need of Dams arises shortly after noticing water scarcity in 1960, DSI of Turkey considered Dams and Ponds as important renewable water resources and immediately designed 41 reservoirs of variable capacities out of which 18 were constructed for Irrigation and 23 others were constructed to purposely prevent direct flow of ephemeral streams to Mediterranean Sea, since then these infrastructures are contributing efficiently for their intended purposes. About 27MCM of water is obtained annually from 28 streams located in North Cyprus, there are also additional ten ephemeral streams that originated from Trodos mountain of South Cyprus discharging about 43MCM of water yearly but nowadays the rivers have been Dammed upstream in southern part of the Island (Gokchekus, 2001).

Mining remnant such as gypsum and halite mineral (Nacl) in Guzelyurt catchment area near Gemikonagi have been contaminating surface water in Gemikonagi basin and the reservoir situated in the area making all surface runoff unfit for the intended Irrigation storage. Furthermore, 4 Dams in TRNC do not function to full capacities due to accumulation of sediments leading to reduction in their storage capacity significantly while one Pond dried off completely (Gokchekus, 2001).

According to Duygu Alan's article in Havadis, scientific observations show that water level in Dams and lake within northern part of Cyprus have fallen by 7.9% because in March 2013 the total volume of standing water in dams was 10,446,436 cubic meters but due to high temperature during summer it decreases to 9,163,464 cubic meter in June, 2013 (Wikipedia, 2013).

A total of 34 streams are actively used for domestic water supply (834,679m^3/year) along with 28 for irrigation of capacity 565,321 m^3/year (Ozturk, 1995). Table 3.2 provides the list of 18 irrigation Dams, locations and their respective capacities.

Table 3.2: Irrigation Dams and Storage Capacities

S/No	Dams	Location of Dams	Year of construction	Capacity (m^3) x10^3	Irrigated area (ha)
1	Yilmazköy polatdere	Nicosia	1994	517.167	40
2	Geçitköy Dam	Kyrenia	2014	26,500.000	13,848
3	Arapköy uzundere	Kyrenia	1990	444.150	40
4	Arapköy ayanidere	Kyrenia	1990	608.881	65
5	Beşparmak alagadi çiftlikdere	Kyrenia	1992	774.575	67
6	Hamitköy baştanlikdere	Nicosia	1992	529.125	95
7	Değirmenlik çataldere	Nicosia	1990	296.814	30
8	Serdarli ağillidere	Nicosia	1992	391.880	56
9	Geçitkale eğridere	Famagusta	1989	1,360.510	240
10	Ergazi sayadere	Famagusta	1989	405.025	84
11	Mersinlik azganlidere	Famagusta	1989	1,145.065	170
12	Dağyolu üçparmakdere	Kyrenia	1994	392.250	82
13	Gemikonaği madendere	Guzelyurt	1988	4,121.205	640
14	Gönyeli	Nicosia	1962	453.857	150
15	Kanliköy	Nicosia	1963	730.294	NA
16	Haspolat	Nicosia	1964	117,390	115
17	Gönendere	Famagusta	1987	938,666	150
18	Akdeniz	Guzelyurt	1988	1,468,157	430
*	Total			41,195,011	16,272

Due to the ongoing water supply project of capacity 75MCM annually, Gecitkoy Dam was upgraded and is expected to start serving for distribution of water to irrigation and domestic sectors, the upgraded storage volume is now 26.5MCM. Figure 3.9 provides yearly peak water storage variation in TRNC Dams.

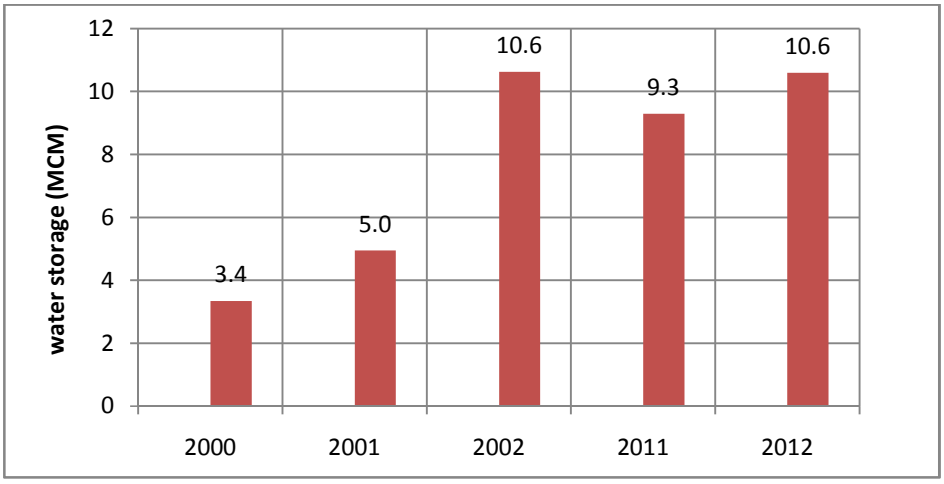


Figure 3.9: Fluctuation of Water Storage in Irrigation Reservoirs Year 2000 to 2012

3.4.3 Ground Water and Sub-Surface Flow

Due to the fact that, TRNC has limited water resources, it largely depends on ground water as a major resource of supply for domestic and Irrigation demand, the other sources includes Dams and ephemeral streams. There are 11 main aquifers of various storage capacities. Guzelyurt, Famagusta and Kyrenia coastal aquifer are the three main aquifers of recharge capacity 37MCM, 5MCM and 10.2MCM respectively. The water extracted from these aquifers is directly used for domestic supply and irrigation. Figure 3.10 provides a map showing location of coastal and the Inland aquifers (Necdet, 2012).

According to geological investigations, Guzelyurt aquifer is the biggest of storage area of 180km^2, storage capacity 920MCM, safe yield 37MCM and approximately 80km^2 lies in the southern part of Cyprus Island. The water obtained from this aquifer was being used for domestic and irrigation purposes in the region and some part of Nicosia. However, overdraft beyond safe yield had lead to sea water intrusion to a very high concentration along with decline of water level to about 60m below mean sea level (Gokcekus 1999; Necdet, 2012).

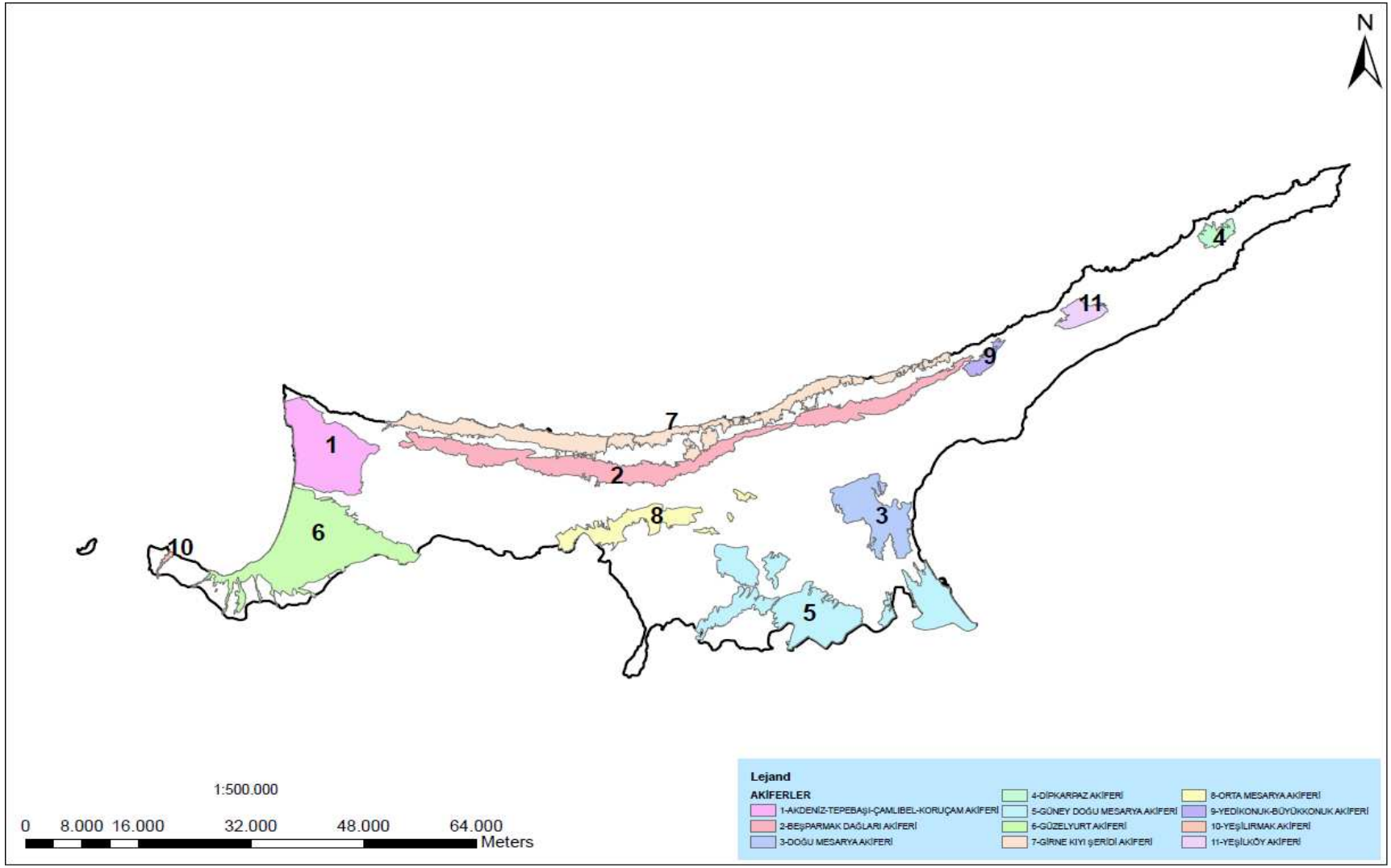


Figure 3.10: Aquifer Map and Locations in NC (Necdet, 2012)

Famagusta coastal aquifer is another important source of fresh located in the eastern part of the Island, it has an area of 45km^2 of which 16km^2 is in NC with storage capacity of 5MCM and safe yield of also 5MCM. There are about 500 pumping wells in the area with average discharge capacity of 12m^3/hr for domestic and irrigation supply, likewise, excessive extraction leads to contamination of the aquifer in 1960's. The normal concentration of Nacl in potable water is less than 400ppm. However, a concentration of about 5000ppm was noticed in the area (Elkiran, 2003; Elkiran and Ongul, 2009).

Kyrenia coastal aquifer had also been contaminated with sea water due to its proximity to Mediterranean Sea as well as due to excessive extraction. It's storage area is 160km^2, storage volume of 8 to 10MCM and has 5 to 7.9MCM as annual extraction capacity but Kyrenia Mountain aquifer of storage capacity 10.2MCM is at safe yield without jeopardy of salt contamination, the status of all TRNC aquifers were provided in Table 3.3. The remaining aquifers which include Yesillkoy, Incirli, guvercinlik, Cayonu e.t.c though, they have relatively small storage capacity and their contribution to domestic use is limited but also had became affected by growing demand in Urban areas and Tourism sector (Elkiran and Ergil, 2002).

Previous studies show that, the annual water demand of NC between 1985 to1996 is about 106.6MCM. According DSI report, annual safe yield of all the aquifers is about 74.1MCM but sequel to inadequacy in supply, an average overdraft of 28.9MCM was recorded in 2002. Camlikoy and lefke are two different regulator channels constructed to divert excess water of the regions to Guzelyurt Dam with the aim of enriching ground water resources of the area but due to impact of drought the canals have dried off. The 41 reservoirs constructed by DSI of Turkey have been contributing efficiently in recharging nearby aquifers. However, late construction of these reservoirs along with overdraft had lead to alarming depletion and salinization of most existing coastal aquifers (Elkiran, 2003).

In 2006, the water demand increases to 125MCM due to increase in population and is expected to keep increasing over time, detail of the aquifer situations was provided in Table 3.3 (Elkiran, 2006).

Table 3.3: Aquifer Storage Capacities and Situation after Extraction Year 2006 (Necdet, 2006)

Aquifers	Storage Area (km^2)	Recharge ($10^6 m^3$)	Safe yield ($10^6 m^3$)	Extraction ($10^6 m^3$)	Situation ($10^6 m^3$)
Guzelyurt	180	37	37	57	-20
Akdeniz	20	1.5	1.5	1.5	Safe
Lefke-G.Konagi-Y.Dalga	3.0	15.5	6	6	Safe
Yesilirmark	2.5	7	1.5	1.5	Safe
Kyrenia Mountain	-	11.5	11.5	11.5	Safe
Famagusta	-	2	2	8.5	-6.5
Beyarmudu	-	0.5	0.5	0.5	Safe
Cayonu-Guvercinlik-Turkmenkoy	12	2	2	2	Safe
Serdarli	60	0.5	0.5	0.5	Safe
Yesilkoy	9.0	1.6	1.6	3	-1.4
Kyrenia Coast	160	5	5	5	Safe
Yedikonuk-Buyukkonuk	2	0.3	0.3	0.3	Safe
Dipkarpaz	1	1.5	1.5	1.5	Safe
Korucam	60	1.2	1.2	1.2	Safe
Others		2	2	2	Safe
Total		89.1	74.1	103.0	-28.9 deficit

3.4.4 Snow Fall

Generally, in cold climate zone, snow fall is considered as a source of water input contributing significant quantity. In North Cyprus, the maximum snowfall ever recorded occurred between 1992 to 2002 and was measured to a maximum depth of 150mm, Since then, it rarely occurred till of recent where very light snow fall unexpectedly occurred in Nicosia area. The depth of the snow was insignificant as such could not generate runoff. Though Besparmak Mountain is high enough but snow rarely occurs there, for that reason, snow is not counted as one of fresh water sources in NC conversely, it is usually available at the peaks of Trodos Mountain of south Cyprus. Previous research shows that, Snowfall in the southern part ranges between 0.5 to 3.0m generating about 100MCM of fresh water which normally occurs between January to February (Elkiran and Ergil 2004).

3.4.5 Water Transportation

Having known that, water scarcity in North Cyprus started since 1960's and had gradually reached an alarming stage, an effort was made to offset water scarcity among which includes water importation from Turkey. Hassan Ali Bicak of Eastern Mediterranean University in collaboration with Glenn Jenkins of Harvard Institute for International Development reviewed water balance in NC, they proposed water importation as one of the modest water potential for new water resources in the country (Elkiran and Ergil 2004).

In summser 1998, NC began importing water from Turkey, at a price of 0.55 USD/m^3. A Norwegian firm ships were used to ships the water in Medusa bags towed behind ship, this plastic bags have capacity of 10,000 to 20,000m^3 each. The shipment is from Aydincik, Turkey to Kumkoy reservior near Guzelyurt. A transfer of 5MCM of water was planned yearly, unfortunately, the first ship arrived in September 1998 over the whole year a total of 65,374m3 was supplied, in the second year 1999 – 2000, 579,339m^3 was transported. Similarly, a total of 1,719,010m^3 was supplied in 2001. The price of the supply including handling charges at NC stand at 0.79 USD/m^3 which is less than other alternative supply options such as desalinization. The total quantity imported in five years from 1998 to 2002

was 4.1MCM as depicted in Figure 3.11, this was quite below expectation compared to the 5MCM planned yearly consequntly, the contract between water works department(SID) and Norwegian firm company was considered inefficient and subsequently terminated in 2002 (Elkiran and Ergil 2004).

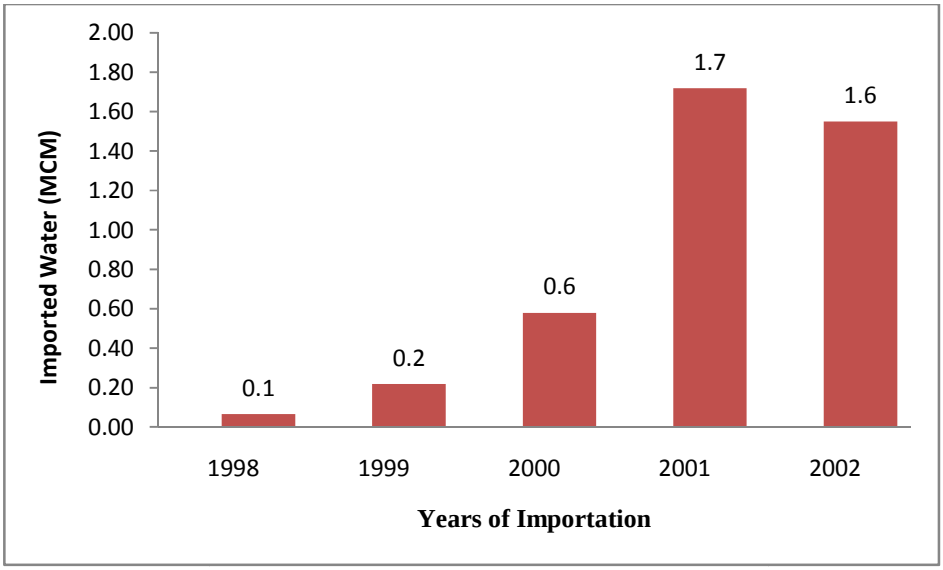


Figure 3.11: Trend of Water Imported from Turkey 1998 to 2002 (Elkiran and Ergil 2004)

Sequel to inefficiency of the above importation processes, undersea pipeleine water supply from Alakopru Dam Turkey to Gecitkoy reservoir of North Cyprus was designed and proposed with a capacity of 75MCM yearly as depicted in Figure 3.12. After conducting feasibility studies, the project was awarded and had commenced, hopefully will be completed by September 2014. After completion, the project is expected to supply Northern Cyprus with water for a period of 50 years. Out of the 75MCM, 37.7 MCM corresponding 50.3% will be distributed for domestic supply and the remaining 37.2MCM (49.7%) will be allocated for irrigation to available potentials. It was hoped that, the project will help to offset groundwater overdraft thereby reviving aquifer situation across Northern Cyprus, similarly, it is expected to positively contribute towards improving the standard of living of Guzelyurt and Mesaria regions by supplying irrigation water to 6,413ha and 7,435 ha of

these areas respectively as well as other regions having serious water stress (Elkiran and Ergil, 2004; DSI, 2010).

Figure 3.12: TRNC Water Supply Project: 75MCM Annually (Gokchekus, 2014)

3.4.6 Effluent Re-use/Anthropogenic Input

Despite the fact that North Cyprus have been in water stress long ago, however, re-use of recycled water to minimize water stress were not accepted due to traditional believe. There are medium scales central treatment plants established for sewerage treatment at Nicosia, Kyrenia, Famagusta and Guzelyurt. Considering year 2011 and 2012, Nicosia modern central treatment plant has capacity of 30,000m^3/day with its picture appearing in Figure 3.13 while Kyrenia, Famagusta and Guzelyurt have daily capacity of 3000, 3000 and 600m^3/day respectively. Considerably large quantity of water is treated and the whole recycled water is diverted to rivers nearby the treatment plants and then the treated water flows to sea without any reuse except few farmers along the downstream part of the rivers that utilize the water for irrigation (Oznel, 2014).

Figure 3.13: Nicosia Central Sewerage Treatment Plant

There are small private institutional sewerage treatment plants that were established at various hotels, the treated water from these Hotels is being use to irrigate trees and flowers within their respective compound. The yearly turnout of recycled water is as follows: Famagusta A (36,870M^3), Yeni Iskele (5,422M^3), Kyrenia West (7,321M^3) and Kyrenia East (41,026M^3) (Muslu, 2003).

3.4.7 Desalinization

Desalinization refers to any of several processes used to remove salt and other minerals from saline water. North Cyprus had considered desalination as a cost effective way of producing fresh water suitable for human consumption as well as for irrigation. Other potential by-product of the process includes table salt which is also a useful ingredient for cooking. This process is independent of rainfall. The cost of desalinating sea water (energy, infrastructure and maintenance) is generally higher than other alternatives such as water recycling. Achievable cost of treatment ranges between 0.5 to 1US$/$m^3$. Table 3.4 provides a list of desalination plants and corresponding average daily active capacities in NC (Elkiran, 2006).

Table 3.4: Desalination Plants and Average Daily Active Capacities Year 2012 (Temel, 2014)

S/No	Desalination Plant	Location	Active Capacity (m^3/day)
1	Salamis	Famagusta A	600
2	Famagusta	Famagusta	7,000
3	Nuhun gemisi	Yeni Eronkoy	300
4	Merit park hotel (mercury)	Kyrenia East	500
5	Cratos	Kyrenia East	1,000
6	Esentepe golf sahası	Kyrenia East	2,500
7	Accapulco	Kyrenia East	900
8	Palm beach	Famagusta A	150
9	Bafra	Mehmetcik	2,000
10	Merit cristal Later	Kyrenia West	500
Total			15,450

The above mentioned desalination plants in Table 3.7 were established at regions of NC, some of which belong to private institutions. Though there are some technical problem such as power failure and maintenance but the average total daily production is 14,950m^3/day roughly the Plants are contributing about 5.8MCM to the water budget of the country yearly (Temel, 2014).

3.5 Water Demand and Utilization

Generally, water demand is considered as one of the main water output in world water budget or any study area of interest. The world average demand for Agriculture, industries and domestic sectors are 70, 22 and 8% respectively. There are three basic sectors that require water supply in NC: Agriculture, industries and domestic sector (Gokcekus et al. 1997).

3.5.1 Domestic and Industrial Demand

Domestic water supply comprises supply of water to House hold, Tourism sector, Universities, commercial and small scale industries across the country. According to census data, the total populations of resident increases over time as shown in Figure 3.14 certainly, the demand will also be increasing proportionally.

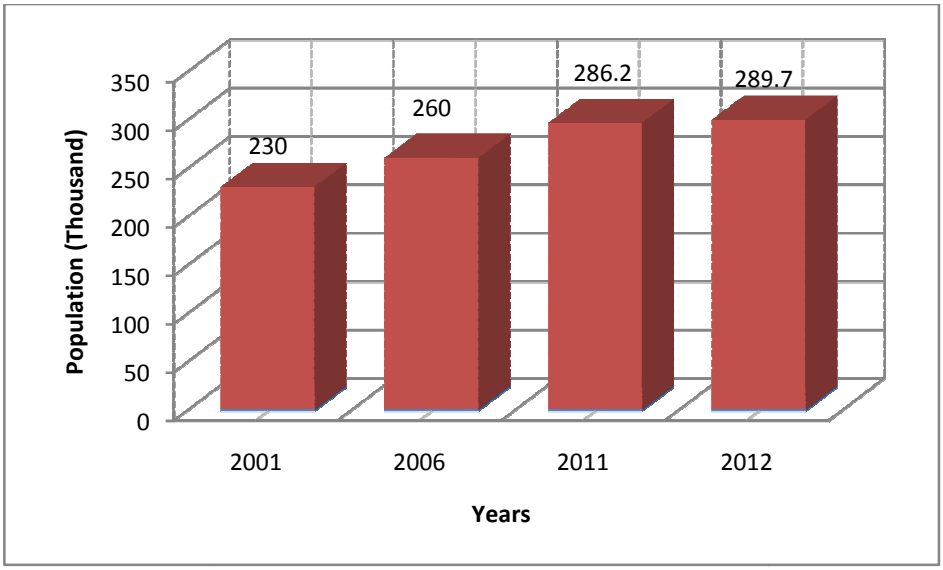


Figure 3.14: Trend of population in North Cyprus (SPD, 2014)

Considering year 2011 having total population 286,257, Based on the approved average consumption of 250L/day/capita, municipal water demand only was estimated to be 57,251.4m^3/day which roughly corresponds to 20.8MCM/year excluding losses.

In NC, there are several small scale industries e.g. beverage requiring fresh water supply for optimum production. Water supply to these industries is considered as integral part of domestic supply via same pipe network (Temel, 2014).

Historical data shows that, water for domestic use was being obtained from 162 wells and boreholes. The total volume of water obtained from these pumping wells is about 24.5MCM per year while stream flow provides about 0.3MCM. It was roughly estimated that, getting to 500m^3/day of water is pumped to the south from North and nearly the same amount of water

is pumped to the North from south due to crossing of previously laid water network which is still in use (Elkiran and Ergil, 2004; SID, 2003).

Though gradual increase in population was noticed but the supply is still below demand, this factor necessitates enforcement of some conservation measures such as restricting water supply for only some hours in a week to some areas (SID, 2003).

3.5.2 Agricultural Demand

Agricultural production have been contributing significant amount of income to economy of NC, the sector takes largest share of water supply accounting about 70%. The efficiency of production depends largely upon quantity and quality of the water supplied as well as land fertility. It is known that, 56.7% of the total land area of NC was allocated to Agricultural sector for cultivation of variety of crop and livestock farming, however, according to a paper titled Water Management difficulties with limited and contaminated water resources in TRNC, water demand for Agriculture, domestic and industrial use was between 190 to 197MCM annually, however, sequel to water scarcity some irrigation areas were abandoned and in some places primitive methods were replaced with modern techniques thus, the demand subsequently dropped to 106.6MCM in 1996 (Gokcekus et al. 2002).

In TRNC, irrigation water is obtained mostly from Dams and tube wells. Out of 41 Dams within the country, 18 were constructed for irrigation as explained previously. Annual water need does not vary significantly but gradually increases over time. Previous literatures came up with different account regarding water demand for irrigation e.g, 82.5 MCM by Bicak and Jenkins (2000), 144MCM by Ozturk (1995), 170 MCM by Gunyakti and Ergil (2002), 117MCM By Elkiran (2006).

3.5.3 Evaporation and Transpiration

Evaporation and Transpiration is an important component of water cycle and is also considered as one of the significant output of a basin for integrated water resources management. Evaporation simply refers to vaporization of water from earth surface to atmosphere while transpiration means transfer of water molecules from plants leaves to atmosphere. In irrigation field, potential evapo-transpiration (PET) simply refers to summation of evaporation and transpiration of a given area and for specific crop type (it represents the evapo-transpiration rate of short green crop that completely shade ground of uniform height having adequate water in its' root zone) (Akintug, 2011).

The rate of Evaporation and Transpiration depends on many factors such as solar radiation, wind speed, relative humidity and the nature of the evaporating surface. In NC these important parameters are considerably high due to high temperature of intensity of about 34 to 42^0C as well as high wind effect particularly during summer period (Gokcekus et al. 2002; Akintug, 2011).

