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Costs and Pricing Policies Related to Transporting Water by Tanker from Turkey to North Cyprus

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Abstract

Water shortages in North Cyprus are quite evident and both supply and demand policies to alleviate these shortages are urgently needed. Due to a decrease in rainfall over a number of decades, and as a consequence of the over extraction of water from the aquifers, seawater intrusion has occurred in several areas. This has killed the citrus trees in some regions and made the publicly supplied water undrinkable in many areas, particularly in the Gazimagusa (Famagusta) region. On the conservation side, projects to convert traditional irrigation to modern methods and the introduction of new pricing policies are expected to address some of the water shortage problems in agriculture. Possible solutions to the potable water shortages include importing water from Turkey and applying better water management practices, and introducing pricing policies that more closely effect the marginal costs of supply.

This paper reports on an evaluation we have carried out on the financial feasibility of importing water by tanker from Manavgat (Turkey) to Kumkoy (North Cyprus). The break-even real price of water (1998 prices) reflecting the cost per cubic meter (m^3) will be calculated at various stages of the delivery process. The cost of water to the shore of North Cyprus reflects only the transportation cost, while the cost to Kumkoy reservoir will include the cost of infrastructure to be built in North Cyprus. The cost of water to households will take into account the high rate of leakage in the distribution systems. In determining the effects of various financial arrangements on the cost of water, the model considers the financial cost of maintaining various length of billing cycles and payment terms for the water. It also includes an examination of the financial repercussions if there are only periodic adjustments made to the nominal price of water for inflation. In a very high inflationary environment like North Cyprus, such items not only affect the financial outcome of the project, but also require the authorities to consider a number of alternative pricing policy schemes.

JEL Codes: D61, H43, L95
Keywords: North Cyprus, evaluation, water transportation, tanker, price policy, inflation.

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1. INTRODUCTION

Geographically North Cyprus is in a semiarid region where the annual rainfall varies between 200 to 600 mm. Starting from the beginning of the century North Cyprus has experienced a reduction in its annual rainfall. The average rainfall, which was 440-450 mm per year at the beginning of the century, fell to 402 mm between 1941-1972 and fell further to 382.4 mm between 1975-1993 (Biyikoglu, 1995: 8). In addition, the over extraction of water from the acquifers has resulted in seawater intrusion all over the island. The level of seawater intrusion in Gazimagusa and Gecitkale acquifers reached such a level that the water is no longer potable. Water stations are established to sell fresh water. Furthermore, due to lack of water and/or use of relatively saline water for irrigation, a large number of citrus trees have died and such land is no longer irrigated. Between 1976 and 1996, the amount of land used for citrus felt from 74,710 donums to 47,700 donums[1]. During the same period total irrigated land fell from 116,400 donums to 74,044 donums (Ministry of Agriculture, 1997a: 33 and Ministry of Agriculture, 1997b: 47)[2].

Some previous studies that were not aware of the sharp fall in the irrigated area, estimated the demand for water in North Cyprus to be between 190 and 197 million m^3 and an actual supply of water between 110 and 125 million m^3, without explaining how in practice the deficit was closed. (Technical Committee Report 1996, and Numan and Agiralioglu, 1995: 287-296). If we account for the sharp fall in the area of irrigated land, and also distinguish between the amount of land irrigated with traditional and modern methods, the demand for water in North Cyprus is estimated to be 106.6 million m^3 for 1996 (Bicak and Ozdemirag, 1997). In the study by Bicak and Ozdemirag the demand for agricultural use was estimated as 87.5 million m^3 (82.1%), 17.1

[1] One donum of land is equal to 0.1338 hectares.
[2] In North Cyprus, land existence is 2,465,552 dn. whose 1,392,123 dn. (57%) is agricultural land. About 881,481 dn. (63.05%) of this land is cultivable while the rest are uncultivable land. From 881,481 dn. of land 805,437 (91.6%) is dry land and 74,044 dn. (8.4%) is irrigated land (Ministry of Agriculture 1997b: 3).

million m^3 (16.1%) for household consumption, including the armed forces, seasonal workers from Turkey, students and the tourists, 1.3 million m^3 (1.2%) for animals and 0.7 million m^3 (0.7%) for commercial and industrial use. Giving a total demand of 106 million m^3. As far as the potential supply of water is concerned, until the current research project being conducted by the Mines Investigation and Search Institute of Turkey is completed, the exact quantity is unknown. Previous data and estimates show that the safe yield from the acquifers is about 74.1 million m^3 per year. It has been estimated that the overextraction of water could be as high as 28.9 million m^3 per year. Hence an estimate of the total amount of the water extracted from the aquifers could be as high as 103 million m.[3] An alternative approach is to consider that the rivers and the existing dams are estimated to provide annually about 13 million m^3 and 7 million m^3 of water, respectively, depending on the amount of precipitation. Thus the total potential water supply of North Cyprus can be said to be 94.1 million m^3 (74.1+13+7). Thus the water deficit of North Cyprus is about 12.5 million m^3 (106.6 – 94.1) and this deficit now being closed by overextraction from the acquifers.

