

The Urgency of Land Reclamation in the Agricultural Sector in Northern Cyprus

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Abstract

In Northern Cyprus, agricultural irrigation occupies the great part of the total water extractions from the aquifers. The amount is about 70 % for the agriculture, and the remaining is used in the domestic consumption including the small industrial sector in the country. The water extractions vary between 100 MCM and 140 MCM per year. This amount depends principally on the cultivated area during the year. However, the safe yield of the aquifers in the country is about 74.1 MCM. This over extractions resulted in sea water intrusion to the only underneath water resources in the country since 1960s. This phenomenon caused degradation in the water quality in the aquifers and as a result an important decrease in the crop production. Despite the statistical data revealing that the present degradation and the reduced crop production is not economic, the water extractions still carries on aggravating the seawater intrusion due to misbelieve among farmers. The traditional crops grown in the country nowadays are not suitable for this contaminated water; hence, the new crops must be chosen which is suitable not only for the water quality but also to the soil characteristics and regional climate under land reclamation. Additionally, the water quantity in the regional aquifers should be considered and the safe yields should not be either met. For this reason, the necessity of the land reclamation has been investigated under IWRM (Integrated Water Resources Planning and Management) considering a balance in the supply and demand water and water quality, soil characteristics, climate, consumption water need and economic value by crops.

Key Words: Water Scarcity, Northern Cyprus, IWRM, Land Reclamation, Water Balance

Introduction

Cyprus is the third largest island in the Mediterranean Sea after Sicily and Sardinia, with an area of 925,100 ha (Figure 1). It is situated in the Eastern Mediterranean region at the crossroads of three continents Europe, Asia and Africa with a coastline of 1,364 kilometers (Elkiran 2006).

The Northern part of the country is comprised of: 56.7 % agricultural land, 19.5 % forest land, 5.0 % grazing, 10.7 % towns, villages, rivers and ponds and nearly 8.2 % bare land (Anon 2001, 2002).

Northern Cyprus (NC) is divided into three main regions; Lefkosa Main Region (LMR), Magosa Main Region (MMR) and Girne Main Region (GMR), and 17 sub-regions (Figure 2) and, therefore, the land classification was adopted following the frontiers of these regions. The total agricultural lands for the main regions are, 59,348 ha for LMR, 99,052 ha for MMR and 28,665 ha for GMR (Anon 2003, 2004).

Water scarcity in NC has started in the 1960s. Several studies were performed to identify the level of water deficiency in the whole island (Konteatitis 1967; UNDP 1970). The backbone of the economy of the country is agriculture, mostly small farms, and subsistence farms. The fruit groups cultivated in the island are: citrus, olive, pomegranate, almond, fig, and others; and the vegetable groups are: eggplant, green paper, carrot, beans, kidney beans, artichoke, potatoes, and others. Citrus fruit occupies the majority of the fruit production and export of NC (35 %) (Anon 2005, 2006).

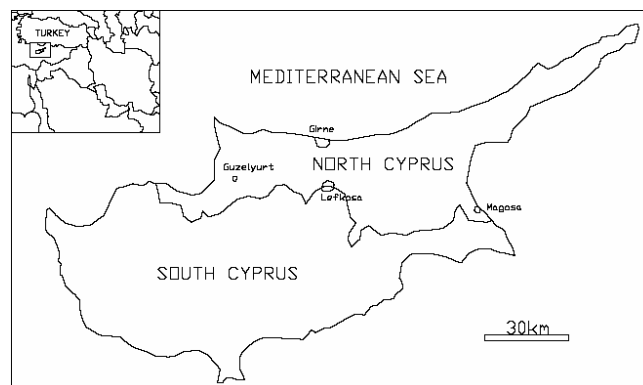


Figure 1: Geographical Location of Cyprus

The traditional crop patterns grown in the country nowadays are affected by the water degradation and the production yield has reduced tremendously. However, the present crops cultivated are necessitating too much water, whereas the aquifer capacities are so limited and already has been depleted and contaminated by sea water invasion owing to excess water withdrawals. Misbelieve among farmers that the crop production decrease is due to less water supplied to the fields, encouraged them to extract more water from the resources, however, the reduction in the production is continuing.