3.6 Socio – Economy of TRNC

3.6.1 Agricultural Structure and Economy

NC Agricultural sector comprises of four sub-sectors: crop production, livestock farming, fishery and forestry. Crop production has significant share as such generate a lot of revenue for economic development. Out of the total land area of NC 329,890.8 ha, 56.7% was suitably allocated as irrigation potential. This potential allows cultivation of wide variety of products such as cereals, Citrus, legumes and vegetables (ASP, 2012).

The agricultural product exported to adjacent countries includes citrus, potatoes and processed products. In 1982, the share of agricultural export was considerably high about 80.05% was Citrus fruits. Potatoes, live stock and processed product were 6.3%, 3.3%, 5.1% and 5.3 respectively. Later due to water scarcity, the total export trim down to 64.4% out of which 28.6% was Citrus fruits, potatoes 1.4% and 23.4% was for processed Agricultural

product. In 2009 export of agricultural product account for $20.9 million of which $14million was for citrus and $2.4 million was generated by Potato production (ASP, 2009).

3.6.2 Citrus Production

The Citrus fruits are cultivated in all the three main regions of NC, some of the fruits include Orange, Lemon, Grapefruit e.t.c and it account for large part of agricultural production. Out of the total Citrus produced about 6% is consumed within the country, 34.9% was exported and 54.6% is processed by NC industrial sector. Details of regional turnout are provided in the Table 3.5 (ASP, 2001).

Table 3.5: Main Agricultural Region and Corresponding Yield for Citrus Production Year 2012 (ASP, 2012)

REGION	AREA (donum)	YIELD/TURNOUT (Ton/donum)
Nicosia	38,840	3.2
Famagusta	345	2.9
Kyrenia	888	1.1
Total	40,073	

3.6.3 Crop Production and Cropping Pattern

There are different types of crops that are cultivated in NC, the profitability of this production depends largely on fertility of the available land, water quality, efficiency of the irrigation methods and soil management. Crops having relatively similar water requirement are grouped together under same cropping pattern. Table 3.6 provides list of the various cropping patterns in TRNC (ASP, 2012).

Table 3.6: Crop Patterns in North Cyprus Year 2012 (ASP, 2012)

S/No	Crop Pattern	Examples of crops
1	Cereals	Wheat, Barley, Oat
2	Pulses	Beans, Chickpea
3	Industrial crops	Tobacco, Cotton lint
4	Oil Seeds	Groundnut
5	Tuber Crops	Potato, Onion, Garlic, Beat,
6	Fodder Crops	Cereal Hay, Barley Forage, Alfalfa,
7	Leafy or Edible Stem Vegetables	Cabbage, Artichoke, Louvana, Lettuce
8	Fruits Bearing Vegetables	Tomatoes, Cucumber, Okra, paper, Sweet Melon
9	Leguminous veg.	Green Beans, Peas
10	Root, Bulb and Tuberous Vegetables	Carrot, Green Onions, Radish
11	Other Vegetables	Cauliflower, Kohlrabi
12	Nuts	Almonds, Walnuts, Pistachio
13	Pome Fruits	Apple, Pear, Loquat,
14	Stone Fruits	Apricot, Peaches, Plum,
15	Grape and Grape like Fruits	Banana, Pomegranates, Olive, Figs, strawberry, Sultana Grape
16	Citrus Fruits	Tangerines, Lemons, Valencia, Shiamouti, Washington, Grapefruits
17	Greenhouses and Tunnels	Cucumber, Papers, Eggplants, Green Kidney Beans, Tomato, S &W. Melon

Cultivation of the above mentioned crops require large quantity of water of good quality for irrigation during dry season however, despite the fact that primitive irrigation methods were replaced with modern techniques (Sprinkler and Drip systems) but still the seasonal supply is below demand.

3.6.4 Animal Production/Husbandry

Livestock farming is also an important sector contributing some income towards the economic development of NC, the total number of livestock grown in its' sub-regions are presented in Table 3.7.

Figure 3.7: Animal Productions (ASP, 2012)

Regions	Cattle	Sheep	Goats
TRNC	51,734	210,792	60,405
NICOSIA	20,115	37,579	12,627
Central Nicosia	2,439	8,714	2,837
Değirmenlik	6,196	13,749	4,964
Ercan	11,480	15,116	4,825
FAMAGUSTA	15,837	65,555	14,904
Famagusta A	803	11,774	2,010
Famagusta B	1,142	11,439	1,683
Akdoğan	9,627	24,319	5,086
Geçitkale	2,400	10,662	3,466
Gönendere	1,865	7,361	2,659
KYRENIA	5,544	29,122	17,743
Kyrenia East	1,305	5,079	3,679
Kyrenia West	132	2,085	1,439
Boğaz	1,963	10,240	4,837
Çamlıbel	2,144	11,718	7,789
GÜZELYURT	4,691	20,765	6,068
Güzelyurt	3,747	13,691	3,921
Lefke	944	7,074	2,147
İSKELE	5,547	57,771	9,063
İskele	3,158	14,513	3,750
Mehmetçik	1,117	14,774	1,380
Yeni Erenköy	1,272	28,484	3,933

The population of the livestock varies from one sub region to another, in 2012 the total population of cattle, sheep and goats were 51,734, 210,792 and 60,405 respectively. This data were also applicable for evaluation water needed for live stock farming.

CHAPTER 4

METHODOLOGY

4.1 Preamble to Agricultural Regions

According to Department of Agriculture, North Cyprus have 3 main administrative regions namely: Kyrenia, Nicosia and Famagusta as shown in the Figure 4.1 each region acting separately, the main regions are further sub-divide in to 17 Agricultural sub region all requiring good quality water for domestic, Agricultural and industrial use. Previous studies discovered that not all the regions were blessed with adequate water resources for daily needs e.g. Nicosia is obtaining water from Guzelyurt region.

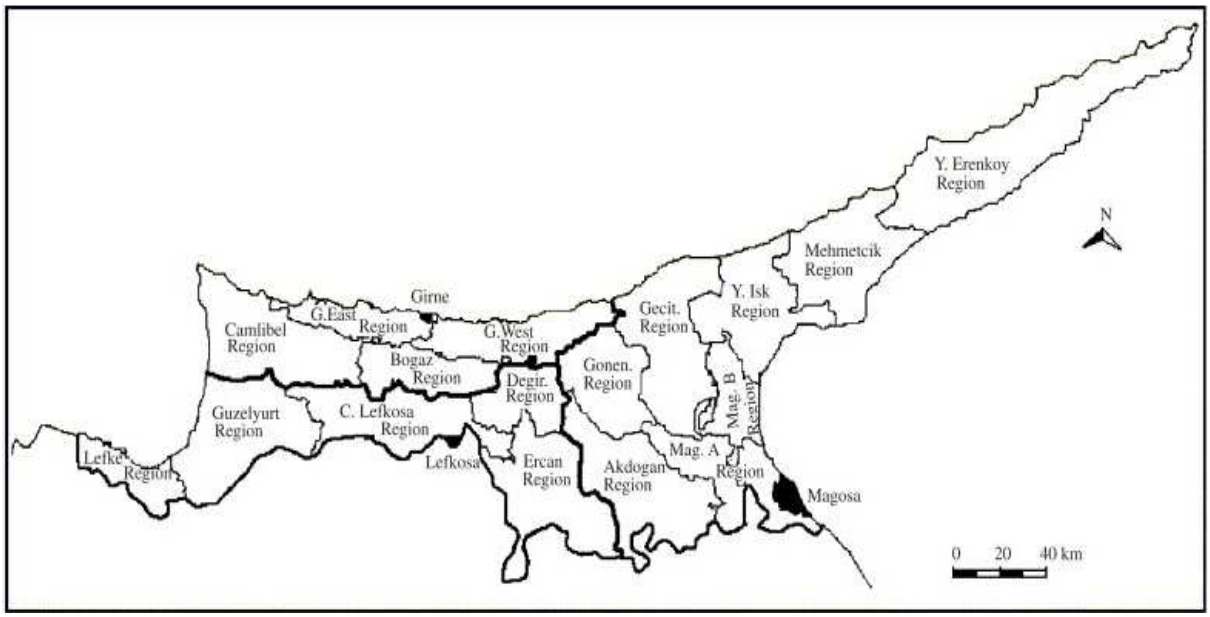


Figure 4.1: Map of Agricultural Regions in North Cyprus (ASP, 2012)

The hydrological and demographic data collected representing all the administrative regions formed the bases for evaluation of water available and water demand respectively. Water demand and supply for 2011 and 2012 was evaluated with the aid of an excel program after which the output were compared with the result of previous research.

4.2 Data Collection

Hydrological and demographic data were formally requested from responsible Authorities. Rainfall data were collected from meteorological department of NC for determination of rainfall pattern and stream flow. A different set of data were obtained for monthly evaporation. Data on ground water were collected from Geology department for assessment of aquifers storage capacities, safe yield, recharge capacity and status in terms of contamination. Dams and ponds storage capacities and variation of storages on monthly bases were requested for estimation of water availability. Daily production of various desalinization plants and historical data related to water importation were all collected from water works department of Nicosia (SID). Data on production of sanitary water for Nicosia, Kyrenia, Famagusta and Guzelyurt central sewerage treatment plants were collected from sewerage department municipality of Nicosia for estimation and justification of sanitary water usage.

To determine water demand for Domestic and Industrial consumption, demographic data on population of residents, students at various universities for the year 2011 and 2012 were obtained from North Cyprus statistics and planning department (census board). For water need by hotels, data on bed capacities was obtained from statistical year book published by tourism department. In addition, population of live stock was obtained from agricultural statistic for year 2011 and 2012. The demand was evaluated based on water regulation in NC and in accordance to approved per capita demand.

For evaluation of Irrigation demand, data on area of cultivated lands, various cropping pattern and irrigation methods were obtained from publication on agricultural statistics, year 2011 and 2012. Description on how all the data were processed was provided in Figure 4.2.

4.3 Summary of Hydrological and Demographic Data

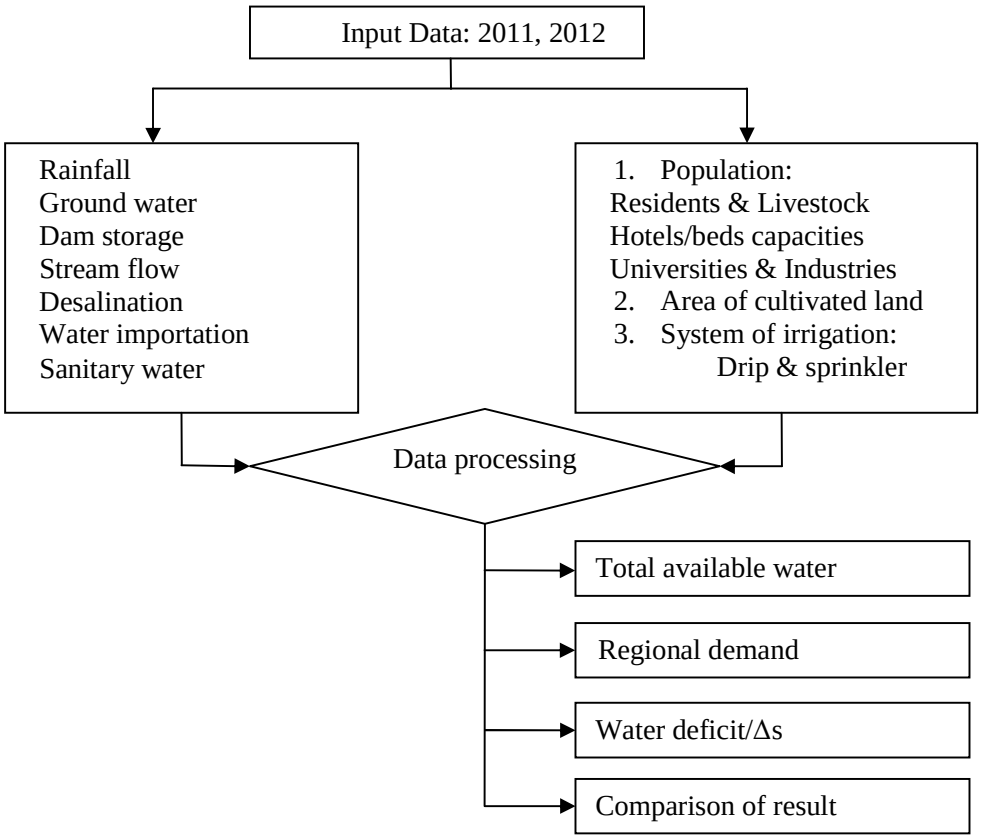


Figure 4.2: Flow of Data Processing Using Prepared Excel Program

4.4 Evaluation of Municipal Water Demand

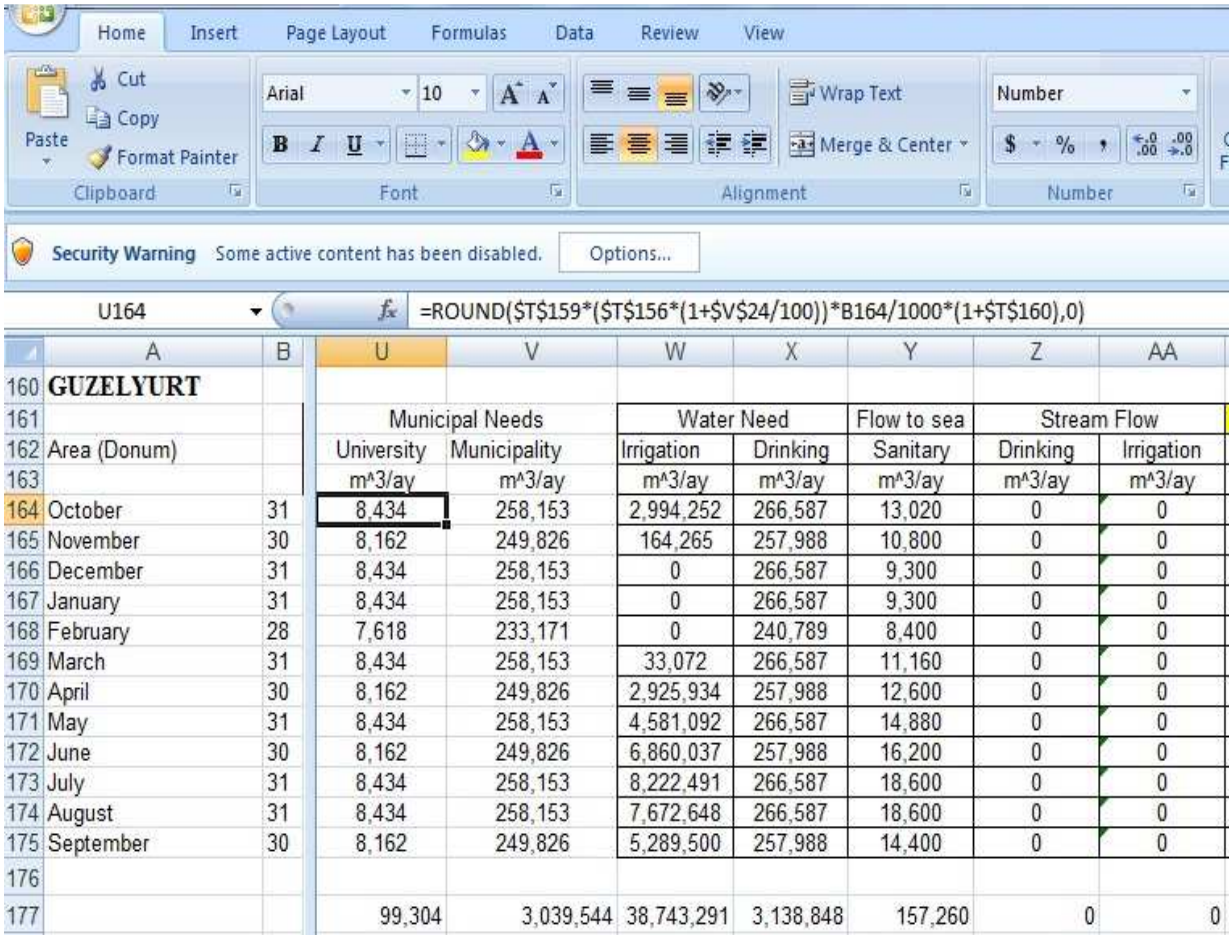
Municipal demand includes water need for domestic supply, universities, small scale industries, livestock and hotels. The total population of resident in NC for 2011 and 2012 are 286,257 and 289,692 respectively. Domestic supply was evaluated regionally on monthly scale and based on total population of resident of each region and in accordance to approved per capita demand as provided in Table 4.1, likewise for universities, small scale industries, livestock and hotels.

Table 4.1: Approved Consumptive Water Supply of Different Sectors in TRNC (Temel, 2014)

Sectors	Water consumption (L/day/capita)
Residents	200
Small industries	30
Commercial	20
Cattle	50
Sheep	15
Universities	150
Tourisms	200

For tourism sector, bed capacities of all active hotels were obtained and entered to the program accordingly, similarly, the populations of live stock that was grown in all the sub-regions were all taken in to consideration. Figure 4.3 shows some results of municipal water for Guzelyurt region year 2012.

As far as previous studies are concerned, conveyance losses in respect of water supply pipelines was 30% but in recent years it is considered to be 25% due to replacement of old water network with new water supply pipes. Water demand and the losses were evaluated separately and then added together to obtain required supply for each region on monthly bases. The monthly demand were than summed to obtain annual demand of each sub region and then for whole North Cyprus (Temel, 2014).



	A	B	U	V	W	X	Y	Z	AA
160	**GUZELYURT**								
161			Municipal Needs		Water Need		Flow to sea	Stream Flow	
162	Area (Donum)		University	Municipality	Irrigation	Drinking	Sanitary	Drinking	Irrigation
163			m^3/ay	m^3/ay	m^3/ay	m^3/ay	m^3/ay	m^3/ay	m^3/ay
164	October	31	8,434	258,153	2,994,252	266,587	13,020	0	0
165	November	30	8,162	249,826	164,265	257,988	10,800	0	0
166	December	31	8,434	258,153	0	266,587	9,300	0	0
167	January	31	8,434	258,153	0	266,587	9,300	0	0
168	February	28	7,618	233,171	0	240,789	8,400	0	0
169	March	31	8,434	258,153	33,072	266,587	11,160	0	0
170	April	30	8,162	249,826	2,925,934	257,988	12,600	0	0
171	May	31	8,434	258,153	4,581,092	266,587	14,880	0	0
172	June	30	8,162	249,826	6,860,037	257,988	16,200	0	0
173	July	31	8,434	258,153	8,222,491	266,587	18,600	0	0
174	August	31	8,434	258,153	7,672,648	266,587	18,600	0	0
175	September	30	8,162	249,826	5,289,500	257,988	14,400	0	0
176									
177			99,304	3,039,544	38,743,291	3,138,848	157,260	0	0

Figure 4.3: Excel Sheet Showing Monthly Water Need for Guzelyurt Region Year 2012

4.5 Evaluation of Irrigation Water Need

Prepared monthly crop water requirement was obtained from Agric Department of TRNC which was prepared based on Blaney-Criddle method. This method is a function of crop coefficient and climate factors. The Tables 4.2, 4.3 and 4.4 provide consumptive water use of some crop which was studied under this research (Kilickaya, 1977).

Table 4.2: Tomato Consumptive Use in m^3/Donum/Month by Regions (Kilickaya, 1977)

	Tomato Consumptive Water Use per Donum			
Month/Regions	Nicosia	Guzelyurt	Famagusta	Kyrenia
October (31)				
November (30)				
December (31)				
January (31)				
February (31)				
March (31)				
April (30)	13.5	15.5	14	13.5
May (31)	95	86	92	95
June (30)	248	220	231	238
July (31)	296	258	269	275
August (31)	65	53	58	58
September (30)				

21 different groups of crops were studied each having different water consumption as outlined in Appendix III. The seasonal consumption of each crop was determined regionally in accordance to monthly consumption, cultivated area and the efficiency of the irrigation methods. In recent years, there are two different types of irrigation methods available in the country: Sprinkler and Drip system with efficiency of 70% and 85% respectively, eventually the results obtained were added together to get total Irrigation demand. Detail results were presented in chapter 5.

Table 4.3: Citrus Consumptive Use in m^3/Donum/Month by Regions (Kilickaya, 1977)

	Citrus Consumptive Water Use per Donum			
Month/Regions	Nicosia	Guzelyurt	Famagusta	Kyrenia
October (31)				
November (30)				
December (31)				
January (31)				
February (31)				
March (31)				
April (30)				
May (31)	136	100	58	68
June (30)	252	253	258	245
July (31)	306	303	283	286
August (31)	248	250	235	235
September (30)	85	95	99	105

Table 4.4: Cabbage Consumptive Use in m^3/Donum/Month by Regions (Kilickaya, 1977)

	Cabbage Consumptive Requirement per Donum			
Month/Regions	Nicosia	Guzelyurt	Famagusta	Kyrenia
October (31)	17	90	14	17
November (30)		27		
December (31)				
January (31)				
February (31)				
March (31)				
April (30)				
May (31)				
June (30)	27		27	27
July (31)	153		139	153
August (31)	221	27	207	221
September (30)	170	92	170	170

4.6 Evaluation of Water Availability for Supply

Municipal and irrigation water supply are being obtained from various water resources of NC, which consist of Rainfall, ground water, Dams, springs and desalination. The quantity of fresh water available from the above mentioned sources was evaluated regionally on monthly bases and then on yearly so as to determine whether there is balance or deficit between demand and supply.

4.6.1 Rainfall

There are 5 rainfall stations in 5 regions of NC: North Sea side/Besparmak Mountain, west Mesaria, east Mesaria, east sea side and Karpaz region as shown in the Table 4.5. The data provided by these stations were prepared to obtain representative data to the seventeen Agricultural regions. The program accepts monthly rainfall data as input and then quantifies the volume of rainfall received in according to the sizes of regional land area.

Table 4.5: Meteorological Stations and Rainfall Data in mm for Year 2012 (ASP, 2012)

Regions	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Besparmak Mountain	191.3	76.4	30.2	12.4	44.1	1.9	0.4	1.3	0.0	73.6	125.9	118.0	675.5
West Mesaria	145.3	72.3	25.2	12.0	28.7	10.9	6.4	0.0	0.0	80.3	85.9	122.7	589.7
Middle Mesaria	94.9	43.8	17.2	12.4	43.3	0.6	1.6	5.6	0.0	64.8	48.6	88.1	420.9
East Mesaria	147.0	38.0	13.0	13.1	84.2	0.7	0.2	0.9	0.0	51.7	42.2	99.3	490.3
East sea side	149.4	59.1	20.0	8.3	83.4	0.9	1.9	0.0	0.0	41.6	50.2	111.5	526.3
Karpaz region	235.9	81.0	29.7	26.6	20.5	5.5	1.9	0.0	0.0	86.1	130.4	101.8	719.4
TRNC (Av.)	160.6	61.8	22.6	14.1	50.7	3.4	2.1	1.3	0.0	66.4	80.5	106.9	570.4

4.6.2 Ground Water Extraction

Annual Ground water extraction, aquifers yield, and storage capacities were obtained from geology department from which Table 4.6 was prepared. Data of year 2012 and that of previous years was entered to the program in order to determine total annual extraction as well as annual water overdraft (Necdet, 2012).

Table 4.6: Aquifer Situation after Extraction (Necdet, 2012)

Aquifers	Storage Area (km^2)	Recharge ($10^6 m^3$)	Safe yield ($10^6 m^3$)	Extraction ($10^6 m^3$)	Status
Guzelyurt	180	37	37	48.0	Contaminated
Kyrenia Mountain Aquifer	62	9.3	9.3	7.9	Safe
Famagusta Coastline	16	1.5	1.5	Varies	Contaminated
Turkmenkoy	13	0.5	0.5	0.5	Contaminated
Beyarmudu	9	0.5	0.5	0.5	Contaminated
Cayonu	12	0.8	0.8	varies	Contaminated
Guvercinlik region	8	0.6	0.6	0.4	Contaminated
Incirli region	14	0.8	0.8	0.8	Contaminated
Lefke-G.Konagi-Yedidalga	8	15.5	15.5	3.0	Safe
Kyrenia shore aquifer	160	10	10	5.0	Safe
Nicosia-Serdarli	60	6.0	6.0	5.0	Contaminated/Gypsum
Yesilirmark	2.5	7	7	1.5	Safe
Yesilkoy	9.0	1.6	1.6	2	Contaminated/ Sulphur
Akdeniz/Mediterranean	20	1.5	1.5	1.7	Contaminated
Korucam	60	1.1	1.1	1.1	Safe/Limited supply
Buyukkonuk- Yedikonuk	2	0.5	0.5	0.5	Safe/Limited supply
Dipkarpaz (Yen. Eronkoy)	1	1.5	1.5	1.5	Safe/Limited supply
East Mesaoria	70	5.0	5.0	varies	Safe/Limited supply
Gypsum aquifer	36	3.6	3.6	2.0	Contaminated/Gypsum
Total		104.8			

4.6.3 Desalination

There are several desalination plants contributing significant quantity of water in North Cyprus. The program evaluated monthly production according to respective average daily active capacities of the desalination plants as given in the Table 4.7, The monthly production of each region was determined from which the annual supply was evaluated to be 5.8MCM.

4.6.4 Water Importation

The program was designed to integrate additional water imported to the country. Meanwhile, according to report provided by DSI of Turkey the contract for water importation were active only between 1998 to 2002, eventually the project was terminated in 2002 due to technical problems and inefficiency of the method. Sequel to that, the program reflects zero quantity of imported water as far year 2011 and 2012 are concerned.

4.6.5 Assessment of Agricultural Economy

It was part of the aim of this study to carry out economic analysis on Agricultural production related to water supply and incomes generated. Water is being supplied to farmers in Guzelyurt area at the cost 0.35, 0.40, 0.55, 0.85 to 1.0TL/m^3 there is no fixed value and this Figure also fluctuate in every region. 21 different groups of crops were studied and the income per cubic meter of water used for each crop were evaluated and compared so as to find out which of these crops generate appreciable return. To achieve this aim, data on annual production of each crop and its corresponding producer price in TL/Kg were considered (ASP, 2012).

Example Tomatoes: year 2012

Total production = 3,950,600Kg Price: 1.37TL/Kg = 0.82USD/Kg

Total Income = 3,951,600*0.82 = 6,221,900 UDS

Total volume of water consumed = 1,189,749.41

Income per cubic meter of water used = 5.23 USD

The excel program computed the water required to grow each crop and their corresponding incomes for comparison and assessment of profit and losses.