The water shortage for both domestic and agriculture use in North Cyprus is quite evident. Various measures are planned and implemented to increase the supply of water and use it more efficiently. Projects have been proposed as to import water from Turkey by a tanker, or through the use of large water bags and/or by pipeline. The first load of water was transported by water bags on 25th July 1998 (Kibris Newspaper, 1998a: 1). Water bags of 10,000-m^3 capacity could potentially bring 3 million m^3 of water in the first year from Soguksu River of Anamur in Turkey. An increase in the capacity of the water bags to 30,000 m^3 would enable 7 million m^3 of water to be imported annually. This amount is the maximum that the system can permit to be pumped from Kumkoy to Serhatkoy and then on to Dikmen where the main reservoirs are situated and from where water is sent to Nicosia and Gazimagusa.

Another important project being currently implemented aims to prevent the excessive use of water by converting traditional irrigation systems to modern irrigation methods is being started in the Guzelyurt area. Through this application not only a large amount of water will be

[3] Guzelyurt acquifer is the biggest acquifer on the island with a 37 million m^3 of safe yield capacity. It is believed that with an overextraction of 20 million m^3, 57 million m^3 of water is used from this acquifer (State Planning Org.,

conserved and salination will be prevented, but also the productivity and quality of the agricultural output will be increased. Among other effects, production costs will be decreased, as lesser fertilizer will be needed. Currently, out of the total irrigated land of 74,044 dn., 66,084 dn. (89.2%) is irrigated by traditional methods and 7,960 dn. (10.8%) is irrigated by modern irrigation methods, with sprinklers (2,989 dn. (37.6%)) and drip irrigation (4,971 dn. (62.4%)) (Ministry of Agriculture, 1997b: 64). The project has started with the conversion of 10,000 dn. of land from traditional irrigation to modern irrigation on the citrus farms in the Guzelyurt area. Authorities are planning to convert 10,000 dn. of citrus land to modern irrigation every year so that all the crops will be irrigated in this way by the end of year 2000 (Sevki, 1997: 4). Considering that a donum of citrus land uses 1,420 m^3 of water annually through traditional methods and only 710 m^3 with modern methods, a large amount of water is expected to be saved through this project. The quantity of water that could be potentially saved could be as high as 47.6 million m^3 (710 * 66,084) if the project is implemented successfully.

One other project to ease the water shortage in North Cyprus for all uses is through importing water by pipeline either from Anamur or from Manavgat in Turkey. Through this project 75 million m^3 of water could be brought to Kumkoy of North Cyprus. The Council of Ministers of Turkey has taken the decision to implement the project with the Turkish firm ALARKO. This project appears to be financially unfeasible if one considers only the revenues from the water sold for use in North Cyprus. The project might be feasible if some quantity of water could be sold to either South Cyprus or other Middle East countries (Bicak, 1996). Alternatively, it might be worthwhile in political terms for Turkey to build this permanent supply link to North Cyprus. Once the capital investment is made, the marginal pumping and other operating costs are very modest.

Another project to supply good quality water to Nicosia and Gazimagusa is to built a dam in the Yesilirmak area where, depending on the level of precipitation, about 8-12 million m^3 of water flows underground, to the sea (Ozdemirag, 1998). This project is now postponed due to some conflicting views between the government and the local villagers that would be affected by this project. Rehabilitation of the Haspolat Sewage Treatment Plant also is expected to be completed

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TRNC, 1992: 180).

by the end of 1998. Once rehabilitated, it will provide 3.5 million m^3 of water to be used in agriculture. Although the plant has been operating since 1980, it provides very limited amount of water for agricultural use, as the infrastructure is not built. (Kibris Newspaper, 1998b: 6).

In this paper a feasibility study of importing water from Turkey to North Cyprus by a tanker is carried out. The model also enables us to separate the effect of various components that are likely to have an impact on the financial outcome of the project and the unit cost of water. These include the impact of inflation, the billing cycle, the payment terms, and the system for adjusting tariffs for inflation. A sensitivity analysis will enable us to identify the key variables that could effect the outcome and risk of the project.