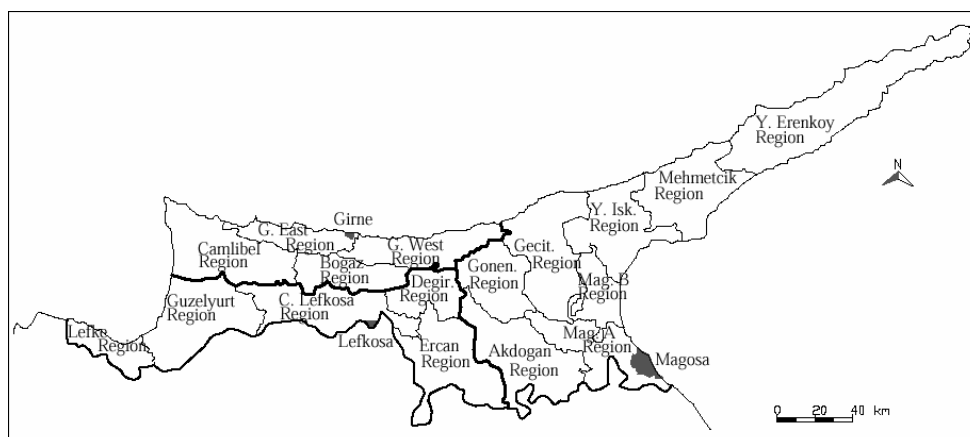


Figure 2: Main Agricultural Regions and Sub-regions of North Cyprus

The Agricultural Land Distribution

The land uses in NC is given in Table 1 and the main crop patterns grown in the agricultural sector are given in Table 2. Cereals, pulses, fodder crops, grapes and grape like fruits and citrus fruits, constitute 52 % of the agricultural land used out of 58.04 % (Anon 2001).

Table 1: Land uses in NC (Anon 2003)

Land Uses	ha	%
Agriculture	187,069	56.7
Forest	64,323	19.5
Grassing	16,344	5.0
Towns, Villages, Rivers and Dams	35,252	10.7
Bare	26,902	8.2
Total	329,890	100

The ratio of population working within the agricultural sector to the working population in NC is 16.50 %, based on 2001 census and this value was as high as 37.34 %, in 1982.

The share of agricultural export is substantially high, 64.4 % in total, where 28.6 % is citrus fruit, 1.4 % is potatoes and 23.4 % is the processed agricultural products. This ratio was 85.8 % in 1982, in a similar way; the share of export of citrus fruit, potatoes, livestock and the processed agricultural products in total (80.5 %) was, 63.8 %, 3.3 %, 5.1 % and 5.3%, respectively.

Table 2: Land uses and their related percentages, based on year 2001 (Anon 2001)

Land Use	Area (ha)	% Total	Dry Land (ha)	% Total	Irrig. Land (ha)	% Total
Cultivated	108,577	58.0	99,504	91.6	9,073	8.4
Cereal	76,355	70.3	76,355	100.0	0	0.0
Fallow	8,401	7.7	8,401	100.0	0	0.0
Pulses	5,888	5.4	5,888	100.0	0	0.0
Industrial crops	58	0.1	58	100.0	0	0.0
Oil Seeds	115	0.1	115	100.0	0	0.0
Tuber Crops	543	0.5	0	0.0	543	100.0
Fodder Crops	3,317	3.1	3,249	97.9	68	2.1
Leafy or Edible Stem Vegetables	209	0.2	0	0.0	209	100.0
Fruits Bearing Vegetables	607	0.6	0	0.0	607	100.0
Leguminous Vegetables	294	0.3	0	0.0	294	100.0
Root, Bulb and Tuberous Vegetables	120	0.1	0	0.0	120	100.0
Other Vegetables	50	0.0	0	0.0	50	100.0
Nuts	316	0.3	0	0.0	316	100.0
Pome Fruits	129	0.1	0	0.0	129	100.0
Stone Fruits	168	0.2	0	0.0	168	100.0
Grape and Grape like Fruits	5,962	5.5	5,438	91.2	524	8.8
Citrus Fruits	5,885	5.4	0	0.0	5,885	100.0
Greenhouses and Tunnels	161	0.1	0	0.0	161	100.0
Uncultivated	78,492	42.0	0	0.0	0	0.0
Total	187,069	100.0	99,504	91.6	9,073	8.4

As a result, for higher value of efficiency in the production of the agriculture, the quantity of water needed by the crops should be supplied. However, the water deficit within the water resources, especially in the drought years, makes this supply impossible. Therefore, the seasonal water needs of crops should be clarified for the optimum use of the water in the agricultural sector. The alternative higher economic value of crop patterns has to be studied. Their product may contribute more to the economy and may need less amount of water in their lifetime. Furthermore, the renewal of the old irrigation techniques also should be studied and new techniques should be applied without any delay in order to reduce the existing water losses. Alternative water resources have to be investigated, so as to contribute the supply side in order to eliminate the water deficits within the water resources and to prevent seawater intrusion of the aquifers.