Table 4.7: Desalination Production in TRNC Year 2012

DESALINATION PLANTS AND DAILY/MONTHLY PRODUCTION											
		Salamis (Famag. A)	(Famag. A)	Nuhun Gemisi (Yen. Eronkoy)	Merit P. Hotel (Kyrenia East)	Cratos (Kyrenia East)	Esentepe G. Sahası (Kyrenia East)	Accapulco (Kyrenia East)	Palm Beach (Famagusta A)	Bafra (Mehmetcik)	Merit C. L. Kyrenia West)
Production (m3/day)		600	7,000	300	500	1,000	2,500	900	150	2,000	500
Oct	31	18,600	217,000	9,300	15,500	31,000	77,500	27,900	4,650	62,000	15,500
Nov	30	18,000	210,000	9,000	15,000	30,000	75,000	27,000	4,500	60,000	15,000
Dec	31	18,600	217,000	9,300	15,500	31,000	77,500	27,900	4,650	62,000	15,500
Jan	31	18,600	217,000	9,300	15,500	31,000	77,500	27,900	4,650	62,000	15,500
Feb	28	16,800	196,000	8,400	14,000	28,000	70,000	25,200	4,200	56,000	14,000
Mar	31	18,600	217,000	9,300	15,500	31,000	77,500	27,900	4,650	62,000	15,500
Apr	30	18,000	210,000	9,000	15,000	30,000	75,000	27,000	4,500	60,000	15,000
May	31	18,600	217,000	9,300	15,500	31,000	77,500	27,900	4,650	62,000	15,500
Jun	30	18,000	210,000	9,000	15,000	30,000	75,000	27,000	4,500	60,000	15,000
Jul	31	18,600	217,000	9,300	15,500	31,000	77,500	27,900	4,650	62,000	15,500
Aug	31	18,600	217,000	9,300	15,500	31,000	77,500	27,900	4,650	62,000	15,500
Sep	30	18,000	210,000	9,000	15,000	30,000	75,000	27,000	4,500	60,000	15,000
Total		219,000	2,555,000	109,500	182,500	365,000	912,500	328,500	54,750	730,000	182,500

CHAPTER 5

RESULTS, COMPARISON AND DISCUSSION

5.1 Results

As it was previously discussed that a simplified water budget of TRNC was created in form of excel sheets/program, this program was adopted for all evaluations on bases of regional measurement of the following components: water demand, ground water extraction, precipitation, stream flow, Dam/Pond storage, Desalination, losses in conveyance system, hotel sanitary treatment and central sewerage treatment.

The result for 2011 and 2012 are summarized and presented in tabular format as Appendix IA and IIA respectively for easy assessment and comparison. The tables provides detail results of water need for Agricultural and domestic use along with losses in conveyance systems on regional and monthly scale. Similarly, detail results of water available from various sources could also be easily observed in a simplified manner within the tables. The results of the following Hydrologic years (2000, 2001, 2002, 2003 and 2010) were obtained from previous Ph.D research of Dr. Gozen Elkiran for comparison and trend assessment.

By carefully looking at tables we can simply observe how the components of the water budget fluctuates based on population growth, sizes of cultivated area and adopted irrigation methods. Likewise, the water available in Dams, Desalination, and Ground water extraction e.t.c all the results obtained were compared and discussed as follows.

5.2 Comparison and Discussion

5.2.1 Trend of Water Demand in TRNC

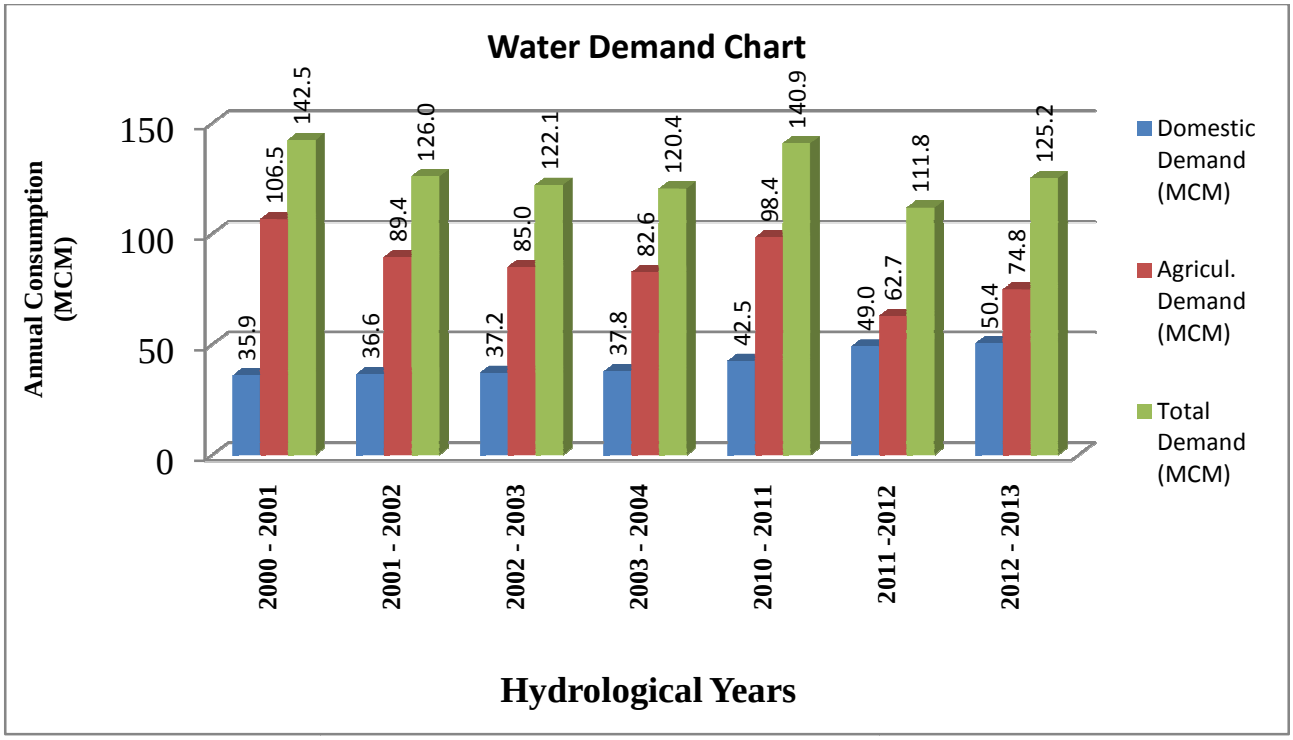


Figure 5.1: Comparison of Water Demand for Domestic, Agricultural and Total Consumption

Figure 5.1 above illustrates the trend of domestic and agricultural water demand as well as total consumption. It was observed that, the trend of domestic consumption gradually increases on yearly bases ranging from 35.9 MCM in year 2000 to 52.0MCM in 2012 losses inclusive. This was associated with gradual increase in population of resident, international students at various universities and tourism sector as depicted in Figure 5.2, however Figure 5.1 and 5.3 shows that, the trend of Agricultural demand gradually descends from 106.5MCM in year 2000 to 62.7MCM in 2011 owing to modernization of primitive irrigation methods with modern techniques such as sprinkler and drip system but the demand rises to 74.0MCM as a result of more cultivated area in 2012 compared to 2011. Similarly

the total demand fluctuates due to effect of fluctuation of agricultural demand, details of the results are provided in appendix I, IA and IIA (ASP, 2011; ASP, 2012; Temel, 2014).

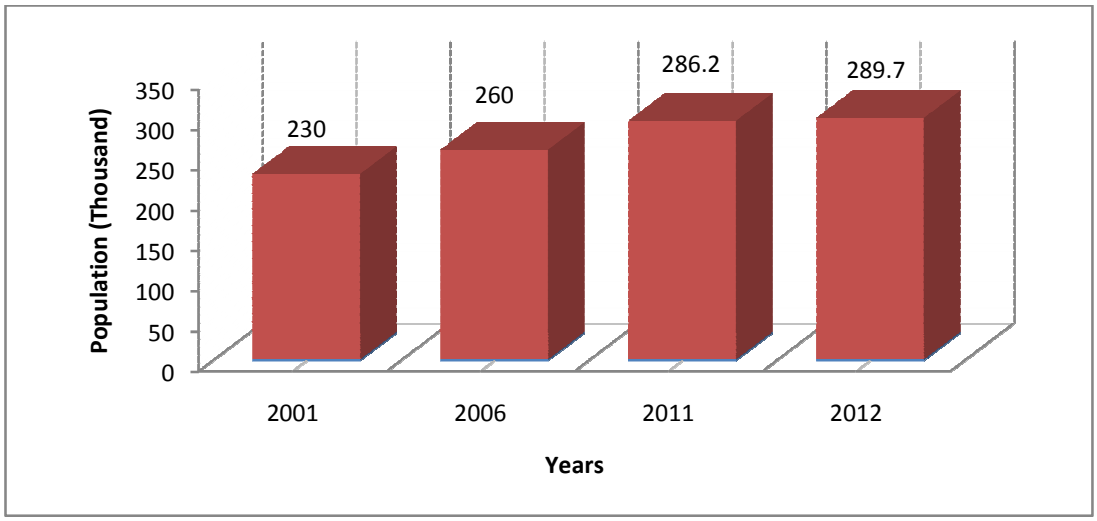


Figure 5.2: Trend of Population Growth in TRNC (SPD, 2013)

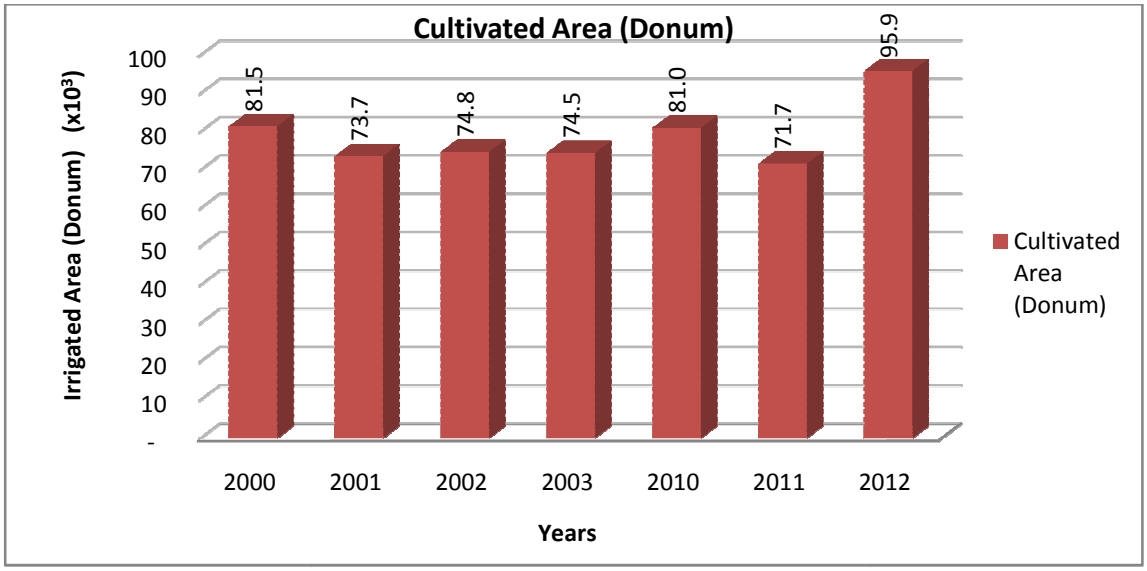


Figure 5.3: Annual Fluctuation of Irrigated Land in TRNC (ASP, 2012)

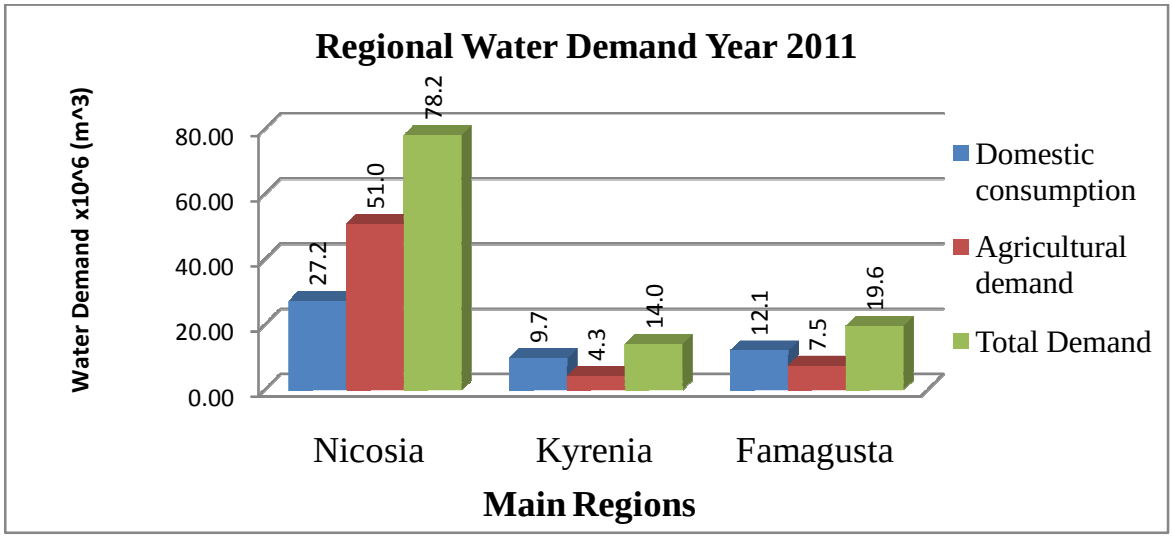


Figure 5.4a: Regional Water Demand Year 2011

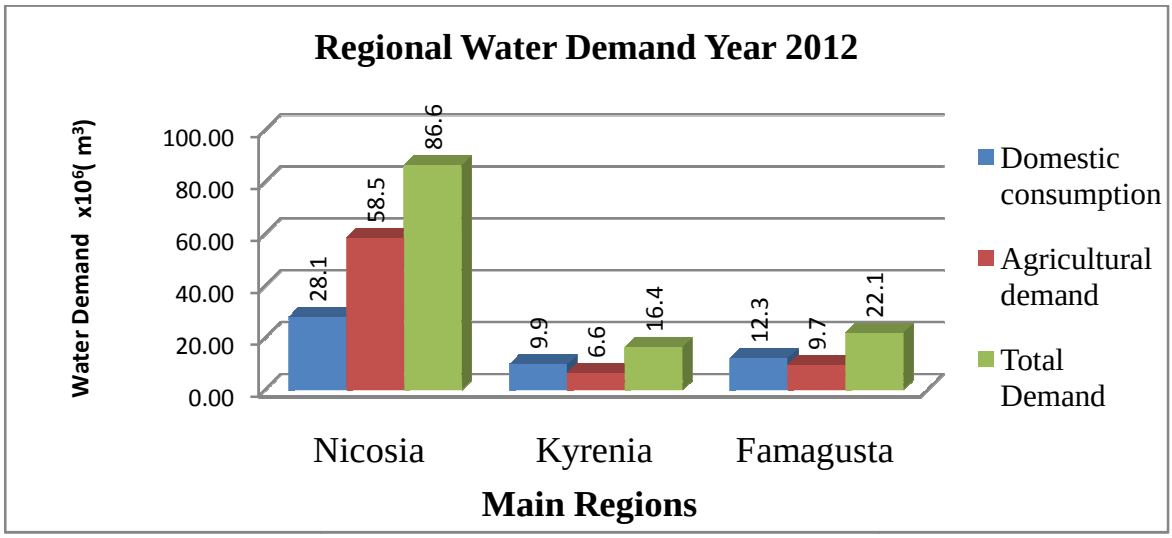


Figure 5.4b: Regional Water Demand Year 2012

Figure 5.4a and Figure 5.4b illustrates the three main administrative regions in North Cyprus each with its respective water demand for year 2011 and 2012. It could be observed that for year 2011, Nicosia main region which comprises of Central Nicosia, Degirmenlik, Ercan and Guzelyurt has higher water consumption compared to Kyrenia and Famagusta main regions. Nicosia main region account for 27.2 and 51.0MCM as water demand for domestic and agricultural demand respectively having grand total of 78.2MCM followed by Famagusta

main region with grand total of 19.6MCM as shown in Figure 5.4a while Kyrenia main region which comprises of Kyrenia East, Kyrenia West, Bogaz and Camlibel has total domestic and Agricultural demand as 9.7 and 4.3MCM respectively with a grand total of 14MCM, therefore Nicosia main region has higher water demand due to large population and irrigation practice, for detail on regional demand see appendix IG, IU, & IP.

considering year 2012, the grand total of domestic and agricultural water demand for Nicosia main region increases to 86.6MCM followed by Famagusta main region with 22.1MCM as shown in Figure 5.4b while that of Kyrenia main region, the grand total for domestic and agricultural demand increases a little bit to 16.4MCM, this shows that Nicosia main region has higher water demand compared to Famagusta and Kyrenia main regions, for detail on regional demand see appendix IIG, IIU & IIP.

5.2.2 Trend of Water Demand and Conveyance Losses

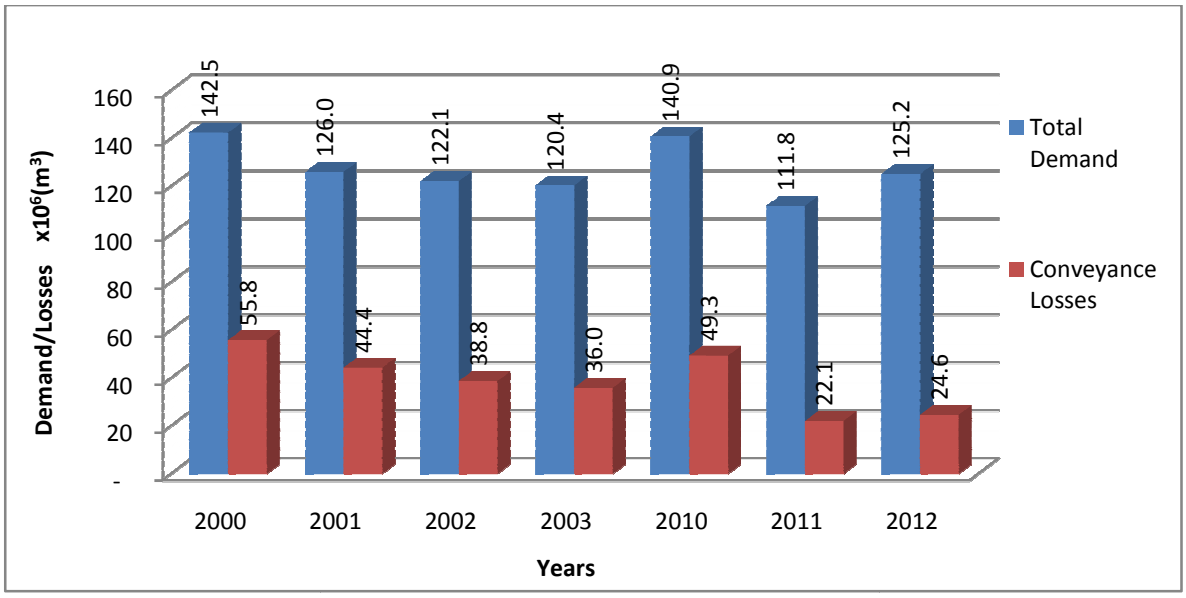


Figure 5.5: Comparison of Annual Water Demand and Conveyance Losses

Figure 5.5 above indicates gradual decline in conveyance losses from 55.8MCM in 2000 to 24.6MCM in 2012 while the total demand fluctuate a little based on fluctuation of Irrigation

consumption, for details see Appendix I, IA and IIA. Previously, losses account for 30% of total supply but in recent years e.g. 2011 and 2012 it dropped to 25%, this was attributed to replacement of some old conveyance system with new pipe network. Considering the extent of water stress in country, conveyance losses need to be controlled to minimal quantity so as to effectively utilize the available water in the best possible way. Therefore it is advisable to replace all the dead water pipes despite what it might cost as it could be recovered from water revenue in a short while.

5.2.3 Trend of Water Resources in TRNC (Input Components of Water Budget)

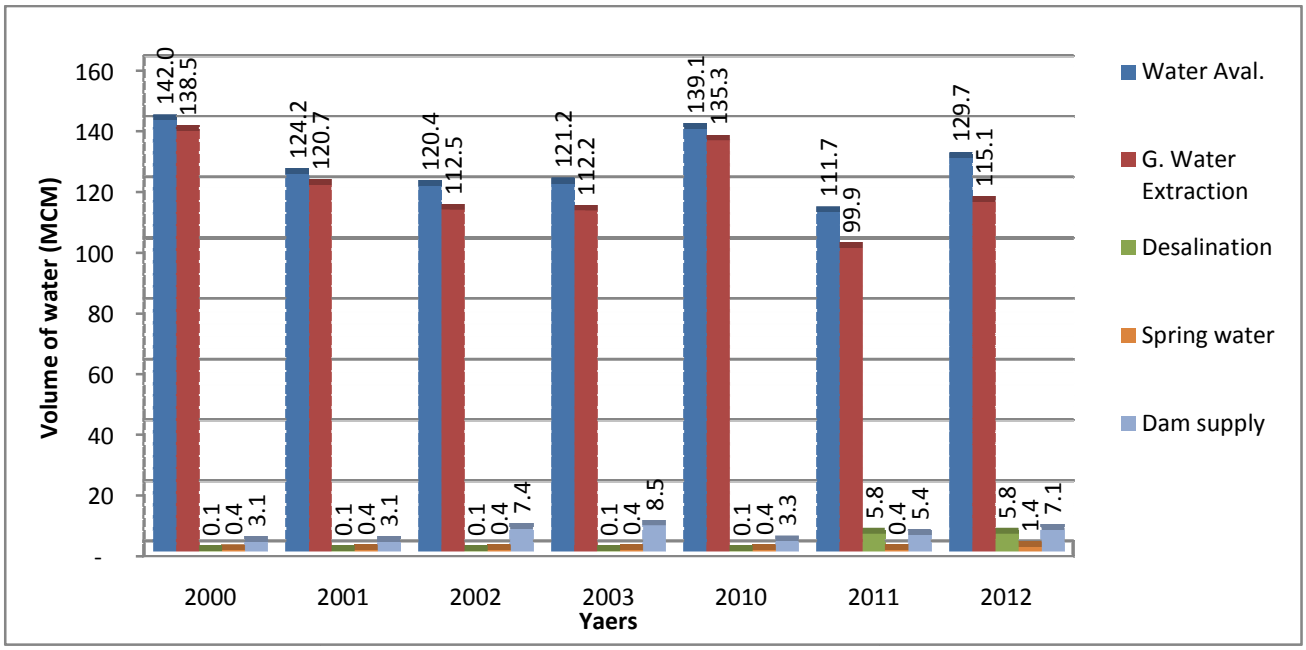


Figure 5.6: Trend of Inputs Components to Water Budgets of TRNC

Figure 5.6 illustrates trend of water resources availability in NC from 2000 to 2012 Hydrological years. The chart clearly indicates dependency on ground water extraction for supply to domestic and agricultural sectors, this was relatively associated to limited supply from other resources especially stream flow, there exist no perennial rivers except ephemeral springs that flows only for a short period in rainy season. It was observed that ground water extraction gradually decreases certainly due to implementation of some desalination plant

along with adoption of new irrigation methods, the quantity of ground water extracted was 138.4MCM in year 2000 but fortunately decreases to 99.9MCM in 2011; however the quantity fluctuates in 2010 and 2012 due increase in size of cultivated land. Desalination account for 109,500m^3 in 2000, 2001, 2002 up to 2003 but in an effort to provide more clean water to the general public, more desalination plant were implemented thereby increasing the quantity to about 5.8MCM in 2011 and 2012, breakdown of the results were provided in appendix IA and appendix IIA.

The central sewerage treatment plant of Nicosia and Kyrenia all together have capacity of 3MCM in year 2000 but in recent years Guzelyurt and Famagusta sewerage treatment plant were constructed which leads to increase in production to 9.5MCM in year 2012 but despite water scarcity such quantity of water is diverted to sea without any reuse due to traditional belief. Similarly, the treated sanitary water in hotels was being used to irrigate flowers and plantations within their respective compounds. In year 2012 their production accounts about 0.226MCM. Check appendix IA or appendix IIA for details.

Stream flow is minimal as a result of impact of Mediterranean climate, aridity and absent of perennial rivers as such the statistics of water stored in Dam varies from year to year. The annual water stored in all irrigation Dams is being used for irrigation and in some places for aquifer recharge, the trend analysis shows only 3.3MCM was available for supply in year 2000 but the quantity fluctuates with incremental value up to 10.5MCM in year 2012 as shown in Figure 5.7, this information point out drought relief which alternatively allows more cultivation in rainy season.

Generally, without ground water, life would have been difficult and threatening in TRNC, this is due to the fact that in 2012 the total quantity of desalinated water and Dam storage was 12.9MCM while that of fresh ground water is minimal all together the total available quantity is far less than total demand. This clearly shows that there was very significant imbalance between demand and supply, for details check Appendix I, IA and Appendix IIA, this justifies and proves dependency on ground water owing limited supply from these sources. As previously discussed, excessive extraction of ground water had lead to decline in level of water table within the whole Country along with salinization of most coastal and

Inland aquifers, the best alternative way of relieving the aquifers will be active supply of 75MCM of water annually from Turkey to NC, which hopefully when completed and properly distributed will simultaneously give rise to cultivate more irrigable land at the same time allowing the aquifers to replenish back to fresh status. To achieve this objective integrated water resources management need to be enforced.

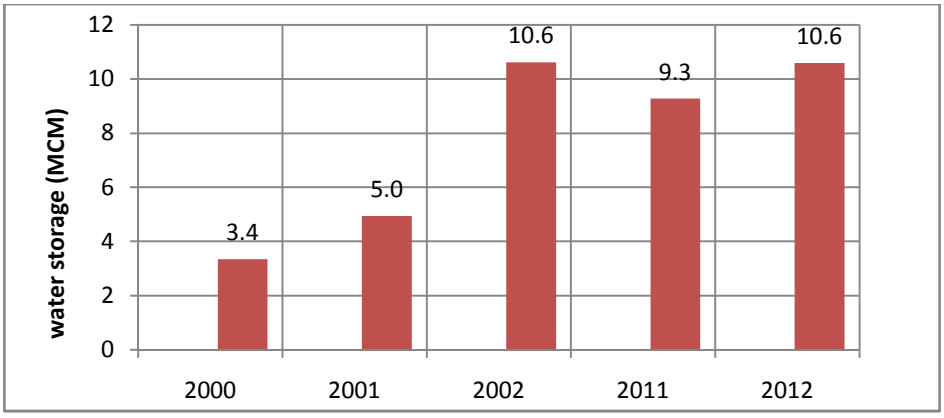


Figure 5.7: Fluctuation of Water Storage in Irrigation Reservoirs Year 2000 to 2012

5.2.4 Trend of Average Annual Precipitation 1975 – 2012

Figure 5.8 above shows trend of annual sum of precipitation in NC, this random variable fluctuates with time and in accordance to drought conditions. Considering the range of the plotted data, the long term average was evaluated to be 373mm for details check appendix IV. It has been stated earlier that NC has arid climate as such experience low rainfall in most of its regions. From Figure 5.8 it could be seen that serious droughts were experienced in 1982, 1989 and 1990 likewise in 1995, 1998, 1999 and year 2008.

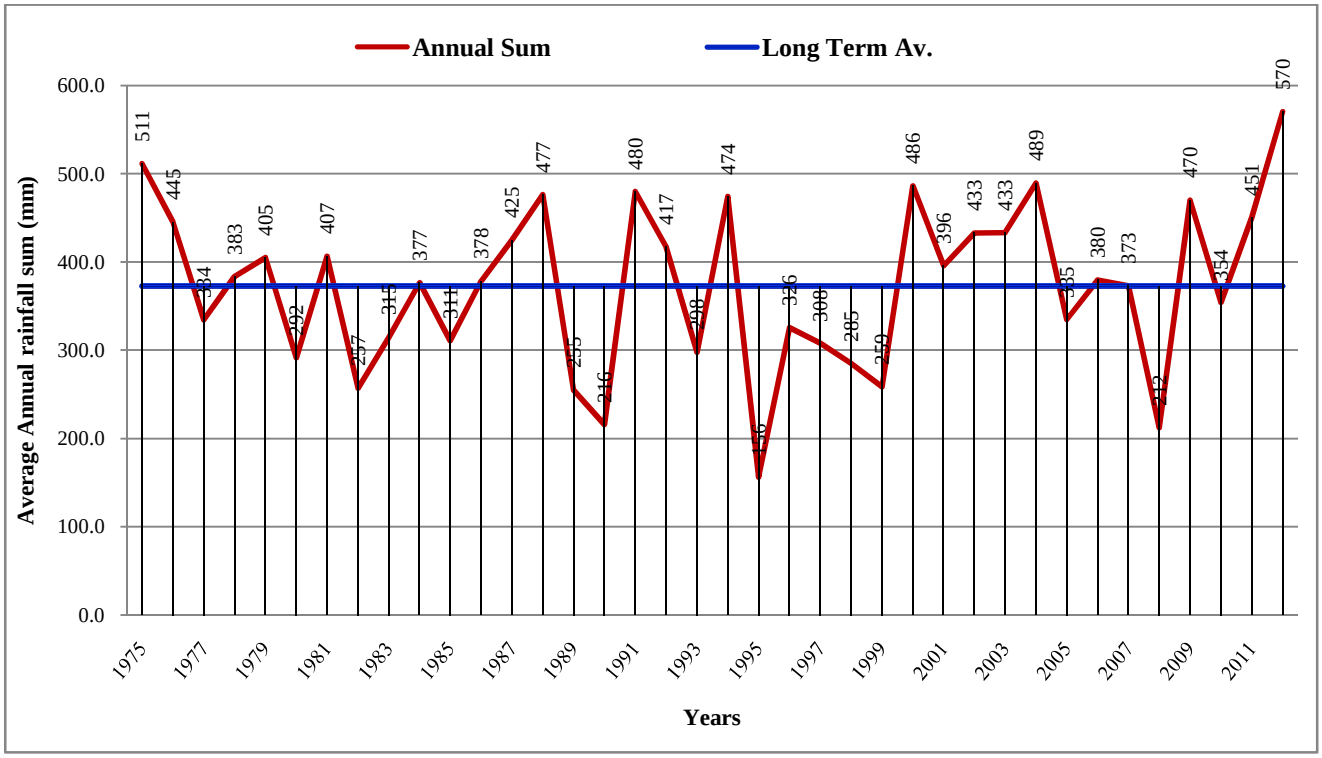


Figure 5.8: Trend of Rainfall in TRNC 1975 to 2012

Luckily, the intensity increases to above long term average right from year 2000 to date (2012) except in 2005 and 2007 where other drought where experienced as depicted in Figure 5.8 and appendix IV. It was also observed that the long term average is small compared to eastern part of Turkey which has up to 2200mm as annual rainfall sum, the impact of climate change and drought contributed greatly in water scarcity due to the fact that rainfall was less yielding relatively small quantity of stream flow as such less Dam storage were registered all over TRNC. Hence there is need for integrated water resources management for efficient utilization of available resources in order to meet up future need which is also associated with increase in population and unexpected drought impact.

5.2.5 Distribution of Arable Land and Fluctuation of Cultivated Area

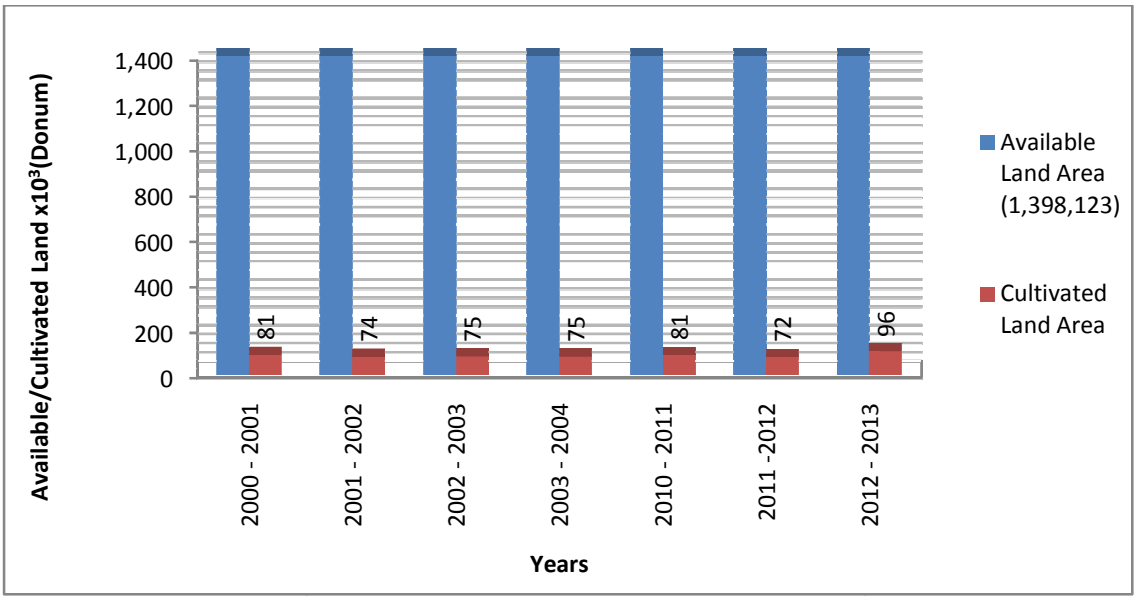


Figure 5.9: Variation of Allocated Land for Agriculture and Cultivated Area

NC was blessed with fertile land consisting of consolidated clay sediment and loamy soil suitable for production of variety of economic crops. A total land area of 1,398,123 donum was allocated for agricultural production as shown in Figure 5.9, unfortunately due to water scarcity, a total land area ranging from 73,677 in 2000 to 95,892 donum in 2012 were put to cultivation through irrigation which correspond to 5.27 to 6.86% of the total available land respectively. This shows that there is plenty irrigation potential which when cultivated will boast economic development very significantly. Table 5.1 provides distribution of regional agricultural land all over the north Cyprus.

Table 5.1: Regional Agricultural Land Distribution

S/NO	Regions	Land Distribution
1	Central Nicosia	105,566
2	Değirmenlik	54,325
3	Ercan	123,203
4	Güzelyurt	106,776
5	Lefke	53,718
6	Famagusta A	34,892
7	Famagusta B	91,588
8	Akdoğan	132,663
9	Geçitkale	100,922
10	Gönendere	73,964
11	Yeni İskele	102,099
12	Mehmetçik	91,549
13	Yeni Erenköy	112,622
14	Kyrenia East	34,725
15	Kyrenia West	20,346
16	Boğaz	50,491
17	Çamlıbel	108,674
Total		1,398,123

The above irrigation potential when properly managed under supply of good quality water, large amount of incomes will be generated for economic growth. Similarly, by utilizing all the land resources, large number of peoples will get employed thereby reducing unemployment through this perspective.

5.2.6 Aquifer status in TRNC Year 2012

Table 5.2: Aquifer Storage Capacities and Status Due to Over Extraction and Mineral Contamination (Necdet, 201)

			2000		2001		2002		2003		2010		2011		2012		
Aquifer Name	Sub-region	Rech. Cap. (10^6) (m^3)	Wat. Ext. (10^6) (m^3)	Aqu. Sit. (10^6) (m^3)	Wat. Ext. (10^6) (m^3)	Aqu. Sit. (10^6) (m^3)	Wat. Ext. (10^6) (m^3)	Aqu. Sit. (10^6) (m^3)	Wat. Ext. (10^6) (m^3)	Aqu. Sit. (10^6) (m^3)	Wat. Ext. (10^6) (m^3)	Aqu. Sit. (10^6) (m^3)	Wat. Ext. (10^6) (m^3)	Aqu. Sit. (10^6) (m^3)	Wat. Ext. (10^6) (m^3)	Aqu. Sit. (10^6) (m^3)	Status
Guzelyurt	Guzelyurt	37	83.2	-46.2	73.6	-36.6	65.8	-28.8	67.2	-30.2	81.8	-44.8	60.1	-23.1	62.2	-25.2	Contaminated
Lefke	Lefke	15.5	5.2	17.3	5.2	17.3	3.6	18.9	3.3	19.2	5.7	16.8	11	11.5	14.1	8.4	Safe
Yesilirmark	Lefke	7															
Serdarli	Nicosia	6	0.6	5.4	0	6	0	6	0	6	0	6	0	6	0	6	Gypsum Contamination
K. Mountain	Degirmenlik	10	4.7	5.3	4.7	5.3	4.8	5.2	5.1	4.9	5.4	4.6	4.9	4.85	6.2	3.55	Safe
	Total	75.5	93.7	-18.2	83.5	-8	74.2	1.3	75.6	-0.1	92.9	-17.4	76	-0.75	82.5	-7.25	
K. Coast	Kyrenia	9	14.4	-5.4	10.9	-1.9	11.1	-2.1	11.5	-2.5	12.5	-3.5	7.6	1.4	9.9	-0.9	Contaminated
Korucam	Camlibel	1.1	2.1	-1	2.1	-1	1.5	-0.4	1	0.1	2.3	-1.2	0.5	0.6	0.5	0.6	Limited supply
Akdeniz	Camlibel	1.5	2.3	-0.8	2.2	-0.7	2	-0.5	2	-0.5	2.5	-1	1.2	0.3	1.4	0.1	Contaminated
	Total	11.6	18.8	-7.2	15.2	-3.6	14.6	-3	14.5	-2.9	17.3	-5.7	9.3	2.3	11.8	-0.2	
Eas. Mesaria	Famagusta A	5	10.6	-4.1	7.8	-1.3	7.7	-1.2	7.4	-0.9	9	-2.5	3.7	2.8	5	1.5	Contaminated
Maras	Famagusta A	1.5															
Turkmenkoy	Akdogan	0.5	4.6	-2	3.5	-0.9	3.8	-1.2	3.3	-0.7	4	-1.4	3.9	-1.3	4.2	-1.6	Contaminated
Beyarmudu	Akdogan	0.5															
Cayonu	Akdogan	0.8															
Incirli	Akdogan	0.8															
Guvercinlik	Famagusta B	0.6	0.9	-0.3	1.1	-0.5	0.9	-0.3	0.9	-0.3	1.3	-0.7	0.9	-0.3	1.7	-1.1	Contaminated
Buyukkonuk	Mehmetcik	0.5	1.9	-1.4	2.1	-1.6	2.2	-1.7	2.6	-2.1	2.3	-1.8	0.2	0.3	0.2	0.3	Safe/Limited supply
Karpaz	Y. Erenkoy	1.5	3.9	-0.9	3.6	-0.6	6.1	-3.1	4.3	-1.3	4.1	-1.1	3.1	-0.15	2.8	0.15	Safe/Limited supply
Yesilkoy	Y. Erenkoy	1.5															Sulphur cont.
Gypsum Aquifers	Scattered	3.6	4.1	-0.5	3.9	-0.3	3	0.6	2.7	0.9	4.5	-0.9	3	0.6	3.4	0.2	Gypsum Contamination
	Sub-Total	16.8	26	-9.2	22	-5.2	23.7	-6.9	21.2	-4.4	25.2	-8.4	14.8	1.95	17.3	-0.55	
	Total	103.9	138.5	-34.6	114.38	-16.8	112.5	-8.6	112.21	-7.4	135.4	-31.5	99.92	3.5	115.13	-8	

Table 5.2 provides information about aquifer situation in TRNC year 2000 - 2012. According to some report by Geology department, the average annual recharge capacity of all the available aquifers is about 103.9MCM however, the findings of this research which was presented in Table 5.2 shows that there had been over pumping beyond safe yield as such almost all the aquifers have became contaminated with sea water except few. In addition, the water level in some of the aquifers had gone down which allow limited extraction only through deep pumping wells. Ground water extraction for year 2000 was 138.5MCM while in year 2001 it was 114.3MCM and for 2002 was found to be 112.5MCM. Similarly, for 2003 the quantity was 112.2MCM while for 2010, 2011 and 2012 were found to be 135.3, 99.9 and 115.1MCM respectively as detailed in Table 5.2. These values also justifies that there is over extraction which needs to be controlled to avoid further contamination.

Though there was overdraft but still Yesilkoy and Lefke aquifers were not contaminated likewise Kyrenia Mountain aquifer is also fresh due to the fact that it is above sea level and it is recharged by rainfall. Then again, owing to overdraft, only limited supply is available from Korucam, east Mesaria, Buyukkonuk and Karpaz aquifers. Mineral contamination also contributed toward making ground water unfit neither for drinking nor for irrigation e.g Nicosia Serdarli was contaminated by Gypsum as indicated in Table 5.2, in the same way, Yesilkoy was contaminated by sulphur as such could not be use for any purpose to society. Apart from the above discussed aquifers all others such as Guzelyurt aquifer are in contact with sea water and had became seriously contaminated with salt to a concentration of about 5000ppm due to overdraft beyond their respective safe yield.

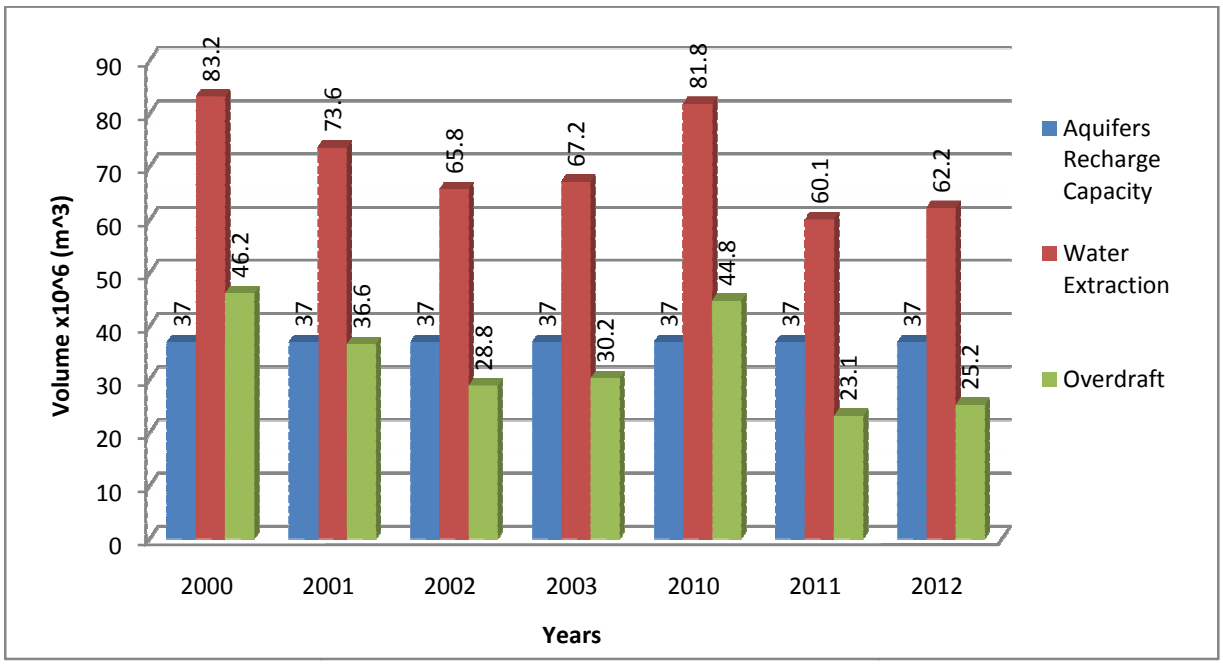


Figure 5.10a: Guzelyurt Aquifer Recharge Capacity, Water Extraction and Overdraft

Guzelyurt aquifer is the main aquifer supplying water to Guzelyurt area, Nicosia and some other parts of the country, Figure 5.10a shows that the aquifer has recharge capacity of 37MCM annually. However, water scarcity had necessitates over pumping beyond its safe yield. It could be observed that in year 2000, there was an overdraft of 46.2MCM, although the salt concentration was very high yet the aquifer is continuously being over extracted up year 2012. Similarly, Kyrenia coastal had been experiencing the same problem of over extraction as presented in Figure 10b detail were provided in Table 5.2 possibly over extraction is to continue in this manner until the ongoing 75MCM water supply project is completed, therefore, judicious water resources management is need.

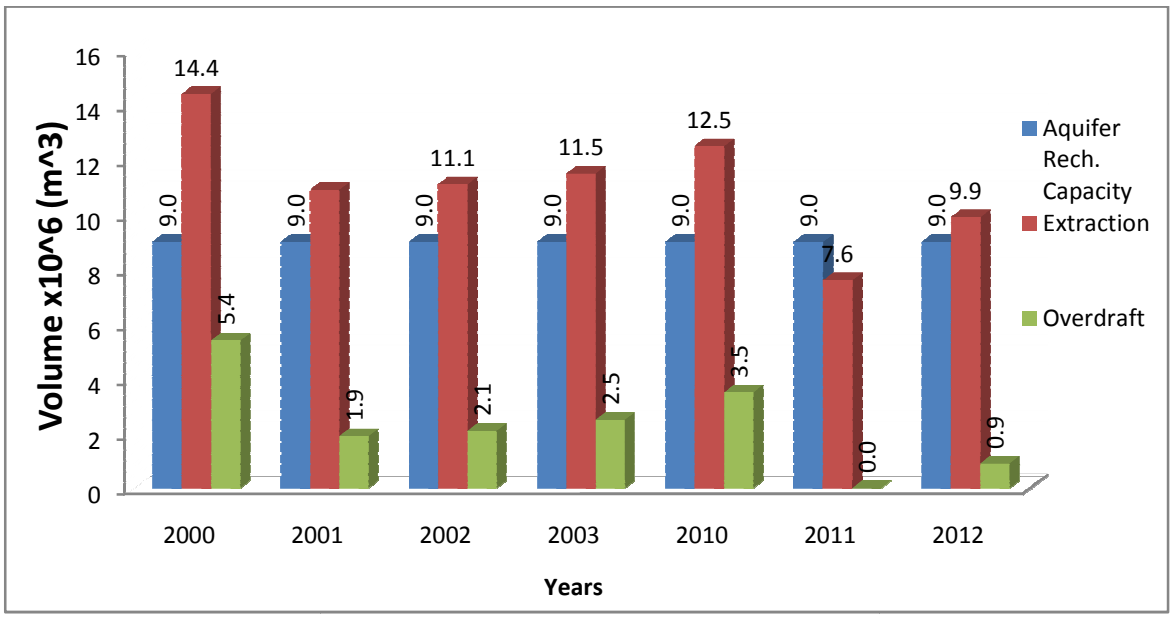


Figure 5.10b: Kyrenia Coastal Aquifer Recharge Capacity, Water Extraction and Overdraft

5.3 Assessment of Agricultural Economy

Cyprus was blessed with fertile land suitable for production of variety of crops. Up to year 2012 several types of crops are grown in almost all regions despite water quality and quantity problem which is expected to be a history in the near future. Effort where made to carry assessment of agricultural economy on 21 groups of crops listed in Figure 5.11. The assessment was intended to be in terms of average charge of water consumption per Donum, cost of farm management and farmer profit per donum, unfortunately data on cost of farm management was difficult to obtain and varies according to crop types and regions. The only available guiding information is water charge per cubic meter for Guzelyurt region which also varies ranging from 0.35, 0.40, 0.55, 0.85 to 1.0TL/m^3 which correspond to a range of 0.20 to 0.484USD/m^3. For detail information on assessment of Agricultural economy check Appendix III

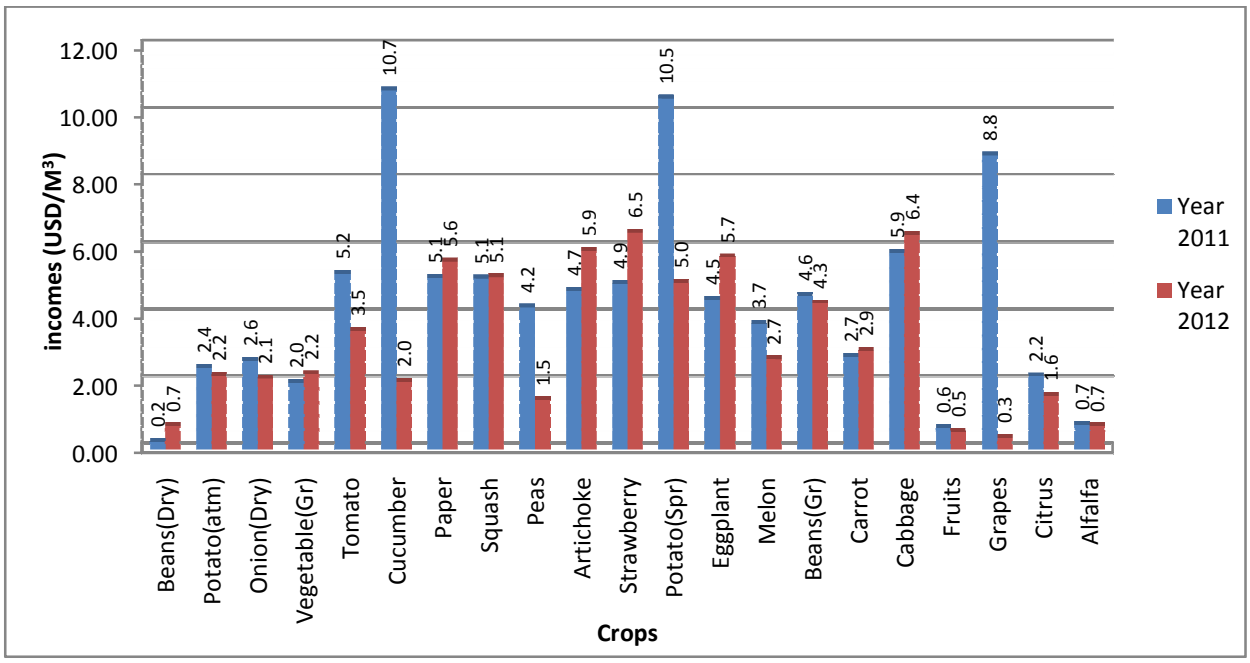


Figure 5.11: Fluctuation of Incomes Generated by 21 Group of Crops

Figure 5.11 provides a list of 21 different crops each with its evaluated incomes in USD/m^3. It could be seen that some crops are very profitable, some are intermediate while others have minimal or no gain at all. Similarly, Figure 5.11 shows how the incomes fluctuate from one year to another which is associated to water quality, land fertility and society need. The assessment of agricultural economy conducted shows that about 146.6 and 115.1million UDS were generated in 2011 and 2012 respectively which is valuable income to NC.

Based on the approach of incomes generated per cubic meter, the chart indicates that, cultivation of Tomato, Cucumber, Pepper, Squash, Artichoke, Strawberry, Potato (spr), Eggplant, Cabbage, and Grapes are most profitable to the farmers with over 5.0USD/m^3 as incomes. The profit of the other crops such as potato (atm), onion (dry), vegetable e.t.c ranges from 2 to 4.99USD/m^3 except beans (dry), Fruit and Alfalfa which have very minimal profit. Within these valuable incomes, the farmers pay water charges, cost of land management and other miscellaneous expenses and also to gain relatively considerable profit to take care of them self and their family. For detail see Appendix III.

In addition, it was observed that, Citrus production consumed the highest percentage of water to a quantity of 41.9MCM and 41.1MCM in year 2011 and 2012 respectively but the farmer ended up with low income of 2.18 in 2011 and eventually dropped to 1.59USD/m^3 in 2012, for that reason, the farmers could hardly gain some profit considering overall cost during cultivation. Therefore, cultivation of Citrus should also be investigated to check whether it is really profitable or not based on water charge, cost of land management and other miscellaneous expenses, if it is profitable then its' production could be allowed and encouraged to carry on or else the annual water consumed by citrus could be diverted to grow other new variety of crops that consume less water and of valuable profit, likewise for Beans (dry) and Alfalfa. Finally, it is advisable for Ministry of Agriculture to orient and advise farmers on how to utilize water, land and other related resources effectively so as to increase yield for high economic benefit. Appendix III illustrate breakdown of the assessment.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

At the beginning of this research it was hypothesized that water demand for domestic and Agricultural demand might be increasing, decreasing or fluctuating over time based on several factors to be investigated.

Based on assessment of water budget of TRNC for 2011, 2012 and on comparison with the results that of previous research conducted by Dr. Gozen Elkiran, it was realized that the trend of Domestic water need is positive which gradually increase in relation to increase in population and is expected keep rising as far as human population keeps increasing. On the other hand, the trend of water demand for agricultural production fluctuates with time due to fluctuation in area of cultivated land, however on average, its' trends is negative owing to modernization of primitive irrigation methods to modern techniques as well as minimization of losses through replacement of old water conveyance system. Though there are limited water resources in NC but these findings strongly shows that, the trend of water demand in TRNC will be positive meaning that the demand will keep increasing if more land will keep being cultivated through irrigation.