The Productivity of the Crops in NC

The historical crop productivity shows great variety in NC. This was caused due to limited and degradation of the water quality supplied, cultivation of very old tree crops, misbeliefs in knowledge of agriculture, and absence of contribution of the experts either in governmental and private agencies. This can be seen in Figure 3. As it can be read from the Figures, the production yields were reached to the maximum in 1997. In this year a big project started to change old irrigation methods to new ones like sprinkler and drip irrigation in order to reduce the salination of the fresh water. The change in irrigation system has reduced the water extractions from the resources however, since the water extractions were beyond the safe yields of the aquifers the salination of the fresh water was augmented and as a result the decrease in the yields were experienced. The decreases in the salt tolerant crops were rarely observed.

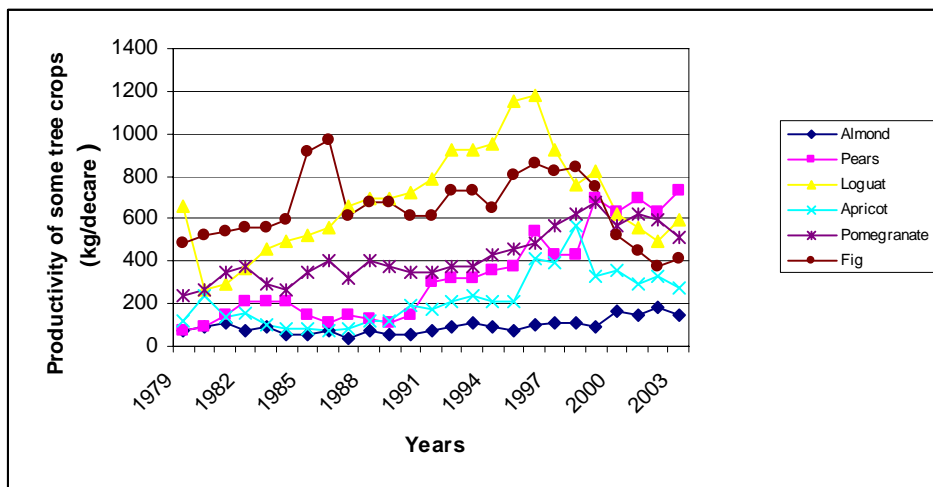


Figure 3: The productivity of some tree crops grown in the country (Anon 2004)

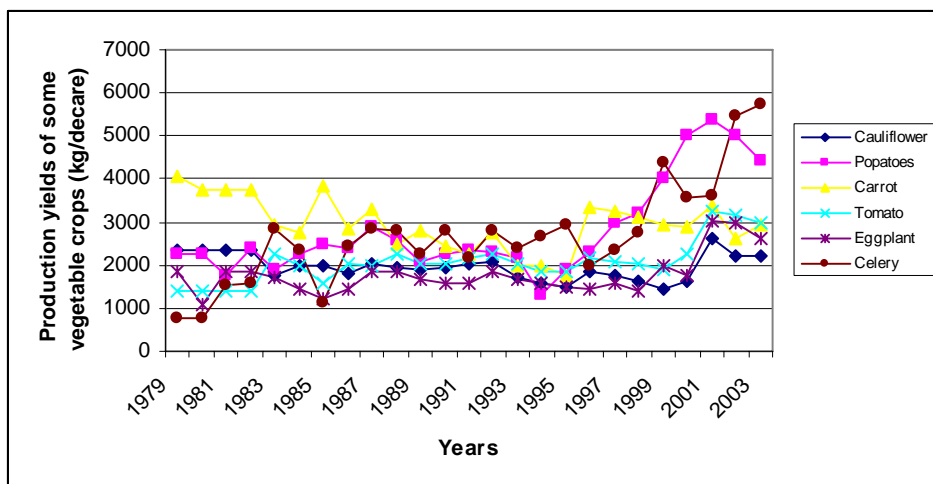


Figure 4: The productivity of some vegetable crops in the country (Anon 2004)

The decrease in the vegetable crops was also observed rarely owing to the availability of the change of the sowing area as it were grown seasonally (Figure 5).