Nicosia main region which comprises of Central Nicosia, Degirmenlik, Ercan and Guzelyurt have higher water consumption compared to Kyrenia and Famagusta main regions. In year 2012, Nicosia main region account for 86.6MCM as grand total of water needed for domestic and agricultural demand followed by Famagusta main region with grand total of 22.1MCM while Kyrenia main region comprising of Kyrenia East, Kyrenia West, Bogaz and Camlibel has total domestic and Agricultural demand as 16.4MCM, therefore, Nicosia main region has higher water demand due to high population and irrigation practice as such require more fresh water than the Famagusta and Kyrenia.

According to geology department the average annual aquifers recharge capacity is 103.9MCM but the findings of the research shows that in 2012 ground water extraction accounts for 115.1MCM, this confirms that yet there is significant overdraft. Guzelyurt aquifer supply water to most part of the country but sequel to water scarcity an overdraft of 25.2MCM was recorded in 2012.

The total demand for year 2012 was 125.2MCM however, the total quantity of desalinated water and Dam storage was 12.9MCM and that of fresh ground water obtained from uncontaminated aquifers is minimal, all together the total quantity of available fresh water is far below demand leading to very significant imbalance between demand and fresh water supply. Therefore despite the ongoing developmental effort of 75MCM water supply project from Turkey to North Cyprus of which 50.3% (37.7MCM) will be allocated for municipal supply and the other 49.7% (37.3MCM) will be use for agriculture still even after completion of this project, the total available fresh water will be less than demand. Hence, it could be concluded that, the water supply project will greatly alleviate water scarcity but there is tendency for some parts of the country to continue experiencing water scarcity. Therefore, to achieve water security, there is need for government to plan more water development project such as implementation of more desalination plants at strategic locations and also there is need to review the existing water laws, policies and integrated water resources management system so as to guarantee water security and avoid defragmentation and duplication of development efforts.

Lastly, the assessment of agricultural economy conducted shows that, about 146.6 and 115.1million UDS were generated in 2011 and 2012 respectively which is valuable income to NC, but there is high water consumption in Agricultural sector particularly citrus cultivation. Hence for efficient water management it is advisable to control excessive consumption in citrus production areas.

6.2 Recommendations

Due to fact that the trend of water budget of TRNC is positive with respect to increase in population growth, urbanization and irrigation practice, therefore the following recommendations could be made:

1. There is need to periodically assess water budget on regional bases e.g. every 5 or 10 years in order to provide periodic update on demand and supply for judicious water management in Domestic and Irrigation sector.
2. There is need to provide periodic update on ground water extraction and yield capacity of all available aquifers including extent of contamination or replenishment.
3. There is need to provide periodic update on stream flow and Dams storage including the extent to which these resources are affected by drought.
4. Sequel to water scarcity and limited water resources in the country, it is advisable to look at possibility of implementing solar desalination plants so as to guarantee water security for sustainable development. This will also give rise to cultivate more land for more economic growth.
5. Though there were many Dam all over the country which depends entirely on rainfall/runoff/stream flow for recharge, the storage capacity of the Dams should be investigated against siltation to ensure that all runoff are collected, stored and distributed judiciously for optimum benefit.
6. The quantity of water treated by Nicosia, Kyrenia, Guzelyurt and Famagusta central sewerage treatment plants is quite much accounting about 9.5MCM in 2012 which water official says that it was being diverted to Mediterranean Sea without any reuse. By considering the level of water scarcity in the country and the need to put more land into cultivation there is need to look at possibilities of utilizing such treated water meanwhile it is advisable to consider the level of its' treatment and assess its' quality based on acceptable standard, if the quality is below standard then more treatment should be done to ensure that it is useful for Agricultural production as it contain much macro nutrient need by crop.

7. Based on assessment of agricultural economy of some selected crops, it is recommended to investigate production yield of Citrus as it consumed high percentage of water yielding less economic benefit so as to increase its productivity or else minimize its' production and introduce new crops that are demanded and profitable with less water consumption.

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APPENDIX I

Comparison of water budget components

YEARS	Domestic Demand (m^3/y)	Agricultural Demand (m^3/y)	Total Demand (m^3/y)	Cultivated Land (Donum)	Available Land (Donum)	Total Losses (m^3/y)	G. Water Extraction (m^3/y)	Desalination (m^3/y)	Dam storage (m^3/y)	Spring water (m^3/y)	Total W. Avail. (m^3/y)
2000	35,920,737	106,534,596	142,455,333	81,462	1,398,123	55,836,613	138,473,532	109,500	3,071,506	350,649	142,005,187
2001	36,554,963	89,429,155	125,984,118	73,677	1,398,123	44,382,970	120,673,984	109,500	3,082,803	365,292	124,231,579
2002	37,158,307	84,960,608	122,118,915	74,785	1,398,123	38,813,130	112,489,542	109,500	7,372,465	384,529	120,356,036
2003	37,791,429	82,624,934	120,416,436	74,500	1,398,123	35,976,635	112,208,231	109,500	8,450,913	386,924	121,155,568
2010	42,496,455	98,372,071	140,868,526	81,045	1,398,123	49,348,805	135,321,110	109,500	3,293,582	365,922	139,090,114
2011	49,047,457	62,746,144	111,793,601	71,707	1,398,123	22,068,779	99,918,231	5,821,750	5,368,174	377,662	111,485,817
2012	50,361,711	74,795,420	125,157,131	95,892	1,398,123	24,633,131	115,127,461	5,821,750	7,126,204	400,550	129,701,551

Treatment of sanitary water year 2012:

Regional Sanitary water: 9,592,860m^3/year

Hotel sanitary water: 226,586m^3/year

APPENDIX IA

Summary of Water Budget of TRNC and its Components on Regional and Monthly Bases for Year 2011

	Agricultural Use			**Domestic Use**						**Total**	**Available Resources**					**Gr. Water**
LMR	**Irrigation**	**Loss.**	**Total**	**Live Stock**	**Hotels**	**Universities**	**Houses**	**Loses**	**Total**	**Consumption**	**Springs**	**Sanitary**	**Dams**	Hotel Sanitary Water	**Desalination**	**Extraction**
C. Nicosia	391,026	72,225	463,251	107,753	58,546	559,888	6,866,747	2,277,880	9,870,815	10,334,066	0	7,863,000	463,251	0	0	0
Değirmenlik	609,157	150,483	759,640	215,507	0	0	1,989,472	661,494	2,866,473	3,626,113	19,238	0	173,895	0	0	3,432,980
Ercan	807,860	258,677	1,066,537	179,950	0	0	105,036	85,496	370,482	1,437,019	0	0	0	0	0	1,437,019
Guzelyurt	31,350,142	5,921,481	37,271,623	164,808	13,578	74,230	9,786,780	3,011,819	13,051,215	50,322,838	0	157,260	0	3,617	0	60,093,537
Lefke	9,413,989	2,003,455	11,417,444	67,713	3,066	89,612	658,138	245,559	1,064,087	12,481,531	0	0	1,491,383	0	0	10,990,148
Total	42,572,174	8,406,321	50,978,495	735,732	75,190	723,730	19,406,173	6,282,248	27,223,073	78,201,568	19,238	8,020,260	2,128,529	3,617	0	75,953,685
MMR																
Magusa A	898,450	185,958	1,084,408	90,122	113,223	357,340	3,618,050	1,253,621	5,432,356	6,516,764	0	786,300	0	25,162	2,828,750	3,662,853
Magusa B	92,955	18,159	111,114	92,684	0	0	516,122	182,642	791,448	902,562	0	0	0	0	0	902,562
Akdogan	2,046,639	741,860	2,788,498	336,685	0	0	527,795	259,344	1,123,824	3,912,322	0	0	0	0	0	3,912,322
Y. Eronkoy	1,454,976	435,970	1,890,946	200,697	24,163	0	809,618	310,344	1,344,822	3,235,768	0	0	0	2,097	109,500	3,124,471
Mehmetcik	244,622	46,351	290,973	108,828	205,130	0	401,884	214,753	930,595	1,221,568	4,995	0	290,973	40,835	730,000	154,765
Y. Iskele	467,529	85,298	552,827	157,623	58,254	0	907,663	337,062	1,460,602	2,013,429	43,375	0	302,486	10,589	182,500	1,489,479
Gönendere	158,877	29,801	188,678	88,896	0	0	422,604	153,450	664,950	853,628	13,474	0	188,678	0	0	651,476
Geçitkale	460,121	107,002	567,123	121,151	0	0	147,482	80,590	349,223	916,346	28,140	0	68,039	0	0	820,167
Total	5,824,170	1,650,397	7,474,567	1,196,687	400,770	357,340	7,351,218	2,791,805	12,097,820	19,572,387	89,984	786,300	850,176	78,682	3,850,750	14,718,094
GMR																
Girne East	796,223	157,361	953,584	71,766	578,963	200,525	3,060,801	1,173,617	5,085,672	6,039,256	14,075	786,300	827,292	111,995	1,788,500	3,297,393
Gine West	1,314,354	237,193	1,551,547	21,703	336,165	0	1,980,838	701,612	3,040,318	4,591,865	110,175	0	0	32,291	182,500	4,266,899
Bogaz	218,293	38,522	256,815	118,371	0	0	745,540	259,173	1,123,084	1,379,899	1,890	0	220,867	0	0	1,157,142
Camlibel	1,270,795	260,341	1,531,136	145,929	0	0	221,372	110,190	477,491	2,008,627	142,300	0	1,341,310	0	0	525,017
Total	3,599,665	693,417	4,293,082	357,769	915,128	200,525	6,008,551	2,244,592	9,726,565	14,019,647	268,440	786,300	2,389,469	144,286	1,971,000	9,246,451
TRNC																
October	4,124,033	992,341	5,116,374	194,509	118,147	143,336	2,801,911	977,371	4,235,275	9,351,649	25,986	794,220	1,082,222	18,759	494,450	7,722,036
November	512,588	193,977	706,565	188,235	114,336	138,713	2,711,526	945,843	4,098,653	4,805,218	32,653	658,800	40,506	15,561	478,500	4,245,067
December	0	0	0	194,509	118,147	143,336	2,801,911	977,371	4,235,275	4,235,275	36,264	567,300	0	13,400	494,450	3,683,265
January	0	0	0	194,509	118,147	143,336	2,801,911	977,371	4,235,275	4,235,275	32,121	567,300	0	13,400	494,450	3,687,108
February	0	0	0	175,686	106,714	46,946	2,490,654	846,000	3,665,999	3,665,999	18,558	512,400	0	12,103	446,600	3,181,335
March	148,206	28,732	176,937	194,509	118,147	130,015	2,788,590	969,379	4,200,641	4,377,578	22,097	680,760	24,992	16,080	494,450	3,811,763
April	3,554,459	723,706	4,278,164	188,235	114,336	125,822	2,698,636	938,109	4,065,137	8,343,301	28,764	768,600	655,610	18,154	478,500	7,154,342
May	6,228,920	1,358,170	7,587,090	194,509	118,147	130,015	2,788,590	969,379	4,200,641	11,787,731	49,841	907,680	484,221	21,439	494,450	10,729,583
June	9,182,148	1,768,322	10,950,470	188,235	114,336	125,822	2,698,636	938,109	4,065,137	15,015,607	37,969	988,200	1,170,530	23,341	478,500	13,297,336
July	10,875,229	2,031,994	12,907,223	194,509	118,147	51,976	2,757,510	936,643	4,058,785	16,966,008	35,819	1,134,600	1,019,436	26,799	494,450	15,381,307
August	9,997,387	2,019,375	12,016,762	194,509	118,147	51,976	2,757,510	936,643	4,058,785	16,075,547	31,057	1,134,600	683,433	26,799	494,450	14,831,611
September	7,373,039	1,633,520	9,006,559	188,235	114,336	50,299	2,668,557	906,428	3,927,855	12,934,414	26,533	878,400	207,224	20,748	478,500	12,193,478
Total	51,996,009	10,750,135	62,746,144	2,290,189	1,391,088	1,281,595	32,765,942	11,318,644	49,047,457	111,793,601	377,662	9,592,860	5,368,174	226,586	5,821,750	99,918,231

APPENDIX IB

Water budget of Central Nicosia Region on Monthly Bases for Year 2011

Central	Agricultural Use			Domestic Use						Total	Available Resources					
Nicosia region	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Ground Water Extraction
October	4,205	1,632	5,837	9,152	4,972	66,602	583,203	199,179	863,108	868,945	0	651,000	5,837	0	0	0
November	651	279	930	8,856	4,812	64,454	564,390	192,754	835,266	836,196	0	540,000	930	0	0	0
December	0	0	0	9,152	4,972	66,602	583,203	199,179	863,108	863,108	0	465,000	0	0	0	0
January	0	0	0	9,152	4,972	66,602	583,203	199,179	863,108	863,108	0	465,000	0	0	0	0
February	0	0	0	8,266	4,491	20,052	526,764	167,872	727,446	727,446	0	420,000	0	0	0	0
March	0	0	0	9,152	4,972	53,282	583,203	195,183	845,791	845,791	0	558,000	0	0	0	0
April	2,083	440	2,523	8,856	4,812	51,563	564,390	188,887	818,508	821,031	0	630,000	2,523	0	0	0
May	44,407	8,124	52,531	9,152	4,972	53,282	583,203	195,183	845,791	898,322	0	744,000	52,531	0	0	0
June	141,692	25,209	166,901	8,856	4,812	51,563	564,390	188,887	818,508	985,409	0	810,000	166,901	0	0	0
July	146,791	25,952	172,743	9,152	4,972	22,201	583,203	185,858	805,386	978,129	0	930,000	172,743	0	0	0
August	42,891	8,068	50,959	9,152	4,972	22,201	583,203	185,858	805,386	856,345	0	930,000	50,959	0	0	0
September	8,306	2,521	10,827	8,856	4,812	21,485	564,390	179,863	779,406	790,233	0	720,000	10,827	0	0	0
Total	391,026	72,225	463,251	107,753	58,546	559,888	6,866,747	2,277,880	9,870,815	10,334,066	0	7,863,000	463,251	0	0	0

APPENDIX IC

Water Budget of Değirmenlik Region on Monthly Bases for the Year 2011

Değirmenlik	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction.
October	30,657	11,092	41,749	18,303	0	0	168,969	56,182	243,454	285,203	1,383	0	41,749	0	0	242,071
November	7,490	1,904	9,394	17,713	0	0	163,518	54,369	235,601	244,995	2,456	0	9,394	0	0	233,145
December	0	0	0	18,303	0	0	168,969	56,182	243,454	243,454	1,574	0	0	0	0	241,880
January	0	0	0	18,303	0	0	168,969	56,182	243,454	243,454	3,055	0	0	0	0	240,399
February	0	0	0	16,532	0	0	152,617	50,745	219,894	219,894	1,321	0	0	0	0	218,573
March	9,100	1,606	10,706	18,303	0	0	168,969	56,182	243,454	254,160	1,260	0	10,706	0	0	242,194
April	10,743	2,024	12,766	17,713	0	0	163,518	54,369	235,601	248,367	1,296	0	12,766	0	0	234,305
May	50,279	13,836	64,114	18,303	0	0	168,969	56,182	243,454	307,568	1,776	0	64,114	0	0	241,678
June	134,862	30,813	165,675	17,713	0	0	163,518	54,369	235,601	401,276	1,504	0	35,166	0	0	364,606
July	154,969	35,536	190,505	18,303	0	0	168,969	56,182	243,454	433,959	1,301	0	0	0	0	432,658
August	131,832	31,569	163,401	18,303	0	0	168,969	56,182	243,454	406,855	1,235	0	0	0	0	405,620
September	79,226	22,104	101,330	17,713	0	0	163,518	54,369	235,601	336,931	1,077	0	0	0	0	335,854
Total	609,157	150,483	759,640	215,507	0	0	1,989,472	661,494	2,866,473	3,626,113	19,238	0	173,895	0	0	3,432,980

APPENDIX ID

Water Budget of Ercan Region on Monthly Bases for Year 2011

Ercan	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
October	37,949	16,264	54,213	15,283	0	0	8,921	7,261	31,466	85,679	0	0	0	0	0	85,679
November	147	63	210	14,790	0	0	8,633	7,027	30,451	30,661	0	0	0	0	0	30,661
December	0	0	0	15,283	0	0	8,921	7,261	31,466	31,466	0	0	0	0	0	31,466
January	0	0	0	15,283	0	0	8,921	7,261	31,466	31,466	0	0	0	0	0	31,466
February	0	0	0	13,804	0	0	8,058	6,559	28,421	28,421	0	0	0	0	0	28,421
March	0	0	0	15,283	0	0	8,921	7,261	31,466	31,466	0	0	0	0	0	31,466
April	4,105	1,528	5,633	14,790	0	0	8,633	7,027	30,451	36,084	0	0	0	0	0	36,084
May	99,038	33,930	132,968	15,283	0	0	8,921	7,261	31,466	164,434	0	0	0	0	0	164,434
June	194,326	56,360	250,686	14,790	0	0	8,633	7,027	30,451	281,137	0	0	0	0	0	281,137
July	216,161	62,789	278,950	15,283	0	0	8,921	7,261	31,466	310,416	0	0	0	0	0	310,416
August	157,810	52,063	209,873	15,283	0	0	8,921	7,261	31,466	241,339	0	0	0	0	0	241,339
September	98,324	35,680	134,004	14,790	0	0	8,633	7,027	30,451	164,455	0	0	0	0	0	164,455
Total	807,860	258,677	1,066,537	179,950	0	0	105,036	85,496	370,482	1,437,019	0	0	0	0	0	1,437,019

APPENDIX IE

Water Budget of Guzelyurt Region on Monthly Bases for Year 2011

Guzelyurt	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction.
October	2,598,181	527,238	3,125,419	13,997	1,153	6,305	850,256	261,513	1,133,225	4,258,644	0	13,020	0	299	0	5,113,257
November	155,359	56,822	212,181	13,546	1,116	6,101	822,828	253,077	1,096,668	1,308,849	0	10,800	0	248	0	2,135,936
December	0	0	0	13,997	1,153	6,305	850,256	261,513	1,133,225	1,133,225	0	9,300	0	214	0	1,987,923
January	0	0	0	13,997	1,153	6,305	850,256	261,513	1,133,225	1,133,225	0	9,300	0	214	0	1,987,923
February	0	0	0	12,643	1,042	5,695	727,869	224,174	971,422	971,422	0	8,400	0	193	0	1,691,272
March	71,641	13,428	85,069	13,997	1,153	6,305	836,935	257,517	1,115,908	1,200,977	0	11,160	0	257	0	2,038,316
April	2,539,530	469,293	3,008,822	13,546	1,116	6,101	809,937	249,210	1,079,910	4,088,732	0	12,600	0	290	0	4,899,019
May	3,767,342	721,529	4,488,870	13,997	1,153	6,305	836,935	257,517	1,115,908	5,604,778	0	14,880	0	342	0	6,442,031
June	5,205,562	959,673	6,165,235	13,546	1,116	6,101	809,937	249,210	1,079,910	7,245,145	0	16,200	0	373	0	8,055,350
July	6,366,614	1,148,069	7,514,683	13,997	1,153	6,305	805,855	248,193	1,075,503	8,590,186	0	18,600	0	428	0	9,386,949
August	6,097,243	1,137,526	7,234,768	13,997	1,153	6,305	805,855	248,193	1,075,503	8,310,271	0	18,600	0	428	0	9,107,034
September	4,548,671	887,905	5,436,576	13,546	1,116	6,101	779,859	240,186	1,040,808	6,477,384	0	14,400	0	331	0	7,248,528
Total	31,350,142	5,921,481	37,271,623	164,808	13,578	74,230	9,786,780	3,011,819	13,051,215	50,322,838	0	157,260	0	3,617	0	60,093,537

APPENDIX IF

Water Budget of Lefke Region on Monthly Bases, Year 2011

Lefke	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
October	825,282	212,573	1,037,854	5,751	260	9,747	55,897	21,496	93,151	1,131,005	0	0	883,618	0	0	247,387
November	118,855	48,883	167,738	5,565	252	9,433	54,094	20,803	90,147	257,885	0	0	0	0	0	257,885
December	0	0	0	5,751	260	9,747	55,897	21,496	93,151	93,151	0	0	0	0	0	93,151
January	0	0	0	5,751	260	9,747	55,897	21,496	93,151	93,151	0	0	0	0	0	93,151
February	0	0	0	5,194	235	2,935	50,487	17,655	76,507	76,507	0	0	0	0	0	76,507
March	6,635	1,598	8,233	5,751	260	9,747	55,897	21,496	93,151	101,384	0	0	8,233	0	0	93,151
April	623,177	121,453	744,629	5,565	252	9,433	54,094	20,803	90,147	834,776	0	0	599,532	0	0	235,244
May	1,112,572	234,929	1,347,501	5,751	260	9,747	55,897	21,496	93,151	1,440,652	0	0	0	0	0	1,440,652
June	1,605,809	313,676	1,919,485	5,565	252	9,433	54,094	20,803	90,147	2,009,632	0	0	0	0	0	2,009,632
July	1,896,833	351,019	2,247,852	5,751	260	3,249	55,897	19,547	84,704	2,332,556	0	0	0	0	0	2,332,556
August	1,807,295	381,504	2,188,799	5,751	260	3,249	55,897	19,547	84,704	2,273,503	0	0	0	0	0	2,273,503
September	1,417,532	337,821	1,755,353	5,565	252	3,145	54,094	18,917	81,972	1,837,325	0	0	0	0	0	1,837,325
Total	9,413,989	2,003,455	11,417,444	67,713	3,066	89,612	658,138	245,559	1,064,087	12,481,531	0	0	1,491,383	0	0	10,990,148

APPENDIX IG

Summary of Water budget for Nicosia Main Region on Monthly Bases, Year 2011

Nicosia	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
Main Region	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
October	3,496,274	768,798	4,265,072	62,487	6,386	82,654	1,667,246	545,632	2,364,404	6,629,476	1,383	664,020	931,204	299	0	5,688,394
November	282,502	107,951	390,453	60,471	6,180	79,988	1,613,463	528,031	2,288,133	2,678,586	2,456	550,800	10,324	248	0	2,657,626
December	0	0	0	62,487	6,386	82,654	1,667,246	545,632	2,364,404	2,364,404	1,574	474,300	0	214	0	2,354,420
January	0	0	0	62,487	6,386	82,654	1,667,246	545,632	2,364,404	2,364,404	3,055	474,300	0	214	0	2,352,939
February	0	0	0	56,440	5,768	28,682	1,465,795	467,005	2,023,689	2,023,689	1,321	428,400	0	193	0	2,014,772
March	87,376	16,632	104,008	62,487	6,386	69,333	1,653,925	537,639	2,329,770	2,433,778	1,260	569,160	18,939	257	0	2,405,127
April	3,179,637	594,737	3,774,373	60,471	6,180	67,097	1,600,572	520,296	2,254,617	6,028,990	1,296	642,600	614,821	290	0	5,404,652
May	5,073,637	1,012,347	6,085,984	62,487	6,386	69,333	1,653,925	537,639	2,329,770	8,415,754	1,776	758,880	116,645	342	0	8,288,795
June	7,282,251	1,385,731	8,667,982	60,471	6,180	67,097	1,600,572	520,296	2,254,617	10,922,599	1,504	826,200	202,067	373	0	10,710,724
July	8,781,369	1,623,365	10,404,733	62,487	6,386	31,755	1,622,844	517,042	2,240,513	12,645,246	1,301	948,600	172,743	428	0	12,462,578
August	8,237,070	1,610,730	9,847,800	62,487	6,386	31,755	1,622,844	517,042	2,240,513	12,088,313	1,235	948,600	50,959	428	0	12,027,495
September	6,152,059	1,286,031	7,438,090	60,471	6,180	30,730	1,570,494	500,363	2,168,238	9,606,328	1,077	734,400	10,827	331	0	9,586,161
Total	42,572,174	8,406,321	50,978,495	735,732	75,190	723,730	19,406,173	6,282,248	27,223,073	78,201,568	19,238	8,020,260	2,128,529	3,617	0	75,953,685

APPENDIX IH

Water Budget of Famagusta Region A on Monthly Bases, Year 2011

Famagusta A	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
October	43,280	11,087	54,366	7,654	9,616	38,872	307,286	109,029	472,458	526,824	0	65,100	0	2,083	240,250	284,491
November	22,822	4,977	27,799	7,407	9,306	37,618	297,374	105,512	457,218	485,017	0	54,000	0	1,728	232,500	250,789
December	0	0	0	7,654	9,616	38,872	307,286	109,029	472,458	472,458	0	46,500	0	1,488	240,250	230,720
January	0	0	0	7,654	9,616	38,872	307,286	109,029	472,458	472,458	0	46,500	0	1,488	240,250	230,720
February	0	0	0	6,913	8,686	11,695	277,549	91,453	396,297	396,297	0	42,000	0	1,344	217,000	177,953
March	22,706	4,408	27,114	7,654	9,616	38,872	307,286	109,029	472,458	499,572	0	55,800	0	1,786	240,250	257,536
April	55,673	13,730	69,403	7,407	9,306	37,618	297,374	105,512	457,218	526,621	0	63,000	0	2,016	232,500	292,105
May	89,446	23,313	112,758	7,654	9,616	38,872	307,286	109,029	472,458	585,216	0	74,400	0	2,381	240,250	342,585
June	193,429	36,663	230,092	7,407	9,306	37,618	297,374	105,512	457,218	687,310	0	81,000	0	2,592	232,500	452,218
July	206,745	37,056	243,801	7,654	9,616	12,948	307,286	101,252	438,757	682,558	0	93,000	0	2,976	240,250	439,332
August	161,110	31,752	192,861	7,654	9,616	12,948	307,286	101,252	438,757	631,618	0	93,000	0	2,976	240,250	388,392
September	103,241	22,974	126,214	7,407	9,306	12,531	297,374	97,985	424,604	550,818	0	72,000	0	2,304	232,500	316,014
Total	898,450	185,958	1,084,408	90,122	113,223	357,340	3,618,050	1,253,621	5,432,356	6,516,764	0	786,300	0	25,162	2,828,750	3,662,853

APPENDIX Ii

Water Budget of Famagusta Region B on Monthly Bases, Year 2011

Famagusta B	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
October	3,207	683	3,890	7,872	0	0	43,835	15,512	67,219	71,109	0	0	0	0	0	71,109
November	101	43	144	7,618	0	0	42,421	15,012	65,051	65,195	0	0	0	0	0	65,195
December	0	0	0	7,872	0	0	43,835	15,512	67,219	67,219	0	0	0	0	0	67,219
January	0	0	0	7,872	0	0	43,835	15,512	67,219	67,219	0	0	0	0	0	67,219
February	0	0	0	7,110	0	0	39,593	14,011	60,714	60,714	0	0	0	0	0	60,714
March	162	70	231	7,872	0	0	43,835	15,512	67,219	67,450	0	0	0	0	0	67,450
April	2,807	835	3,642	7,618	0	0	42,421	15,012	65,051	68,693	0	0	0	0	0	68,693
May	10,766	2,523	13,289	7,872	0	0	43,835	15,512	67,219	80,508	0	0	0	0	0	80,508
June	22,905	4,438	27,343	7,618	0	0	42,421	15,012	65,051	92,394	0	0	0	0	0	92,394
July	24,794	4,382	29,176	7,872	0	0	43,835	15,512	67,219	96,395	0	0	0	0	0	96,395
August	18,706	3,369	22,075	7,872	0	0	43,835	15,512	67,219	89,294	0	0	0	0	0	89,294
September	9,508	1,816	11,324	7,618	0	0	42,421	15,012	65,051	76,375	0	0	0	0	0	76,375
Total	92,955	18,159	111,114	92,684	0	0	516,122	182,642	791,448	902,562	0	0	0	0	0	902,562

APPENDIX IJ

Water Budget of Akdogan Region on Monthly Bases, Year 2011

Akdogan	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
October	276,128	110,886	387,014	28,595	0	0	44,826	22,026	95,448	482,462	0	0	0	0	0	482,462
November	114,867	45,199	160,066	27,673	0	0	43,380	21,316	92,369	252,435	0	0	0	0	0	252,435
December	0	0	0	28,595	0	0	44,826	22,026	95,448	95,448	0	0	0	0	0	95,448
January	0	0	0	28,595	0	0	44,826	22,026	95,448	95,448	0	0	0	0	0	95,448
February	0	0	0	25,828	0	0	40,488	19,895	86,211	86,211	0	0	0	0	0	86,211
March	21,095	4,576	25,671	28,595	0	0	44,826	22,026	95,448	121,119	0	0	0	0	0	121,119
April	170,583	64,522	235,104	27,673	0	0	43,380	21,316	92,369	327,473	0	0	0	0	0	327,473
May	349,494	138,608	488,102	28,595	0	0	44,826	22,026	95,448	583,550	0	0	0	0	0	583,550
June	244,339	73,651	317,990	27,673	0	0	43,380	21,316	92,369	410,359	0	0	0	0	0	410,359
July	238,786	69,917	308,703	28,595	0	0	44,826	22,026	95,448	404,151	0	0	0	0	0	404,151
August	297,244	105,796	403,040	28,595	0	0	44,826	22,026	95,448	498,488	0	0	0	0	0	498,488
September	334,103	128,705	462,808	27,673	0	0	43,380	21,316	92,369	555,177	0	0	0	0	0	555,177
Total	2,046,639	741,860	2,788,498	336,685	0	0	527,795	259,344	1,123,824	3,912,322	0	0	0	0	0	3,912,322

APPENDIX IK

Water Budget of Yeni Eronkoy Region on Monthly Bases, Year 2011

Y. Eronkoy	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
October	136,025	56,682	192,707	17,046	2,052	0	68,762	26,358	114,218	306,925	0	0	0	174	9,300	297,451
November	65,148	27,921	93,069	16,496	1,986	0	66,544	25,508	110,533	203,602	0	0	0	144	9,000	194,458
December	0	0	0	17,046	2,052	0	68,762	26,358	114,218	114,218	0	0	0	124	9,300	105,094
January	0	0	0	17,046	2,052	0	68,762	26,358	114,218	114,218	0	0	0	124	9,300	104,794
February	0	0	0	15,396	1,854	0	62,108	23,807	103,164	103,164	0	0	0	112	8,400	94,652
March	119	51	170	17,046	2,052	0	68,762	26,358	114,218	114,388	0	0	0	149	9,300	104,939
April	78,986	32,699	111,685	16,496	1,986	0	66,544	25,508	110,533	222,218	0	0	0	168	9,000	213,050
May	216,985	77,515	294,500	17,046	2,052	0	68,762	26,358	114,218	408,718	0	0	0	198	9,300	399,219
June	220,362	41,687	262,049	16,496	1,986	0	66,544	25,508	110,533	372,582	0	0	0	216	9,000	363,366
July	257,362	52,190	309,552	17,046	2,052	0	68,762	26,358	114,218	423,770	0	0	0	248	9,300	414,222
August	266,367	73,359	339,726	17,046	2,052	0	68,762	26,358	114,218	453,944	0	0	0	248	9,300	444,396
September	213,622	73,866	287,488	16,496	1,986	0	66,544	25,508	110,533	398,021	0	0	0	192	9,000	388,829
Total	1,454,976	435,970	1,890,946	200,697	24,163	0	809,618	310,344	1,344,822	3,235,768	0	0	0	2,097	109,500	3,124,471

APPENDIX IL

Water Budget of Mehmetcik Region on Monthly Bases, Year 2011

Mehmetcik	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
October	2,066	592	2,658	9,243	17,422	0	34,133	18,239	79,037	81,695	134	0	2,658	3,381	62,000	13,522
November	916	197	1,113	8,945	16,860	0	33,032	17,651	76,487	77,600	562	0	1,113	2,804	60,000	13,121
December	0	0	0	9,243	17,422	0	34,133	18,239	79,037	79,037	321	0	0	2,415	62,000	14,301
January	0	0	0	9,243	17,422	0	34,133	18,239	79,037	79,037	1,557	0	0	2,415	62,000	13,065
February	0	0	0	8,348	15,736	0	30,829	16,474	71,388	71,388	693	0	0	2,181	56,000	12,514
March	1,016	218	1,234	9,243	17,422	0	34,133	18,239	79,037	80,271	476	0	1,234	2,898	62,000	13,663
April	4,333	1,461	5,793	8,945	16,860	0	33,032	17,651	76,487	82,280	233	0	5,793	3,272	60,000	12,982
May	19,760	4,825	24,585	9,243	17,422	0	34,133	18,239	79,037	103,622	228	0	24,585	3,864	62,000	12,945
June	62,907	11,260	74,167	8,945	16,860	0	33,032	17,651	76,487	150,654	236	0	74,167	4,207	60,000	12,045
July	68,831	12,187	81,018	9,243	17,422	0	34,133	18,239	79,037	160,055	216	0	81,018	4,830	62,000	11,991
August	58,716	10,638	69,353	9,243	17,422	0	34,133	18,239	79,037	148,390	177	0	69,353	4,830	62,000	12,030
September	26,078	4,974	31,052	8,945	16,860	0	33,032	17,651	76,487	107,539	162	0	31,052	3,739	60,000	12,586
Total	244,622	46,351	290,973	108,828	205,130	0	401,884	214,753	930,595	1,221,568	4,995	0	290,973	40,835	730,000	154,765

APPENDIX IM

Water Budget of Yeni Iskele Region on Monthly Bases, Year 2011

Y. Iskele	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
October	15,412	3,833	19,245	13,387	4,948	0	77,089	28,627	124,051	143,296	2,391	0	19,207	877	15,500	105,321
November	4,672	1,060	5,731	12,955	4,788	0	74,602	27,704	120,050	125,781	7,404	0	5,620	727	15,000	112,029
December	0	0	0	13,387	4,948	0	77,089	28,627	124,051	124,051	3,694	0	0	626	15,500	104,231
January	0	0	0	13,387	4,948	0	77,089	28,627	124,051	124,051	7,407	0	0	626	15,500	100,518
February	0	0	0	12,092	4,469	0	69,629	25,857	112,046	112,046	3,176	0	0	566	14,000	94,305
March	4,141	731	4,872	13,387	4,948	0	77,089	28,627	124,051	128,923	3,484	0	4,819	751	15,500	104,369
April	9,604	1,705	11,309	12,955	4,788	0	74,602	27,704	120,050	131,359	2,969	0	11,259	848	15,000	101,282
May	30,497	5,421	35,918	13,387	4,948	0	77,089	28,627	124,051	159,969	3,575	0	35,854	1,002	15,500	104,038
June	109,423	19,336	128,759	12,955	4,788	0	74,602	27,704	120,050	248,809	2,908	0	128,703	1,091	15,000	101,107
July	123,081	21,720	144,801	13,387	4,948	0	77,089	28,627	124,051	268,852	2,304	0	97,024	1,252	15,500	152,772
August	111,276	19,940	131,216	13,387	4,948	0	77,089	28,627	124,051	255,267	2,205	0	0	1,252	15,500	236,310
September	59,424	11,553	70,976	12,955	4,788	0	74,602	27,704	120,050	191,026	1,858	0	0	970	15,000	173,198
Total	467,529	85,298	552,827	157,623	58,254	0	907,663	337,062	1,460,602	2,013,429	43,375	0	302,486	10,589	182,500	1,489,479

APPENDIX IN

Water Budget of Gönendere Region on Monthly Bases, Year 2011

Gönendere	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
October	1,499	643	2,142	7,550	0	0	35,892	13,033	56,475	58,617	685	0	2,142	0	0	55,790
November	231	99	330	7,307	0	0	34,735	12,612	54,653	54,983	2,199	0	330	0	0	52,454
December	0	0	0	7,550	0	0	35,892	13,033	56,475	56,475	914	0	0	0	0	55,561
January	0	0	0	7,550	0	0	35,892	13,033	56,475	56,475	2,093	0	0	0	0	54,382
February	0	0	0	6,819	0	0	32,419	11,772	51,010	51,010	901	0	0	0	0	50,109
March	0	0	0	7,550	0	0	35,892	13,033	56,475	56,475	915	0	0	0	0	55,560
April	234	100	334	7,307	0	0	34,735	12,612	54,653	54,987	962	0	334	0	0	53,691
May	10,822	2,146	12,968	7,550	0	0	35,892	13,033	56,475	69,443	1,259	0	12,968	0	0	55,216
June	42,864	7,723	50,587	7,307	0	0	34,735	12,612	54,653	105,240	1,066	0	50,587	0	0	53,587
July	46,957	8,327	55,284	7,550	0	0	35,892	13,033	56,475	111,759	892	0	55,284	0	0	55,583
August	39,868	7,352	47,220	7,550	0	0	35,892	13,033	56,475	103,695	878	0	47,220	0	0	55,597
September	16,402	3,411	19,813	7,307	0	0	34,735	12,612	54,653	74,466	710	0	19,813	0	0	53,943
Total	158,877	29,801	188,678	88,896	0	0	422,604	153,450	664,950	853,628	13,474	0	188,678	0	0	651,476

APPENDIX IO

Water Budget of Geçitkale Region on Monthly Bases, Year 2011

Geçitkale	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
October	37,027	11,689	48,716	10,290	0	0	12,526	6,845	29,660	78,376	1,763	0	48,422	0	0	28,191
November	16,512	4,465	20,977	9,958	0	0	12,122	6,624	28,703	49,680	6,397	0	19,617	0	0	23,666
December	0	0	0	10,290	0	0	12,526	6,845	29,660	29,660	2,231	0	0	0	0	27,429
January	0	0	0	10,290	0	0	12,526	6,845	29,660	29,660	5,381	0	0	0	0	24,279
February	0	0	0	9,294	0	0	11,314	6,182	26,790	26,790	2,408	0	0	0	0	24,382
March	11,480	2,026	13,506	10,290	0	0	12,526	6,845	29,660	43,166	3,832	0	0	0	0	39,334
April	28,267	6,794	35,061	9,958	0	0	12,122	6,624	28,703	63,764	1,606	0	0	0	0	62,158
May	43,594	12,759	56,353	10,290	0	0	12,526	6,845	29,660	86,013	1,888	0	0	0	0	84,125
June	85,791	17,098	102,889	9,958	0	0	12,122	6,624	28,703	131,592	991	0	0	0	0	130,601
July	87,495	16,067	103,562	10,290	0	0	12,526	6,845	29,660	133,222	728	0	0	0	0	132,494
August	86,096	18,787	104,883	10,290	0	0	12,526	6,845	29,660	134,543	542	0	0	0	0	134,001
September	63,859	17,317	81,176	9,958	0	0	12,122	6,624	28,703	109,879	373	0	0	0	0	109,506
Total	460,121	107,002	567,123	121,151	0	0	147,482	80,590	349,223	916,346	28,140	0	68,039	0	0	820,167

APPENDIX IP

Summary Water Budget for Famagusta Main Region on Monthly Bases, Year 2011

Famagusta	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
Main Region	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
October	514,644	196,094	710,738	101,636	34,038	38,872	624,350	239,669	1,038,566	1,749,304	4,973	65,100	72,429	6,514	327,050	1,338,337
November	225,269	83,961	309,229	98,358	32,940	37,618	604,210	231,938	1,005,064	1,314,293	16,562	54,000	26,680	5,404	316,500	964,147
December	0	0	0	101,636	34,038	38,872	624,350	239,669	1,038,566	1,038,566	7,160	46,500	0	4,653	327,050	700,003
January	0	0	0	101,636	34,038	38,872	624,350	239,669	1,038,566	1,038,566	16,438	46,500	0	4,653	327,050	690,425
February	0	0	0	91,801	30,744	11,695	563,929	209,451	907,620	907,620	7,178	42,000	0	4,203	295,400	600,839
March	60,719	12,080	72,798	101,636	34,038	38,872	624,350	239,669	1,038,566	1,111,364	8,707	55,800	6,053	5,584	327,050	763,970
April	350,486	121,845	472,331	98,358	32,940	37,618	604,210	231,938	1,005,064	1,477,395	5,770	63,000	17,386	6,304	316,500	1,131,435
May	771,364	267,110	1,038,473	101,636	34,038	38,872	624,350	239,669	1,038,566	2,077,039	6,950	74,400	73,407	7,445	327,050	1,662,187
June	982,020	211,856	1,193,876	98,358	32,940	37,618	604,210	231,938	1,005,064	2,198,940	5,201	81,000	253,457	8,105	316,500	1,615,676
July	1,054,051	221,846	1,275,897	101,636	34,038	12,948	624,350	231,892	1,004,865	2,280,762	4,140	93,000	233,326	9,306	327,050	1,706,940
August	1,039,382	270,992	1,310,374	101,636	34,038	12,948	624,350	231,892	1,004,865	2,315,239	3,802	93,000	116,573	9,306	327,050	1,858,508
September	826,236	264,615	1,090,851	98,358	32,940	12,531	604,210	224,411	972,450	2,063,301	3,103	72,000	50,865	7,205	316,500	1,685,628
Total	5,824,170	1,650,397	7,474,567	1,196,687	400,770	357,340	7,351,218	2,791,805	12,097,820	19,572,387	89,984	786,300	850,176	78,682	3,850,750	14,718,094

APPENDIX IQ

Water Budget of Kyrenia East Region on Monthly Bases, Year 2011

Kyrenia East	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
October	19,552	5,637	25,189	6,095	49,172	21,810	259,958	101,111	438,147	463,336	1,196	65,100	24,185	9,272	151,900	276,782
November	1,738	745	2,483	5,899	47,586	21,107	251,573	97,849	424,014	426,497	3,316	54,000	0	7,691	147,000	268,489
December	0	0	0	6,095	49,172	21,810	259,958	101,111	438,147	438,147	198	46,500	0	6,623	151,900	279,426
January	0	0	0	6,095	49,172	21,810	259,958	101,111	438,147	438,147	449	46,500	0	6,623	151,900	279,175
February	0	0	0	5,505	44,414	6,569	234,801	87,387	378,676	378,676	131	42,000	0	5,982	137,200	235,363
March	111	20	131	6,095	49,172	21,810	259,958	101,111	438,147	438,278	215	55,800	0	7,948	151,900	278,215
April	3,807	1,393	5,199	5,899	47,586	21,107	251,573	97,849	424,014	429,213	1,591	63,000	3,646	8,973	147,000	268,002
May	73,196	15,490	88,686	6,095	49,172	21,810	259,958	101,111	438,147	526,833	1,942	74,400	86,744	10,597	151,900	275,650
June	198,613	38,027	236,640	5,899	47,586	21,107	251,573	97,849	424,014	660,654	1,364	81,000	235,276	11,537	147,000	265,476
July	225,167	41,865	267,032	6,095	49,172	7,273	259,958	96,750	419,249	686,281	1,360	93,000	265,672	13,246	151,900	254,102
August	178,807	34,270	213,077	6,095	49,172	7,273	259,958	96,750	419,249	632,326	1,308	93,000	211,769	13,246	151,900	254,102
September	95,232	19,915	115,147	5,899	47,586	7,038	251,573	93,629	405,725	520,872	1,005	72,000	0	10,255	147,000	362,611
Total	796,223	157,361	953,584	71,766	578,963	200,525	3,060,801	1,173,617	5,085,672	6,039,256	14,075	786,300	827,292	111,995	1,788,500	3,297,393

APPENDIX IR

Water Budget of Kyrenia West Region on Monthly Bases, Year 2011

Kyrenia West	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
October	51,095	9,460	60,555	1,843	28,551	0	168,236	59,589	258,219	318,774	11,460	0	0	2,673	15,500	289,141
November	216	93	309	1,784	27,630	0	162,809	57,667	249,889	250,198	309	0	0	2,218	15,000	232,671
December	0	0	0	1,843	28,551	0	168,236	59,589	258,219	258,219	0	0	0	1,910	15,500	240,809
January	0	0	0	1,843	28,551	0	168,236	59,589	258,219	258,219	0	0	0	1,910	15,500	240,809
February	0	0	0	1,665	25,788	0	151,955	53,822	233,230	233,230	0	0	0	1,725	14,000	217,505
March	0	0	0	1,843	28,551	0	168,236	59,589	258,219	258,219	0	0	0	2,292	15,500	240,427
April	4,297	1,220	5,516	1,784	27,630	0	162,809	57,667	249,889	255,405	5,516	0	0	2,587	15,000	232,302
May	139,477	26,257	165,734	1,843	28,551	0	168,236	59,589	258,219	423,953	27,705	0	0	3,055	15,500	377,693
June	315,081	56,534	371,615	1,784	27,630	0	162,809	57,667	249,889	621,504	19,203	0	0	3,326	15,000	583,975
July	361,668	63,933	425,601	1,843	28,551	0	168,236	59,589	258,219	683,820	18,210	0	0	3,819	15,500	646,291
August	281,220	50,337	331,557	1,843	28,551	0	168,236	59,589	258,219	589,776	16,664	0	0	3,819	15,500	553,793
September	161,300	29,360	190,660	1,784	27,630	0	162,809	57,667	249,889	440,549	11,108	0	0	2,957	15,000	411,484
Total	1,314,354	237,193	1,551,547	21,703	336,165	0	1,980,838	701,612	3,040,318	4,591,865	110,175	0	0	32,291	182,500	4,266,899

APPENDIX IS

Water Budget of Bogaz Region on Monthly Bases, Year 2011

Bogaz	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
October	0	0	0	10,053	0	0	63,320	22,012	95,385	95,385	127	0	0	0	0	95,258
November	0	0	0	9,729	0	0	61,277	21,302	92,308	92,308	351	0	0	0	0	91,957
December	0	0	0	10,053	0	0	63,320	22,012	95,385	95,385	135	0	0	0	0	95,250
January	0	0	0	10,053	0	0	63,320	22,012	95,385	95,385	332	0	0	0	0	95,053
February	0	0	0	9,081	0	0	57,192	19,882	86,154	86,154	132	0	0	0	0	86,022
March	0	0	0	10,053	0	0	63,320	22,012	95,385	95,385	85	0	0	0	0	95,300
April	0	0	0	9,729	0	0	61,277	21,302	92,308	92,308	34	0	0	0	0	92,274
May	14,938	2,636	17,574	10,053	0	0	63,320	22,012	95,385	112,959	199	0	17,375	0	0	95,385
June	58,312	10,290	68,602	9,729	0	0	61,277	21,302	92,308	160,910	138	0	68,464	0	0	92,308
July	67,721	11,951	79,672	10,053	0	0	63,320	22,012	95,385	175,057	134	0	79,538	0	0	95,385
August	55,272	9,754	65,026	10,053	0	0	63,320	22,012	95,385	160,411	127	0	55,490	0	0	104,794
September	22,050	3,891	25,941	9,729	0	0	61,277	21,302	92,308	118,249	96	0	0	0	0	118,153
Total	218,293	38,522	256,815	118,371	0	0	745,540	259,173	1,123,084	1,379,899	1,890	0	220,867	0	0	1,157,142

APPENDIX IT

Water Budget of Camlibel Region on Monthly Bases, Year 2011

Camlibel	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
October	42,468	12,352	54,820	12,394	0	0	18,801	9,359	40,554	95,374	6,847	0	54,404	0	0	34,123
November	2,864	1,228	4,091	11,994	0	0	18,195	9,057	39,246	43,337	9,659	0	3,502	0	0	30,176
December	0	0	0	12,394	0	0	18,801	9,359	40,554	40,554	27,197	0	0	0	0	13,357
January	0	0	0	12,394	0	0	18,801	9,359	40,554	40,554	11,847	0	0	0	0	28,707
February	0	0	0	11,195	0	0	16,982	8,453	36,629	36,629	9,796	0	0	0	0	26,833
March	0	0	0	12,394	0	0	18,801	9,359	40,554	40,554	11,830	0	0	0	0	28,724
April	16,233	4,512	20,745	11,994	0	0	18,195	9,057	39,246	59,991	14,557	0	19,757	0	0	25,677
May	156,308	34,331	190,639	12,394	0	0	18,801	9,359	40,554	231,193	11,269	0	190,050	0	0	29,874
June	345,871	65,884	411,755	11,994	0	0	18,195	9,057	39,246	451,001	10,559	0	411,266	0	0	29,176
July	385,254	69,034	454,288	12,394	0	0	18,801	9,359	40,554	494,842	10,674	0	268,157	0	0	216,011
August	205,636	43,292	248,928	12,394	0	0	18,801	9,359	40,554	289,482	7,921	0	248,642	0	0	32,919
September	116,162	29,708	145,870	11,994	0	0	18,195	9,057	39,246	185,116	10,144	0	145,532	0	0	29,440
Total	1,270,795	260,341	1,531,136	145,929	0	0	221,372	110,190	477,491	2,008,627	142,300	0	1,341,310	0	0	525,017

APPENDIX IU

Summary of Water Budget for Kyrenia Main Region on Monthly Bases, Year 2011

Kyrenia	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
Main Region	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
October	113,115	27,449	140,564	30,386	77,723	21,810	510,315	192,070	832,305	972,869	19,630	65,100	78,589	11,945	167,400	695,304
November	4,818	2,066	6,883	29,406	75,216	21,107	493,853	185,875	805,457	812,340	13,635	54,000	3,502	9,909	162,000	623,293
December	0	0	0	30,386	77,723	21,810	510,315	192,070	832,305	832,305	27,530	46,500	0	8,533	167,400	628,842
January	0	0	0	30,386	77,723	21,810	510,315	192,070	832,305	832,305	12,628	46,500	0	8,533	167,400	643,744
February	0	0	0	27,445	70,202	6,569	460,930	169,544	734,690	734,690	10,059	42,000	0	7,707	151,200	565,724
March	111	20	131	30,386	77,723	21,810	510,315	192,070	832,305	832,436	12,130	55,800	0	10,240	167,400	642,666
April	24,336	7,124	31,460	29,406	75,216	21,107	493,853	185,875	805,457	836,917	21,698	63,000	23,403	11,560	162,000	618,255
May	383,919	78,714	462,633	30,386	77,723	21,810	510,315	192,070	832,305	1,294,938	41,115	74,400	294,169	13,652	167,400	778,602
June	917,877	170,735	1,088,612	29,406	75,216	21,107	493,853	185,875	805,457	1,894,069	31,264	81,000	715,006	14,863	162,000	970,936
July	1,039,810	186,783	1,226,593	30,386	77,723	7,273	510,315	187,709	813,407	2,040,000	30,378	93,000	613,367	17,065	167,400	1,211,789
August	720,935	137,653	858,588	30,386	77,723	7,273	510,315	187,709	813,407	1,671,995	26,020	93,000	515,901	17,065	167,400	945,608
September	394,744	82,874	477,618	29,406	75,216	7,038	493,853	181,654	787,168	1,264,786	22,353	72,000	145,532	13,212	162,000	921,689
Total	3,599,665	693,417	4,293,082	357,769	915,128	200,525	6,008,551	2,244,592	9,726,565	14,019,647	268,440	786,300	2,389,469	144,286	1,971,000	9,246,451

APPENDIX IIA

Summary of Water Budget of TRNC and its Components on Regional and Monthly Bases, Year 2012