Calculation of Irrigation Water Demand

The adopted crop patterns within the country were studied using the data in Statistical Yearbooks (SY) supplied by Department of Agriculture of State. The regional cultivated lands, grown crop types, adopted irrigation techniques, and the area of the greenhouses were obtained and evaluated separately, country-wide. The net water requirements for each crop patterns in the irrigable lands were procured from the bulletins published by the Department of Agriculture, where Blaney-Criddle Method has been used for the preparation (Kilickaya 1977). Then, irrigation techniques and the relevant efficiencies, 50 % for surface irrigation, 70 % for sprinkle irrigation and 85 % for trickle irrigation were introduced, for 21 different groups of crops patterns. The patterns were categorized considering the ones in the same group wasting almost the same amount of water for all types of crops grown within the country, so as to find the gross water consumption for the irrigation period between 1996 and 2003 (Table 3).

Table 3: The agricultural and domestic water extractions and water supplying resources based on years

Years	Water use (m ³)			Water Extractions (m ³)	
	Agriculture	Domestic	Total	G. Water	Dams
1996	110,829,062	31,759,200	142,588,262	138,046,107	4,046,821
1997	109,301,265	34,803,090	144,104,355	141,191,791	2,471,985
1998	106,438,542	35,141,722	141,580,264	139,310,409	1,785,206
1999	102,280,834	35,531,659	137,812,493	133,565,495	3,611,696
2000	106,534,596	35,920,737	142,455,333	138,473,532	3,071,506
2001	89,429,155	36,554,963	125,984,118	120,673,984	3,082,803
2002	84,960,608	37,158,307	122,118,915	112,489,542	7,372,465
2003	82,624,934	37,791,492	120,416,426	111,208,231	8,450,913

A great attention was paid to prepare the new crop patterns, and their water requirements during their lifetime on the basis of future evaluation, by introducing the land reclamation throughout the country. The new products chosen were evaluated after a detailed research and discussions between the authorities and scientists dealing with agricultural structure of the country (Nalbantoglu 2004, Ince 2004, Kersting 2005, Allen et al 1998). The plants have been chosen by considering the traditional behaviors of the farmers and the public, the quantity and the quality of water required to grow them and the present water qualities within the regions of the country. The competition in the sector throughout the country, the growing seasons of the crops, and the climate of the country and the suitability of the soil types were all considered.

The Adoption of Land Reclamation in TRNC

Based on the study performed in the whole island, it is noticed that, the water consumption within the aquifers are far beyond their safe yields and the fruit yields of the crops are far below the expectations. As an example, the average yield of orange trees is 15 t/ha, in 2001, whereas the expectation was 35 t/ha. The decrease in the yield can be seen in all the crops and orchards (Anon 2001, Markou and Mavrogenis 2002). In addition, the decrease in the yield is aggravating every year (Anon 2000, 2001). Therefore, in order to balance the aquifer discharges and illustrate the increase in the production yield, the land reclamation in the country should be put forward.

The adoption of the water quality and quantity, the soil suitability for the grown crops and orchards were considered and analyzed (Table 4 and 5). For this purpose, the suggested changes in the crops patterns were studied and evaluated (Kersting 2005).

Table 4: The proposed crop patterns and their suggested areas to be used in TRNC

Field Crops	Area (ha)	Forage Crops	Area (ha)
Chickpeas	1,200	Alfalfa	10,000
Vetch	10,000	Triticale	10,000
Maize	5,000	Sorghum	10,000
Spring Potatoes	500	Sweet Clover	5,000
Autumn Potatoes	100	Opuntia	200
Aromatic Plants	5,000		

Table 5: The proposed vegetables and orchards and their suggested areas to be used in NC

Fruits	Area (ha)	Vegetable	Area (ha)
Almond	10,000	Artichoke	100
Walnut	500	Cole crops	200
Pistachio	2,500	Spinach	33
Olive	60,000	Leek	12
Apple	1,000	Lettuce	50
Pears	100	Tomatoes	100
Loquats	2,000	Cucumber	48
Apricots	5,000	Eggplant	40
Peaches	900	Okra	20
Nectarines	7,500	Pepper	35
Plums	1,000	Squash	35
Pomegranates	3,500	Broad Beans	120
Figs	3,000	Green Beans	50
Bananas	300	Kidney Bean	100
Grapes	55,000	Peas	80
Cherry	200	Onions	100
Persimmon	500	Garlic	10
Date Palms	1,500	Carrots	30
Cacti	500	Honey Melon	200
Oranges	40,000	Water Melon	300
Mandarins	15,000	Strawberry	25
Lemons	20,000	Small berries	50
Grape Fruits	5,000	Asparagus	50

The consumptive water requirements and domestic water needs were studied together and, a balance with the demand/supply water for the aquifers considering the safe yields were tried to be met (Table 6 and 7). An economic analysis for the new crops were done based on the new prices and production yields under the land reclamation (Markou and Mavrogenis 2002). In the analysis, the expected productions suggested in Cyprus and in Anamur, Turkey (having similar climate with NC) were accepted and used for overall analysis (Anon 2001, Markou and Mavrogenis 2002, Tarim Yilligi 2004). The adoption of the new irrigation techniques were considered, however the conveyance losses of the pipes were disregarded. The crops were divided into 27 groups and their yields were evaluated. The results were given in Table 6.