	Agricultural Use			Domestic Use						Total	Available Resources					Gr. Water
LMR	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel Sanitary Water	Desalination	Extraction
C. Nicosia	594,653	106,266	700,919	116,304	58,546	681,434	6,948,894	2,341,553	10,146,731	10,847,650	0	7,863,000	695,814	0	0	5,105
Değirmenlik	1,148,400	245,264	1,393,664	231,899	0	0	2,012,795	673,408	2,918,102	4,311,766	20,725	0	69,826	0	0	4,221,215
Ercan	1,081,301	306,929	1,388,230	340,717	0	0	100,256	132,292	573,265	1,961,495	0	0	0	0	0	1,961,495
Guzelyurt	32,607,036	6,136,255	38,743,291	177,596	13,578	76,388	10,028,502	3,088,819	13,384,883	52,128,174	0	157,260	0	3,617	0	62,171,984
Lefke	13,540,591	2,757,224	16,297,815	73,458	3,066	99,643	665,814	252,594	1,094,575	17,392,390	0	0	3,263,035	0	0	14,129,355
Total	48,971,981	9,551,938	58,523,919	939,974	75,190	857,465	19,756,261	6,488,667	28,117,556	86,641,475	20,725	8,020,260	4,028,675	3,617	0	82,489,154
MMR																
Magusa A	1,948,098	368,314	2,316,412	97,278	113,223	374,885	3,661,294	1,274,004	5,520,684	7,837,096	0	786,300	0	25,162	2,828,750	4,983,184
Magusa B	664,171	251,128	915,299	99,692	0	0	522,082	186,532	808,306	1,723,605	0	0	0	0	0	1,723,605
Akdogan	2,275,422	753,929	3,029,351	360,405	0	0	533,375	268,134	1,161,914	4,191,265	0	0	0	0	0	4,191,265
Y. Eronkoy	1,212,579	327,121	1,539,699	216,319	24,163	0	818,844	317,798	1,377,124	2,916,823	0	0	0	2,097	109,500	2,805,226
Mehmetcik	439,445	80,998	520,443	116,705	205,130	0	406,494	218,499	946,828	1,467,271	6,780	0	520,443	40,836	730,000	174,042
Y. Iskele	604,886	117,134	722,020	169,942	58,254	0	918,113	343,893	1,490,201	2,212,221	47,181	0	71,087	10,588	182,500	1,900,866
Gönendere	167,742	43,839	211,581	96,212	0	0	427,368	157,074	680,654	892,235	14,205	0	211,581	0	0	666,449
Geçitkale	376,723	89,363	466,086	131,028	0	0	148,945	83,992	363,964	830,050	30,231	0	0	0	0	799,819
Total	7,689,065	2,031,826	9,720,891	1,287,581	400,770	374,885	7,436,515	2,849,925	12,349,677	22,070,568	98,397	786,300	803,111	78,683	3,850,750	17,244,457
GMR																
Girne East	1,262,478	240,746	1,503,224	78,751	578,963	224,097	3,097,559	1,193,811	5,173,180	6,676,404	14,250	786,300	600,481	111,993	1,788,500	4,161,180
Gine West	2,512,116	448,706	2,960,822	24,086	336,165	0	2,004,349	709,380	3,073,980	6,034,802	108,742	0	0	32,291	182,500	5,726,769
Bogaz	340,687	60,122	400,808	129,091	0	0	754,165	264,977	1,148,233	1,549,041	2,033	0	137,153	0	0	1,409,855
Camlibel	1,403,367	282,390	1,685,756	160,467	0	0	223,445	115,173	499,085	2,184,841	156,403	0	1,556,784	0	0	471,654
Total	5,518,647	1,031,963	6,550,610	392,395	915,128	224,097	6,079,517	2,283,341	9,894,478	16,445,088	281,428	786,300	2,294,418	144,284	1,971,000	11,769,458
TRNC																
October	4,015,921	959,158	4,975,079	222,516	118,147	163,538	2,849,053	1,005,976	4,359,231	9,334,310	34,184	794,220	568,144	18,759	494,450	8,210,839
November	477,527	178,722	656,248	215,338	114,336	158,262	2,757,148	973,525	4,218,609	4,874,857	34,316	658,800	169,037	15,560	478,500	4,168,782
December	0	0	0	222,516	118,147	163,538	2,849,053	1,005,976	4,359,231	4,359,231	51,022	567,300	0	13,400	494,450	3,791,925
January	0	0	0	222,516	118,147	163,538	2,849,053	1,005,976	4,359,231	4,359,231	44,775	567,300	0	13,400	494,450	3,799,672
February	0	0	0	200,982	106,714	53,148	2,524,524	865,610	3,750,978	3,750,978	19,439	512,400	0	12,103	446,600	3,263,718
March	128,136	25,507	153,643	222,516	118,147	147,325	2,832,841	996,249	4,317,079	4,470,722	16,897	680,760	39,498	16,081	494,450	3,895,862
April	3,644,447	773,571	4,418,018	215,338	114,336	142,572	2,741,459	964,112	4,177,817	8,595,835	24,258	768,600	887,082	18,154	478,500	7,179,179
May	6,873,538	1,546,109	8,419,647	222,516	118,147	147,325	2,832,841	996,249	4,317,079	12,736,726	51,209	907,680	2,070,536	21,439	494,450	10,091,158
June	12,536,907	2,378,553	14,915,460	215,338	114,336	142,572	2,741,459	964,112	4,177,817	19,093,277	33,955	988,200	1,688,964	23,342	478,500	16,859,854
July	14,531,122	2,670,205	17,201,326	222,516	118,147	58,842	2,795,008	958,354	4,152,869	21,354,195	36,060	1,134,600	1,031,502	26,799	494,450	19,761,779
August	12,758,361	2,492,672	15,251,033	222,516	118,147	58,842	2,795,008	958,354	4,152,869	19,403,902	30,274	1,134,600	603,052	26,799	494,450	18,241,393
September	7,213,734	1,591,232	8,804,966	215,338	114,336	56,944	2,704,847	927,440	4,018,905	12,823,871	24,161	878,400	68,389	20,748	478,500	12,238,911
Total	62,179,693	12,615,727	74,795,420	2,619,950	1,391,088	1,456,446	33,272,294	11,621,933	50,361,711	125,157,131	400,550	9,592,860	7,126,204	226,584	5,821,750	111,503,069

APPENDIX IIB

Water budget of Central Nicosia Region on Monthly Bases, Year 2012

Central	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					
Nicosia Region	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Gr. Water
region																Extraction
October	455	195	650	9,878	4,972	81,062	590,180	205,828	891,920	892,570	0	651,000	650	0	0	0
November	0	0	0	9,559	4,812	78,447	571,142	199,188	863,148	863,148	0	540,000	0	0	0	0
December	0	0	0	9,878	4,972	81,062	590,180	205,828	891,920	891,920	0	465,000	0	0	0	0
January	0	0	0	9,878	4,972	81,062	590,180	205,828	891,920	891,920	0	465,000	0	0	0	0
February	0	0	0	8,922	4,491	24,403	533,066	171,265	742,147	742,147	0	420,000	0	0	0	0
March	0	0	0	9,878	4,972	64,850	590,180	200,964	870,844	870,844	0	558,000	0	0	0	0
April	1,057	259	1,316	9,559	4,812	62,758	571,142	194,481	842,752	844,068	0	630,000	1,316	0	0	0
May	44,768	8,188	52,956	9,878	4,972	64,850	590,180	200,964	870,844	923,800	0	744,000	52,956	0	0	0
June	210,291	37,315	247,606	9,559	4,812	62,758	571,142	194,481	842,752	1,090,358	0	810,000	247,606	0	0	0
July	221,816	39,192	261,008	9,878	4,972	27,018	590,180	189,614	821,662	1,082,670	0	930,000	261,008	0	0	0
August	112,192	20,086	132,278	9,878	4,972	27,018	590,180	189,614	821,662	953,940	0	930,000	132,278	0	0	0
September	4,074	1,031	5,105	9,559	4,812	26,146	571,142	183,498	795,157	800,262	0	720,000	0	0	0	5,105
Total	594,653	106,266	700,919	116,304	58,546	681,434	6,948,894	2,341,553	10,146,731	10,847,650	0	7,863,000	695,814	0	0	5,105

APPENDIX IIC

Water Budget of Değirmenlik Region on Monthly Bases, Year 2012

Değirmenlik	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	31,687	11,241	42,928	19,696	0	0	170,950	57,194	247,839	290,767	1,936	0	42,928	0	0	245,903
November	8,230	2,035	10,265	19,060	0	0	165,435	55,349	239,844	250,109	2,126	0	10,265	0	0	237,718
December	0	0	0	19,696	0	0	170,950	57,194	247,839	247,839	2,419	0	0	0	0	245,420
January	0	0	0	19,696	0	0	170,950	57,194	247,839	247,839	3,877	0	0	0	0	243,962
February	0	0	0	17,790	0	0	154,406	51,659	223,854	223,854	1,525	0	0	0	0	222,329
March	10,400	1,835	12,235	19,696	0	0	170,950	57,194	247,839	260,074	1,137	0	12,235	0	0	246,702
April	12,198	2,260	14,457	19,060	0	0	165,435	55,349	239,844	254,301	1,078	0	4,398	0	0	248,825
May	67,902	16,864	84,765	19,696	0	0	170,950	57,194	247,839	332,604	2,044	0	0	0	0	330,560
June	308,557	61,406	369,963	19,060	0	0	165,435	55,349	239,844	609,807	1,059	0	0	0	0	608,748
July	348,225	69,627	417,852	19,696	0	0	170,950	57,194	247,839	665,691	1,313	0	0	0	0	664,378
August	280,970	57,805	338,775	19,696	0	0	170,950	57,194	247,839	586,614	1,270	0	0	0	0	585,344
September	80,232	22,192	102,424	19,060	0	0	165,435	55,349	239,844	342,268	941	0	0	0	0	341,327
Total	1,148,400	245,264	1,393,664	231,899	0	0	2,012,795	673,408	2,918,102	4,311,766	20,725	0	69,826	0	0	4,221,215

APPENDIX IID

Water Budget of Ercan Region on Monthly Bases, Year 2012

Ercan	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	37,949	16,264	54,213	28,938	0	0	8,515	11,236	48,688	102,901	0	0	0	0	0	102,901
November	147	63	210	28,004	0	0	8,240	10,873	47,118	47,328	0	0	0	0	0	47,328
December	0	0	0	28,938	0	0	8,515	11,236	48,688	48,688	0	0	0	0	0	48,688
January	0	0	0	28,938	0	0	8,515	11,236	48,688	48,688	0	0	0	0	0	48,688
February	0	0	0	26,137	0	0	7,691	10,148	43,976	43,976	0	0	0	0	0	43,976
March	0	0	0	28,938	0	0	8,515	11,236	48,688	48,688	0	0	0	0	0	48,688
April	4,105	1,528	5,633	28,004	0	0	8,240	10,873	47,118	52,751	0	0	0	0	0	52,751
May	107,564	35,434	142,998	28,938	0	0	8,515	11,236	48,688	191,686	0	0	0	0	0	191,686
June	283,240	72,050	355,290	28,004	0	0	8,240	10,873	47,118	402,408	0	0	0	0	0	402,408
July	315,428	80,306	395,734	28,938	0	0	8,515	11,236	48,688	444,422	0	0	0	0	0	444,422
August	234,544	65,604	300,148	28,938	0	0	8,515	11,236	48,688	348,836	0	0	0	0	0	348,836
September	98,324	35,680	134,004	28,004	0	0	8,240	10,873	47,118	181,122	0	0	0	0	0	181,122
Total	1,081,301	306,929	1,388,230	340,717	0	0	100,256	132,292	573,265	1,961,495	0	0	0	0	0	1,961,495

APPENDIX IIE

Water Budget of Guzelyurt Region on Monthly Bases, Year 2012

Guzelyurt	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	2,493,640	500,612	2,994,252	15,084	1,153	6,488	874,923	269,294	1,166,941	4,161,193	0	13,020	0	299	0	5,044,381
November	118,113	46,152	164,265	14,597	1,116	6,278	846,699	260,607	1,129,298	1,293,563	0	10,800	0	248	0	2,148,301
December	0	0	0	15,084	1,153	6,488	874,923	269,294	1,166,941	1,166,941	0	9,300	0	214	0	2,050,214
January	0	0	0	15,084	1,153	6,488	874,923	269,294	1,166,941	1,166,941	0	9,300	0	214	0	2,050,214
February	0	0	0	13,624	1,042	5,860	741,439	228,589	990,553	990,553	0	8,400	0	193	0	1,724,889
March	27,610	5,462	33,072	15,084	1,153	6,488	858,711	264,430	1,145,865	1,178,937	0	11,160	0	257	0	2,041,091
April	2,466,687	459,248	2,925,934	14,597	1,116	6,278	831,010	255,900	1,108,902	4,034,836	0	12,600	0	290	0	4,869,136
May	3,835,807	745,285	4,581,092	15,084	1,153	6,488	858,711	264,430	1,145,865	5,726,957	0	14,880	0	342	0	6,589,026
June	5,789,998	1,070,039	6,860,037	14,597	1,116	6,278	831,010	255,900	1,108,902	7,968,939	0	16,200	0	373	0	8,803,156
July	6,970,766	1,251,725	8,222,491	15,084	1,153	6,488	820,878	253,081	1,096,683	9,319,174	0	18,600	0	428	0	10,131,975
August	6,474,227	1,198,421	7,672,648	15,084	1,153	6,488	820,878	253,081	1,096,683	8,769,331	0	18,600	0	428	0	9,582,132
September	4,430,188	859,312	5,289,500	14,597	1,116	6,278	794,398	244,917	1,061,307	6,350,807	0	14,400	0	331	0	7,137,471
Total	32,607,036	6,136,255	38,743,291	177,596	13,578	76,388	10,028,502	3,088,819	13,384,883	52,128,174	0	157,260	0	3,617	0	62,171,984

APPENDIX IIF

Water Budget of Lefke Region on Monthly Bases, Year 2012

Lefke	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	804,028	203,448	1,007,475	6,239	260	10,838	56,549	22,166	96,052	1,103,527	0	0	426,173	0	0	677,354
November	99,489	40,715	140,204	6,038	252	10,488	54,724	21,451	92,953	233,157	0	0	140,204	0	0	92,953
December	0	0	0	6,239	260	10,838	56,549	22,166	96,052	96,052	0	0	0	0	0	96,052
January	0	0	0	6,239	260	10,838	56,549	22,166	96,052	96,052	0	0	0	0	0	96,052
February	0	0	0	5,635	235	3,263	51,076	18,063	78,272	78,272	0	0	0	0	0	78,272
March	3,863	1,268	5,131	6,239	260	10,838	56,549	22,166	96,052	101,183	0	0	5,131	0	0	96,052
April	658,651	137,590	796,240	6,038	252	10,488	54,724	21,451	92,953	889,193	0	0	796,240	0	0	92,953
May	1,338,130	299,079	1,637,209	6,239	260	10,838	56,549	22,166	96,052	1,733,261	0	0	1,637,209	0	0	96,052
June	2,972,532	567,546	3,540,078	6,038	252	10,488	54,724	21,451	92,953	3,633,031	0	0	258,078	0	0	3,374,953
July	3,353,546	605,616	3,959,162	6,239	260	3,613	56,549	19,998	86,659	4,045,821	0	0	0	0	0	4,045,821
August	2,910,056	571,301	3,481,357	6,239	260	3,613	56,549	19,998	86,659	3,568,016	0	0	0	0	0	3,568,016
September	1,400,297	330,662	1,730,959	6,038	252	3,496	54,724	19,353	83,863	1,814,822	0	0	0	0	0	1,814,822
Total	13,540,591	2,757,224	16,297,815	73,458	3,066	99,643	665,814	252,594	1,094,575	17,392,390	0	0	3,263,035	0	0	14,129,355

APPENDIX IIG

Summary of Water budget for Nicosia Main Region on Monthly Bases, Year 2012

Nicosia	Agricultural Use (cubic meter)			Domestic Use (cubic meter)						Total	Available Resources					Gr. Water
Main Region	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	3,367,759	731,759	4,099,518	79,833	6,386	98,388	1,701,116	565,717	2,451,441	6,550,959	1,936	664,020	469,751	299	0	6,070,539
November	225,979	88,965	314,944	77,258	6,180	95,214	1,646,241	547,468	2,372,361	2,687,305	2,126	550,800	150,469	248	0	2,526,300
December	0	0	0	79,833	6,386	98,388	1,701,116	565,717	2,451,441	2,451,441	2,419	474,300	0	214	0	2,440,374
January	0	0	0	79,833	6,386	98,388	1,701,116	565,717	2,451,441	2,451,441	3,877	474,300	0	214	0	2,438,916
February	0	0	0	72,108	5,768	33,526	1,487,678	479,724	2,078,803	2,078,803	1,525	428,400	0	193	0	2,069,467
March	41,873	8,565	50,438	79,833	6,386	82,176	1,684,904	555,990	2,409,289	2,459,727	1,137	569,160	17,366	257	0	2,432,533
April	3,142,697	600,884	3,743,580	77,258	6,180	79,525	1,630,552	538,054	2,331,569	6,075,149	1,078	642,600	801,954	290	0	5,263,665
May	5,394,170	1,104,850	6,499,020	79,833	6,386	82,176	1,684,904	555,990	2,409,289	8,908,309	2,044	758,880	1,690,165	342	0	7,207,324
June	9,564,618	1,808,356	11,372,974	77,258	6,180	79,525	1,630,552	538,054	2,331,569	13,704,543	1,059	826,200	505,684	373	0	13,189,265
July	11,209,780	2,046,467	13,256,247	79,833	6,386	37,118	1,647,071	531,123	2,301,532	15,557,779	1,313	948,600	261,008	428	0	15,286,596
August	10,011,989	1,913,217	11,925,206	79,833	6,386	37,118	1,647,071	531,123	2,301,532	14,226,738	1,270	948,600	132,278	428	0	14,084,328
September	6,013,115	1,248,877	7,261,992	77,258	6,180	35,921	1,593,940	513,990	2,227,289	9,489,281	941	734,400	0	331	0	9,479,847
Total	48,971,981	9,551,938	58,523,919	939,974	75,190	857,465	19,756,261	6,488,667	28,117,556	86,641,475	20,725	8,020,260	4,028,675	3,617	0	82,489,154

APPENDIX IIH

Water Budget of Famagusta Region A on Monthly Bases, Year 2012

Famagusta A	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	64,099	15,588	79,686	8,262	9,616	40,777	310,959	110,884	480,499	560,185	0	65,100	0	2,083	240,250	317,852
November	33,406	6,668	40,073	7,995	9,306	39,462	300,928	107,307	464,999	505,072	0	54,000	0	1,728	232,500	270,844
December	0	0	0	8,262	9,616	40,777	310,959	110,884	480,499	480,499	0	46,500	0	1,488	240,250	238,761
January	0	0	0	8,262	9,616	40,777	310,959	110,884	480,499	480,499	0	46,500	0	1,488	240,250	238,761
February	0	0	0	7,462	8,686	12,277	280,866	92,787	402,079	402,079	0	42,000	0	1,344	217,000	183,735
March	35,868	6,897	42,764	8,262	9,616	40,777	310,959	110,884	480,499	523,263	0	55,800	0	1,786	240,250	281,227
April	69,741	14,206	83,946	7,995	9,306	39,462	300,928	107,307	464,999	548,945	0	63,000	0	2,016	232,500	314,429
May	159,986	31,183	191,168	8,262	9,616	40,777	310,959	110,884	480,499	671,667	0	74,400	0	2,381	240,250	429,036
June	473,779	86,383	560,162	7,995	9,306	39,462	300,928	107,307	464,999	1,025,161	0	81,000	0	2,592	232,500	790,069
July	547,987	98,712	646,699	8,262	9,616	13,592	310,959	102,729	445,159	1,091,858	0	93,000	0	2,976	240,250	848,632
August	442,473	81,889	524,361	8,262	9,616	13,592	310,959	102,729	445,159	969,520	0	93,000	0	2,976	240,250	726,294
September	120,762	26,791	147,553	7,995	9,306	13,154	300,928	99,415	430,799	578,352	0	72,000	0	2,304	232,500	343,548
Total	1,948,098	368,314	2,316,412	97,278	113,223	374,885	3,661,294	1,274,004	5,520,684	7,837,096	0	786,300	0	25,162	2,828,750	4,983,184

APPENDIX IIi

Water Budget of Famagusta Region B on Monthly Bases, Year 2012

Famagusta B	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	152,770	64,781	217,551	8,467	0	0	44,341	15,842	68,651	286,202	0	0	0	0	0	286,202
November	79,834	34,215	114,049	8,194	0	0	42,911	15,331	66,436	180,485	0	0	0	0	0	180,485
December	0	0	0	8,467	0	0	44,341	15,842	68,651	68,651	0	0	0	0	0	68,651
January	0	0	0	8,467	0	0	44,341	15,842	68,651	68,651	0	0	0	0	0	68,651
February	0	0	0	7,648	0	0	40,050	14,309	62,007	62,007	0	0	0	0	0	62,007
March	85	37	121	8,467	0	0	44,341	15,842	68,651	68,772	0	0	0	0	0	68,772
April	1,783	421	2,203	8,194	0	0	42,911	15,331	66,436	68,639	0	0	0	0	0	68,639
May	13,059	2,510	15,569	8,467	0	0	44,341	15,842	68,651	84,220	0	0	0	0	0	84,220
June	35,269	6,361	41,630	8,194	0	0	42,911	15,331	66,436	108,066	0	0	0	0	0	108,066
July	71,197	20,235	91,432	8,467	0	0	44,341	15,842	68,651	160,083	0	0	0	0	0	160,083
August	144,069	53,640	197,709	8,467	0	0	44,341	15,842	68,651	266,360	0	0	0	0	0	266,360
September	166,106	68,929	235,035	8,194	0	0	42,911	15,331	66,436	301,471	0	0	0	0	0	301,471
Total	664,171	251,128	915,299	99,692	0	0	522,082	186,532	808,306	1,723,605	0	0	0	0	0	1,723,605

APPENDIX IIJ

Water Budget of Akdogan Region on Monthly Bases, Year 2012

Akdogan	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	234,659	91,950	326,609	30,610	0	0	45,300	22,773	98,683	425,292	0	0	0	0	0	425,292
November	93,228	35,571	128,799	29,622	0	0	43,839	22,038	95,500	224,299	0	0	0	0	0	224,299
December	0	0	0	30,610	0	0	45,300	22,773	98,683	98,683	0	0	0	0	0	98,683
January	0	0	0	30,610	0	0	45,300	22,773	98,683	98,683	0	0	0	0	0	98,683
February	0	0	0	27,647	0	0	40,916	20,569	89,133	89,133	0	0	0	0	0	89,133
March	22,556	4,809	27,364	30,610	0	0	45,300	22,773	98,683	126,047	0	0	0	0	0	126,047
April	201,592	76,798	278,389	29,622	0	0	43,839	22,038	95,500	373,889	0	0	0	0	0	373,889
May	427,227	164,978	592,205	30,610	0	0	45,300	22,773	98,683	690,888	0	0	0	0	0	690,888
June	321,655	84,536	406,191	29,622	0	0	43,839	22,038	95,500	501,691	0	0	0	0	0	501,691
July	326,722	80,643	407,365	30,610	0	0	45,300	22,773	98,683	506,048	0	0	0	0	0	506,048
August	353,900	105,658	459,558	30,610	0	0	45,300	22,773	98,683	558,241	0	0	0	0	0	558,241
September	293,884	108,987	402,871	29,622	0	0	43,839	22,038	95,500	498,371	0	0	0	0	0	498,371
Total	2,275,422	753,929	3,029,351	360,405	0	0	533,375	268,134	1,161,914	4,191,265	0	0	0	0	0	4,191,265

APPENDIX IIK

Water Budget of Yeni Eronkoy Region on Monthly Bases, Year 2012

Y. Eronkoy	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	20,940	7,275	28,215	18,372	2,052	0	69,546	26,991	116,961	145,176	0	0	0	174	9,300	135,702
November	2,171	930	3,101	17,780	1,986	0	67,302	26,120	113,188	116,289	0	0	0	144	9,000	107,145
December	0	0	0	18,372	2,052	0	69,546	26,991	116,961	116,961	0	0	0	124	9,300	107,537
January	0	0	0	18,372	2,052	0	69,546	26,991	116,961	116,961	0	0	0	124	9,300	107,537
February	0	0	0	16,594	1,854	0	62,815	24,379	105,642	105,642	0	0	0	112	8,400	97,130
March	476	204	680	18,372	2,052	0	69,546	26,991	116,961	117,641	0	0	0	149	9,300	108,192
April	131,003	54,901	185,903	17,780	1,986	0	67,302	26,120	113,188	299,091	0	0	0	168	9,000	289,923
May	320,702	121,410	442,112	18,372	2,052	0	69,546	26,991	116,961	559,073	0	0	0	198	9,300	549,575
June	227,875	43,919	271,794	17,780	1,986	0	67,302	26,120	113,188	384,982	0	0	0	216	9,000	375,766
July	241,582	43,054	284,636	18,372	2,052	0	69,546	26,991	116,961	401,597	0	0	0	248	9,300	392,049
August	179,413	34,827	214,240	18,372	2,052	0	69,546	26,991	116,961	331,201	0	0	0	248	9,300	321,653
September	88,417	20,601	109,018	17,780	1,986	0	67,302	26,120	113,188	222,206	0	0	0	192	9,000	213,014
Total	1,212,579	327,121	1,539,699	216,319	24,163	0	818,844	317,798	1,377,124	2,916,823	0	0	0	2,097	109,500	2,805,226

APPENDIX IIL

Water Budget of Mehmetcik Region on Monthly Bases, Year 2012

Mehmetcik	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	2,679	760	3,439	9,912	17,422	0	34,524	18,557	80,416	83,855	157	0	3,439	3,381	62,000	14,878
November	1,247	273	1,520	9,592	16,860	0	33,410	17,959	77,822	79,342	560	0	1,520	2,804	60,000	14,458
December	0	0	0	9,912	17,422	0	34,524	18,557	80,416	80,416	277	0	0	2,415	62,000	15,724
January	0	0	0	9,912	17,422	0	34,524	18,557	80,416	80,416	3,352	0	0	2,415	62,000	12,649
February	0	0	0	8,953	15,736	0	31,183	16,762	72,633	72,633	849	0	0	2,181	56,000	13,603
March	1,536	369	1,904	9,912	17,422	0	34,524	18,557	80,416	82,320	418	0	1,904	2,898	62,000	15,100
April	4,943	1,597	6,539	9,592	16,860	0	33,410	17,959	77,822	84,361	203	0	6,539	3,272	60,000	14,347
May	36,137	7,554	43,691	9,912	17,422	0	34,524	18,557	80,416	124,107	249	0	43,691	3,864	62,000	14,303
June	118,727	21,164	139,891	9,592	16,860	0	33,410	17,959	77,822	217,713	218	0	139,891	4,207	60,000	13,397
July	135,285	23,928	159,213	9,912	17,422	0	34,524	18,557	80,416	239,629	220	0	159,213	4,830	62,000	18,196
August	111,888	20,108	131,996	9,912	17,422	0	34,524	18,557	80,416	212,412	179	0	131,996	4,830	62,000	13,407
September	27,004	5,246	32,250	9,592	16,860	0	33,410	17,959	77,822	110,072	98	0	32,250	3,739	60,000	13,985
Total	439,445	80,998	520,443	116,705	205,130	0	406,494	218,499	946,828	1,467,271	6,780	0	520,443	40,836	730,000	174,042

APPENDIX IIM

Water Budget of Yeni Iskele Region on Monthly Bases, Year 2012

Y. Iskele	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	34,087	7,666	41,753	14,433	4,948	0	77,977	29,207	126,565	168,318	2,994	0	0	877	15,500	148,947
November	16,630	3,284	19,914	13,968	4,788	0	75,461	28,265	122,482	142,396	5,748	0	4,011	727	15,000	116,911
December	0	0	0	14,433	4,948	0	77,977	29,207	126,565	126,565	5,393	0	0	626	15,500	105,046
January	0	0	0	14,433	4,948	0	77,977	29,207	126,565	126,565	10,727	0	0	626	15,500	99,712
February	0	0	0	13,037	4,469	0	70,431	26,381	114,317	114,317	3,894	0	0	566	14,000	95,857
March	17,172	3,101	20,273	14,433	4,948	0	77,977	29,207	126,565	146,838	2,918	0	20,228	751	15,500	107,441
April	38,429	8,458	46,886	13,968	4,788	0	75,461	28,265	122,482	169,368	2,256	0	46,848	848	15,000	104,416
May	44,704	11,272	55,976	14,433	4,948	0	77,977	29,207	126,565	182,541	4,751	0	0	1,002	15,500	161,288
June	116,197	21,736	137,933	13,968	4,788	0	75,461	28,265	122,482	260,415	2,421	0	0	1,091	15,000	241,903
July	123,602	21,812	145,414	14,433	4,948	0	77,977	29,207	126,565	271,979	2,324	0	0	1,252	15,500	252,903
August	133,578	24,022	157,600	14,433	4,948	0	77,977	29,207	126,565	284,165	2,220	0	0	1,252	15,500	265,193
September	80,487	15,784	96,271	13,968	4,788	0	75,461	28,265	122,482	218,753	1,535	0	0	970	15,000	201,248
Total	604,886	117,134	722,020	169,942	58,254	0	918,113	343,893	1,490,201	2,212,221	47,181	0	71,087	10,588	182,500	1,900,866