The proposed forage crops as maize, sorghum and sweet clover, were evaluated in the analysis. However, due to their high water consumption requirements, they were excluded in this study. If it is decided to cultivate these crops they necessitate 135 MCM of additional water which is not possible from the supply point of view. The domestic water supply was kept constant, based on the year 2001 values.

Recommendations and conclusions

NC is experiencing water scarcity phenomenon very often, hence the adoption of the land reclamation is a must for water protection. The present water save precautions like; rotational water supply and water valorization is not satisfactory enough for more for water conservation. Especially, when global warming, and as a result, the change in the rainfall intensity all over Cyprus is considered, more drastic decisions are necessary for better water protection.

Table 6: The balanced sector-wise water extractions in NC considering aquifers safe yields

NC	Agricultural Use (m ³)			Domestic Use (m ³)						Total Consump. (m ³)
	Irrigation	Loss.	Total	Live Stock	Hotels	Univer.	Houses	Loses	Total	
Oct.	3,178,917	724,697	3,903,614	172,723	64,548	75,999	2,101,809	724,524	3,139,604	7,043,218
Nov.	404,563	108,897	513,460	167,152	62,466	73,548	2,034,009	701,152	3,038,327	3,551,787
Dec.	0	0	0	172,723	64,548	75,999	2,101,809	724,524	3,139,604	3,139,604
Jan.	0	0	0	172,723	64,548	75,999	2,101,809	724,524	3,139,604	3,139,604
Feb.	0	0	0	156,008	58,302	22,881	1,881,941	635,739	2,754,871	2,754,871
March	342,667	70,611	413,277	172,723	64,548	75,999	2,101,809	724,524	3,139,604	3,552,881
April	3,856,685	856,289	4,712,974	167,152	62,466	73,548	2,034,009	701,152	3,038,327	7,751,301
May	8,592,094	1,944,590	10,536,684	172,723	64,548	75,999	2,101,809	724,524	3,139,604	13,676,288
June	11,260,723	2,233,579	13,494,302	167,152	62,466	73,548	2,034,009	701,152	3,038,327	16,532,629
July	12,447,049	2,342,961	14,790,010	172,723	64,548	25,333	2,083,578	703,855	3,050,037	17,840,047
August	10,412,207	2,077,828	12,490,035	172,723	64,548	25,333	2,083,578	703,855	3,050,037	15,540,072
Sept.	8,187,565	1,693,162	9,880,727	167,152	62,466	24,516	2,016,366	681,150	2,951,649	12,832,376
Total	58,682,469	12,052,614	70,735,083	2,033,678	760,003	698,705	24,676,535	8,450,676	36,619,597	107,354,680

Table 7: Water resource- base contribution to the water extractions (m³)

NC	Available Resources					Groundwater Extractions
	Springs	Sanitary	Dams	Balloon	Desalination	
October	44,107	275,751	1,272,817	69,124	9,300	5,639,745
November	36,763	376,392	10,182	130,974	9,000	3,358,466
December	30,958	387,454	0	51,853	9,300	3,042,362
January	26,759	387,454	0	84,530	9,300	3,013,884
February	16,824	349,958	0	54,220	8,400	2,670,793
March	16,391	387,996	321,634	172,430	9,300	3,027,453
April	24,438	302,943	818,139	179,470	9,000	6,713,303
May	44,142	275,835	116,763	273,540	9,300	13,238,663
June	34,521	194,925	329,944	167,780	9,000	15,981,454
July	35,914	201,423	87,110	169,080	9,300	17,528,382
August	30,264	201,423	10,155	122,810	9,300	15,357,282
September	24,037	194,925	3,890	186,090	9,000	12,599,429
Total	365,118	3,536,478	2,970,634	1,661,901	109,500	102,171,218

The aquifer water should not be exploited and the safe yields should never be exceeded. The cultivation lands should be controlled for maximum water protection. The rainfall intensities in the country can be considered as a hallmark for decision of the cultivation area for the coming season. When the season was dry, reduced aquifers capacities should be considered instead of wet season capacities.

The adoption of the old irrigation techniques to the new ones is extremely needed; also water losses in the conveyance pipeline system should be reduced by changing very old pipeline system, as soon as possible.

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