APPENDIX IIN

Water Budget of Gönendere Region on Monthly Bases, Year 2012

Gönendere	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	15,563	6,670	22,233	8,171	0	0	36,297	13,341	57,809	80,042	903	0	22,233	0	0	56,906
November	7,707	3,303	11,010	7,908	0	0	35,126	12,910	55,944	66,954	1,696	0	11,010	0	0	54,248
December	0	0	0	8,171	0	0	36,297	13,341	57,809	57,809	1,354	0	0	0	0	56,455
January	0	0	0	8,171	0	0	36,297	13,341	57,809	57,809	2,989	0	0	0	0	54,820
February	0	0	0	7,381	0	0	32,784	12,050	52,215	52,215	1,072	0	0	0	0	51,143
March	0	0	0	8,171	0	0	36,297	13,341	57,809	57,809	805	0	0	0	0	57,004
April	234	100	334	7,908	0	0	35,126	12,910	55,944	56,278	703	0	334	0	0	55,241
May	8,350	1,709	10,059	8,171	0	0	36,297	13,341	57,809	67,868	1,479	0	10,059	0	0	56,330
June	31,906	5,789	37,695	7,908	0	0	35,126	12,910	55,944	93,639	830	0	37,695	0	0	55,114
July	37,472	7,368	44,840	8,171	0	0	36,297	13,341	57,809	102,649	894	0	44,840	0	0	56,915
August	39,378	9,893	49,271	8,171	0	0	36,297	13,341	57,809	107,080	888	0	49,271	0	0	56,921
September	27,132	9,007	36,139	7,908	0	0	35,126	12,910	55,944	92,083	592	0	36,139	0	0	55,352
Total	167,742	43,839	211,581	96,212	0	0	427,368	157,074	680,654	892,235	14,205	0	211,581	0	0	666,449

APPENDIX IIO

Water Budget of Geçitkale Region on Monthly Bases, Year 2012

Geçitkale	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	26,829	8,366	35,195	11,128	0	0	12,650	7,134	30,912	66,107	2,322	0	0	0	0	63,785
November	12,603	3,489	16,092	10,769	0	0	12,242	6,903	29,915	46,007	4,933	0	0	0	0	41,074
December	0	0	0	11,128	0	0	12,650	7,134	30,912	30,912	3,308	0	0	0	0	27,604
January	0	0	0	11,128	0	0	12,650	7,134	30,912	30,912	7,683	0	0	0	0	23,229
February	0	0	0	10,051	0	0	11,426	6,443	27,921	27,921	2,862	0	0	0	0	25,059
March	8,461	1,507	9,968	11,128	0	0	12,650	7,134	30,912	40,880	3,371	0	0	0	0	37,509
April	26,599	7,368	33,966	10,769	0	0	12,242	6,903	29,915	63,881	1,174	0	0	0	0	62,707
May	46,918	14,479	61,397	11,128	0	0	12,650	7,134	30,912	92,309	2,219	0	0	0	0	90,090
June	74,473	14,527	89,000	10,769	0	0	12,242	6,903	29,915	118,915	771	0	0	0	0	118,144
July	75,552	13,891	89,443	11,128	0	0	12,650	7,134	30,912	120,355	731	0	0	0	0	119,624
August	61,053	13,597	74,649	11,128	0	0	12,650	7,134	30,912	105,561	547	0	0	0	0	105,014
September	44,236	12,140	56,376	10,769	0	0	12,242	6,903	29,915	86,291	310	0	0	0	0	85,981
Total	376,723	89,363	466,086	131,028	0	0	148,945	83,992	363,964	830,050	30,231	0	0	0	0	799,819

APPENDIX IIP

Summary Water Budget for Famagusta Main Region on Monthly Bases, Year 2012

Famagusta	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
Main Region	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	551,626	203,056	754,681	109,356	34,038	40,777	631,594	244,730	1,060,495	1,815,176	6,376	65,100	25,672	6,515	327,050	1,449,563
November	246,826	87,733	334,558	105,829	32,940	39,462	611,220	236,835	1,026,286	1,360,844	12,937	54,000	16,541	5,403	316,500	1,009,463
December	0	0	0	109,356	34,038	40,777	631,594	244,730	1,060,495	1,060,495	10,332	46,500	0	4,653	327,050	718,460
January	0	0	0	109,356	34,038	40,777	631,594	244,730	1,060,495	1,060,495	24,751	46,500	0	4,653	327,050	704,041
February	0	0	0	98,773	30,744	12,277	570,472	213,680	925,947	925,947	8,677	42,000	0	4,203	295,400	617,667
March	86,152	16,922	103,074	109,356	34,038	40,777	631,594	244,730	1,060,495	1,163,569	7,512	55,800	22,132	5,584	327,050	801,291
April	474,321	163,846	638,166	105,829	32,940	39,462	611,220	236,835	1,026,286	1,664,452	4,336	63,000	53,721	6,304	316,500	1,283,591
May	1,057,083	355,095	1,412,177	109,356	34,038	40,777	631,594	244,730	1,060,495	2,472,672	8,698	74,400	53,750	7,445	327,050	2,075,729
June	1,399,881	284,415	1,684,296	105,829	32,940	39,462	611,220	236,835	1,026,286	2,710,582	4,240	81,000	177,586	8,106	316,500	2,204,150
July	1,559,399	309,643	1,869,042	109,356	34,038	13,592	631,594	236,574	1,025,155	2,894,197	4,169	93,000	204,053	9,306	327,050	2,354,449
August	1,465,751	343,633	1,809,384	109,356	34,038	13,592	631,594	236,574	1,025,155	2,834,539	3,834	93,000	181,267	9,306	327,050	2,313,082
September	848,028	267,485	1,115,513	105,829	32,940	13,154	611,220	228,943	992,086	2,107,599	2,535	72,000	68,389	7,205	316,500	1,712,970
Total	7,689,065	2,031,826	9,720,891	1,287,581	400,770	374,885	7,436,515	2,849,925	12,349,677	22,070,568	98,397	786,300	803,111	78,683	3,850,750	17,244,457

APPENDIX IIQ

Water Budget of Kyrenia East Region on Monthly Bases, Year 2012

Kyrenia	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
East	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	20,054	6,032	26,086	6,688	49,172	24,372	263,080	102,994	446,307	472,393	1,576	65,100	24,763	9,272	151,900	284,882
November	2,048	878	2,925	6,473	47,586	23,586	254,594	99,672	431,910	434,835	3,567	54,000	0	7,691	147,000	276,577
December	0	0	0	6,688	49,172	24,372	263,080	102,994	446,307	446,307	298	46,500	0	6,623	151,900	287,486
January	0	0	0	6,688	49,172	24,372	263,080	102,994	446,307	446,307	622	46,500	0	6,623	151,900	287,162
February	0	0	0	6,041	44,414	7,345	237,621	88,626	384,046	384,046	167	42,000	0	5,982	137,200	240,697
March	111	20	131	6,688	49,172	24,372	263,080	102,994	446,307	446,438	207	55,800	0	7,948	151,900	286,383
April	4,649	1,725	6,374	6,473	47,586	23,586	254,594	99,672	431,910	438,284	1,072	63,000	5,328	8,973	147,000	275,911
May	88,788	18,557	107,345	6,688	49,172	24,372	263,080	102,994	446,307	553,652	1,993	74,400	105,352	10,597	151,900	283,810
June	351,670	65,274	416,944	6,473	47,586	23,586	254,594	99,672	431,910	848,854	1,191	81,000	415,753	11,537	147,000	273,373
July	394,521	71,689	466,210	6,688	49,172	8,132	263,080	98,122	425,194	891,404	1,365	93,000	49,285	13,246	151,900	675,608
August	306,655	56,700	363,355	6,688	49,172	8,132	263,080	98,122	425,194	788,549	1,325	93,000	0	13,246	151,900	622,078
September	93,983	19,871	113,854	6,473	47,586	7,869	254,594	94,957	411,478	525,332	867	72,000	0	10,255	147,000	367,210
Total	1,262,478	240,746	1,503,224	78,751	578,963	224,097	3,097,559	1,193,811	5,173,180	6,676,404	14,250	786,300	600,481	111,993	1,788,500	4,161,180

APPENDIX IIR

Water Budget of Kyrenia West Region on Monthly Bases, Year 2012

Kyrenia	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
West	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	38,651	7,637	46,288	2,046	28,551	0	170,232	60,249	261,078	307,366	15,094	0	0	2,673	15,500	274,599
November	638	274	911	1,980	27,630	0	164,741	58,305	252,656	253,567	911	0	0	2,218	15,000	234,938
December	0	0	0	2,046	28,551	0	170,232	60,249	261,078	261,078	0	0	0	1,910	15,500	243,668
January	0	0	0	2,046	28,551	0	170,232	60,249	261,078	261,078	0	0	0	1,910	15,500	245,168
February	0	0	0	1,848	25,788	0	153,758	54,418	235,812	235,812	0	0	0	1,725	14,000	218,587
March	0	0	0	2,046	28,551	0	170,232	60,249	261,078	261,078	0	0	0	2,292	15,500	243,786
April	2,176	629	2,805	1,980	27,630	0	164,741	58,305	252,656	255,461	2,805	0	0	2,587	15,000	234,569
May	151,345	27,776	179,121	2,046	28,551	0	170,232	60,249	261,078	440,199	28,436	0	0	3,055	15,500	393,708
June	722,452	128,254	850,706	1,980	27,630	0	164,741	58,305	252,656	1,103,362	16,763	0	0	3,326	15,000	1,067,773
July	816,190	144,156	960,346	2,046	28,551	0	170,232	60,249	261,078	1,221,424	18,269	0	0	3,819	15,500	1,183,836
August	643,487	114,447	757,934	2,046	28,551	0	170,232	60,249	261,078	1,019,012	16,877	0	0	3,819	15,500	983,316
September	137,178	25,533	162,711	1,980	27,630	0	164,741	58,305	252,656	415,367	9,587	0	0	2,957	15,000	402,823
Total	2,512,116	448,706	2,960,822	24,086	336,165	0	2,004,349	709,380	3,073,980	6,034,802	108,742	0	0	32,291	182,500	5,726,769

APPENDIX IIS

Water Budget of Bogaz Region on Monthly Bases, Year 2012

Bogaz	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	0	0	0	10,964	0	0	64,052	22,505	97,521	97,521	184	0	0	0	0	97,337
November	0	0	0	10,610	0	0	61,986	21,779	94,375	94,375	298	0	0	0	0	94,077
December	0	0	0	10,964	0	0	64,052	22,505	97,521	97,521	211	0	0	0	0	97,310
January	0	0	0	10,964	0	0	64,052	22,505	97,521	97,521	413	0	0	0	0	97,108
February	0	0	0	9,903	0	0	57,854	20,327	88,084	88,084	164	0	0	0	0	87,920
March	0	0	0	10,964	0	0	64,052	22,505	97,521	97,521	75	0	0	0	0	97,446
April	0	0	0	10,610	0	0	61,986	21,779	94,375	94,375	26	0	0	0	0	94,349
May	18,793	3,316	22,109	10,964	0	0	64,052	22,505	97,521	119,630	201	0	21,908	0	0	97,521
June	98,050	17,303	115,353	10,610	0	0	61,986	21,779	94,375	209,728	108	0	115,245	0	0	94,375
July	112,099	19,783	131,881	10,964	0	0	64,052	22,505	97,521	229,402	135	0	0	0	0	229,267
August	89,590	15,810	105,400	10,964	0	0	64,052	22,505	97,521	202,921	131	0	0	0	0	202,790
September	22,155	3,910	26,065	10,610	0	0	61,986	21,779	94,375	120,440	87	0	0	0	0	120,353
Total	340,687	60,122	400,808	129,091	0	0	754,165	264,977	1,148,233	1,549,041	2,033	0	137,153	0	0	1,409,855

APPENDIX IIT

Water Budget of Camlibel Region on Monthly Bases, Year 2012

Camlibel	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	37,832	10,674	48,506	13,629	0	0	18,978	9,782	42,388	90,894	9,018	0	47,958	0	0	33,918
November	2,037	873	2,910	13,189	0	0	18,365	9,466	41,021	43,931	14,477	0	2,027	0	0	27,427
December	0	0	0	13,629	0	0	18,978	9,782	42,388	42,388	37,762	0	0	0	0	4,626
January	0	0	0	13,629	0	0	18,978	9,782	42,388	42,388	15,112	0	0	0	0	27,276
February	0	0	0	12,310	0	0	17,141	8,835	38,286	38,286	8,906	0	0	0	0	29,380
March	0	0	0	13,629	0	0	18,978	9,782	42,388	42,388	7,966	0	0	0	0	34,422
April	20,605	6,488	27,093	13,189	0	0	18,365	9,466	41,021	68,114	14,941	0	26,079	0	0	27,094
May	163,360	36,515	199,875	13,629	0	0	18,978	9,782	42,388	242,263	9,837	0	199,361	0	0	33,065
June	400,236	74,951	475,187	13,189	0	0	18,365	9,466	41,021	516,208	10,594	0	474,696	0	0	30,918
July	439,133	78,467	517,600	13,629	0	0	18,978	9,782	42,388	559,988	10,809	0	517,156	0	0	32,023
August	240,889	48,865	289,754	13,629	0	0	18,978	9,782	42,388	332,142	6,837	0	289,507	0	0	35,798
September	99,275	25,556	124,831	13,189	0	0	18,365	9,466	41,021	165,852	10,144	0	0	0	0	155,708
Total	1,403,367	282,390	1,685,756	160,467	0	0	223,445	115,173	499,085	2,184,841	156,403	0	1,556,784	0	0	471,654

APPENDIX IIU

Summary of Water Budget for Kyrenia Main Region on Monthly Bases, Year 2012

Kyrenia	Agricultural Use (m3)			Domestic Use (m3)						Total	Available Resources					Gr. Water
Main Region	Irrigation	Loss.	Total	Live Stock	Hotels	Universities	Houses	Loses	Total	Consumption	Springs	Sanitary	Dams	Hotel sanitary water	Desalination	Extraction
October	96,536	24,344	120,880	33,327	77,723	24,372	516,343	195,529	847,294	968,174	25,872	65,100	72,721	11,945	167,400	690,736
November	4,722	2,024	6,746	32,252	75,216	23,586	499,686	189,222	819,962	826,708	19,253	54,000	2,027	9,909	162,000	633,019
December	0	0	0	33,327	77,723	24,372	516,343	195,529	847,294	847,294	38,271	46,500	0	8,533	167,400	633,090
January	0	0	0	33,327	77,723	24,372	516,343	195,529	847,294	847,294	16,147	46,500	0	8,533	167,400	656,714
February	0	0	0	30,102	70,202	7,345	466,374	172,207	746,228	746,228	9,237	42,000	0	7,707	151,200	576,584
March	111	20	131	33,327	77,723	24,372	516,343	195,529	847,294	847,425	8,248	55,800	0	10,240	167,400	662,037
April	27,430	8,842	36,272	32,252	75,216	23,586	499,686	189,222	819,962	856,234	18,844	63,000	31,407	11,560	162,000	631,923
May	422,286	86,164	508,450	33,327	77,723	24,372	516,343	195,529	847,294	1,355,744	40,467	74,400	326,621	13,652	167,400	808,104
June	1,572,408	285,782	1,858,190	32,252	75,216	23,586	499,686	189,222	819,962	2,678,152	28,656	81,000	1,005,694	14,863	162,000	1,466,439
July	1,761,942	314,095	2,076,037	33,327	77,723	8,132	516,343	190,657	826,181	2,902,218	30,578	93,000	566,441	17,065	167,400	2,120,734
August	1,280,621	235,822	1,516,443	33,327	77,723	8,132	516,343	190,657	826,181	2,342,624	25,170	93,000	289,507	17,065	167,400	1,843,982
September	352,591	74,870	427,461	32,252	75,216	7,869	499,686	184,507	799,530	1,226,991	20,685	72,000	0	13,212	162,000	1,046,094
Total	5,518,647	1,031,963	6,550,610	392,395	915,128	224,097	6,079,517	2,283,341	9,894,478	16,445,088	281,428	786,300	2,294,418	144,284	1,971,000	11,769,458

APPENDIX III

Evaluation of Agricultural Economy Year 2011 and 2012

	2011							2012					
S/NO	CROPS	Cultivated Area (Donum)	Av. Water consumption m^3/Donum	Tot. Water consumption (m^3)	Incomes (USD)/ Donum	Total Incomes (USD)	Incomes (USD)/ (m^3)	Cultivated Area (Donum)	Av. Water consumption (m^3)/Donum	Tot. Water consumption (m^3)	Incomes (USD)/Donum	Tot. Incomes (USD)	Incomes (USD)/ (m^3)
1	Beans(Dry)	1561	416.58	650284.71	90.79	141719.57	0.22	1671	414.58	692765.8571	287.16	479841.18	0.69
2	Potato(Atm)	4710	663.27	3123982.14	1610.69	7586353.66	2.43	3940	664.30	2617338.571	1454.24	5729723.66	2.19
3	Onion(Dry)	1212	538.26	652372.57	1418.58	1719317.48	2.64	1225	540.61	662250.5714	1139.11	1395410.13	2.11
4	Vegetable(Gr)	2406	337.83	812812.86	667.01	1604826.86	1.97	2598	337.84	877703.7143	755.92	1963867.63	2.24
5	Tomato	1505	790.53	1189749.41	4134.15	6221899.65	5.23	1475	785.30	1158322.941	2770.74	4086842.95	3.53
6	Cucumber	375	559.15	209683.06	5981.56	2243083.30	10.70	356	555.05	197599.2941	1118.59	398216.45	2.02
7	Paper	246	771.69	189835.06	3942.79	969926.11	5.11	235	769.97	180942	4309.42	1012713.47	5.60
8	Squash	150	463.53	69529.41	2362.35	354352.58	5.10	256	463.53	118663.5294	2377.00	608512.41	5.13
9	Peas	175	494.29	86500.00	2088.18	365431.12	4.22	349	480.83	167810	701.38	244782.47	1.46
10	Artichoke	2399	427.02	1024431.18	2017.95	4841056.78	4.73	2429	419.01	1017773.529	2478.35	6019916.54	5.91
11	Strawberry	91	708.07	64434.71	3490.43	317629.07	4.93	107	706.01	75543.26471	4554.81	487364.74	6.45
12	Potato(Spr)	2088	403.97	843484.29	4223.50	8818668.57	10.46	3322	402.61	1337454.286	1996.14	6631172.83	4.96
13	Eggplant	388	768.86	298316.94	3422.77	1328036.40	4.45	440	762.94	335694.3529	4369.12	1922412.53	5.73
14	Melon	2068	497.89	1029632.35	1862.89	3852452.84	3.74	2098	495.71	1039996.471	1331.92	2794373.73	2.69
15	Beans(Gr)	1487	580.39	863034.29	2654.61	3947411.51	4.57	1608	578.03	929480	2510.81	4037385.69	4.34
16	Carrot	231	596.58	137808.86	1639.35	378689.61	2.75	549	605.26	332288.2857	1771.89	972766.20	2.93
17	Cabbage	556	441.43	245435.88	2586.57	1438131.03	5.86	607	393.94	239123.0588	2516.39	1527446.87	6.39
18	Fruits	6352	1126.78	7157310.59	719.60	4570906.14	0.64	6393	1130.31	7226097.647	585.26	3741544.03	0.52
19	Grapes	686	530.54	363950.59	4645.58	3186869.44	8.76	24145	530.32	12804648	182.77	4412980.29	0.34
20	Citrus	40935	1025.59	41982430.41	2235.62	91515148.51	2.18	40073	1025.42	41091552.76	1633.46	65457494.44	1.59
21	Alfalfa	2086	839.46	1751120.71	609.88	1272208.91	0.73	2016	839.47	1692379.286	579.19	1167651.05	0.69
	Total	71,707		62,746,140.02	52,404.84	146,674,119.2		95,892		74,795,427.42		115,092,419.3	

- Beans(dry) - Dry Bean
- Potato(atm) - Potato Autum
- Potato (spr) - Potato Spring
- Vegetable(Gr) - Green Vegetable

APPENDIX IV

Long Term Average Annual Precipitation in TRNC

Month	January	February	March	April	May	June	July	August	September	October	November	December	Annual sum (mm)	Long term Av. Ann. Sum (mm)
Years														
1975	85.5	144.2	24.3	47.2	32.4	5.4	0.0	0.2	2.3	5.4	34.7	129.8	511.4	373.0
1976	37.9	53.8	53.8	74.4	45.5	2.0	5.4	0.6	8.4	32.6	55.4	75.6	445.4	373.0
1977	82.6	11.6	54.5	33.1	0.2	1.4	4.0	0.0	15.0	12.3	3.4	116.2	334.3	373.0
1978	149.6	37.4	43.1	16.4	0.0	0.2	0.0	0.0	0.2	21.6	6.4	108.5	383.4	373.0
1979	63.6	67.7	41.0	10.8	15.8	19.9	0.4	0.4	1.1	38.6	38.8	107.0	405.1	373.0
1980	46.3	100.3	37.6	12.0	12.6	0.2	0.0	0.3	1.5	18.9	12.0	49.8	291.5	373.0
1981	123.5	70.7	41.6	18.1	22.7	24.0	0.0	0.0	0.2	3.3	64.4	38.1	406.6	373.0
1982	34.1	50.7	55.1	13.4	8.7	12.3	0.2	2.0	3.2	15.2	27.0	35.1	257.0	373.0
1983	45.0	58.6	43.7	21.0	20.2	14.0	0.0	0.8	2.8	22.0	53.7	32.9	314.7	373.0
1984	41.6	35.5	36.4	63.7	1.6	0.0	1.5	3.1	0.0	2.5	130.5	60.2	376.6	373.0
1985	77.5	44.5	31.4	13.6	6.1	1.9	0.0	0.0	5.7	27.4	23.7	78.9	310.7	373.0
1986	33.2	68.7	18.7	9.7	55.6	5.8	0.0	0.0	2.6	47.3	85.0	51.6	378.2	373.0
1987	40.8	16.7	118.4	16.4	11.8	0.5	1.3	0.2	0.0	55.3	25.3	138.2	424.9	373.0
1988	63.6	112.9	79.9	8.7	5.1	3.3	2.0	0.9	2.4	34.0	60.6	103.1	476.5	373.0
1989	86.1	13.1	31.5	0.0	5.7	1.4	0.0	0.0	0.3	48.9	34.5	33.4	254.9	373.0
1990	23.3	106.2	29.2	6.5	6.3	0.2	0.0	4.8	0.0	14.5	6.6	18.2	215.8	373.0
1991	67.0	57.2	39.9	8.5	1.2	0.2	0.0	0.0	0.7	18.0	70.6	216.8	480.1	373.0
1992	31.2	81.3	20.5	5.0	21.6	31.3	10.7	6.3	0.0	3.2	62.8	143.5	417.4	373.0
1993	53.0	65.1	55.2	6.9	38.5	11.6	0.0	0.0	0.0	0.8	55.0	11.6	297.7	373.0
1994	106.9	62.9	54.1	23.2	4.0	0.6	1.9	1.9	5.4	41.9	127.9	43.5	474.2	373.0
1995	20.4	21.6	11.9	20.2	15.9	0.1	13.7	0.0	0.1	5.7	35.8	10.7	156.1	373.0
1996	101.7	37.3	46.4	24.9	0.9	2.7	0.0	2.5	0.4	39.1	12.0	57.8	325.7	373.0
1997	11.2	32.2	40.3	35.5	8.0	8.1	0.1	4.3	28.1	26.5	53.9	59.9	308.1	373.0
1998	54.5	13.7	42.1	8.9	28.1	3.8	0.0	0.0	3.0	0.6	31.1	99.2	285.0	373.0
1999	86.0	37.8	24.5	22.3	2.3	15.2	1.0	4.5	5.7	19.6	18.5	21.1	258.5	373.0
2000	44.9	52.5	43.3	62.9	12.7	1.6	0.0	0.8	19.1	36.5	86.0	125.9	486.2	373.0
2001	44.3	48.0	8.5	18.6	23.2	0.0	0.0	12.4	0.6	18.6	41.3	180.4	395.9	373.0
2002	88.0	36.5	30.0	45.5	28.1	3.4	6.8	3.8	9.8	11.2	23.6	146.3	433.0	373.0
2003	52.4	122.0	87.5	23.8	5.0	20.6	0.0	0.2	1.3	9.1	21.3	90.1	433.3	373.0
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	373.0
2005	85.9	28.5	20.6	23.4	11.4	32.3	0.0	0.8	10.3	11.5	101.1	8.9	334.9	373.0
2006	98.7	38.0	37.3	13.4	4.6	1.5	13.2	0.0	6.8	63.7	38.1	64.3	379.5	373.0
2007	32.4	129.3	36.0	21.3	73.1	0.5	0.8	1.9	0.4	6.4	27.8	43.3	373.1	373.0
2008	23.2	29.8	9.6	7.5	17.1	0.2	0.0	3.6	8.8	19.6	16.6	76.5	212.4	373.0
2009	60.5	74.3	52.8	15.8	13.6	0.1	0.5	3.7	26.1	33.2	39.0	150.7	470.2	373.0
2010	105.7	143.2	5.7	11.7	13.6	7.3	1.3	0.4	1.9	11.7	0.4	51.4	354.1	373.0
2011	95.7	43.5	37.7	43.5	30.1	17.2	0.0	0.2	14.4	11.2	92.8	64.4	450.7	373.0
2012	160.6	61.8	22.6	14.1	50.7	3.4	2.1	1.3	0.0	66.4	80.5	106.9	570.4	373.0

APPENDIX V

Implication of Excessive Water Extraction in Guzelyurt Aquifer (Sea Water Intrusion)