2. METHODOLOGY USED IN THE STUDY

A financial analysis of importing water from Turkey to North Cyprus by a tanker involves constructing a pro-forma cash flow statement. The cash flow considers all the revenues and expenditures involved throughout the life of the project. The net cash flow is prepared from the equity (owner) and from the total investment's (banker) point of views. The net cash flow prepared from the equity point of view includes the loans, and repayment of the principal and the interest, while the cash flow prepared from the total investment view excludes these items from the cash flow. Total investment view analyzes the strength of the project in the absence of such a financing arrangements (Jenkins and Harberger, 1998: Chp.3, 11-17). In the study, the net present value is calculated from the point of view of the owner (equity) using a real discount rate of 12 percent.

North Cyprus not having issued its own currency uses Turkish Lira as its medium of exchange, and like Turkey experiences inflation rates in the range of 80% per year. In such an inflationary environment the impact of the length of the billing and payment cycle, along with the system for the adjustment of the nominal water tariffs for inflation plays a significant role in determining the financial performance of the project. The impact of inflation on the project incorporated into the model by constructing the net cash flows in nominal prices first (using assumed rates of nominal price adjustment). These nominal values are then converted into real prices by deflating them with a general price index that reflects the assumed overall rate of inflation in North Cyprus (Jenkins and Harberger, 1998: Chp.6, 1-33).

With the net cash flows prepared as described above we are able to estimate the transportation cost per m^3 of water transferred from Turkey to North Cyprus when all the infrastructure investments and operating costs in North Cyprus are excluded from the calculations. The cost per unit of delivered water, evaluated at the point of Kumkoy will exclude the cost of every leakages from the system, and the financial effects of the time lags in billing and payment for the water, including the administrative lag in the adjustment of nominal tariffs for inflation. We will also estimate the unit cost of the water including the cost of the water leakages from the distribution system. The last set of cost calculations will introduce alternative scenarios or combinations of administrative practice dealing with accounts receivable, accounts payable and the lags in the adjustment of the nominal prices for water. Such an approach will show the financial implications of alternative pricing policies that could be used by the municipalities in North Cyprus.

3. PROJECT DESCRIPTION

3.1 Objective and Scope of the Project

The objective of the project is to import fresh water from Turkey by a tanker to meet the demand for potable water by households. The project does not aim to provide water for agricultural use or for recharging the acquifers badly effected by the seawater intrusion.

Currently fresh water is pumped from Kumkoy to Serhatkoy and from there to the main reservoir in Dikmen through which the water is distributed to Nicosia and Gazimagusa. Kumkoy is supported by 14 wells and sends 9,000 m^3 of water per day to Serhatkoy. Contributed 3,500 m^3 of water from 4 wells, Serhatkoy pumps a total of 12,500 m^3 of water per day, of this amount 3,500 m^3 is sent to Turkish part of Nicosia through South Cyprus and 9,000 m^3 to Dikmen from where 3,000 m^3 is sent to Gazimagusa and 6,000 m^3 to Nicosia. Not only the amount of water sent is not sufficient, but also the quality of the water is very poor. It should be noted that the pipes are 18 inches and they can not transport more than 18,000 m^3 per day or 6.57 million m^3 per year (Table 1).

Table 1. Distribution of Water and the Existing Infrastructure.

Capacity of the Existing Infrastructure	
Vol. of water sent from Kumkoy and Serhatkoy to Dikmen (m^3/day)	18,000
Vol. of water sent from Kumkoy and Serhatkoy to Dikmen (m^3/hr)	750
Vol. of water sent from Kumkoy and Serhatkoy to Dikmen (m^3/year)	**6,570,000**
Sources and Distribution of Water	
Water comes to Kumkoy from 14 wells (m^3/hr)	375
Water comes to Kumkoy from 14 wells (m^3/day)	9,000
Water sent to Serhatkoy from Kumkoy (m^3/hr)	375
Water sent to Serhatkoy from the 4 wells nearby (m^3/hr)	145
Total Amount of Water Coming to Serhatkoy (m^3/day)	**12,500**
Water sent from Serhatkoy to South and to Nicosia (m^3/day)	3,500
Water sent from Serhatkoy to Dikmen (m^3/day)	9,000
Total Amount of Water Distributed from Serhatkoy (m^3/day)	**12,500**

Manavgat was chosen among a number of possible sources of water in the south coast of Turkey for filling the tankers as it already has completed the necessary infrastructure on the land and some of the structures in the sea are expected to be completed shortly. Currently at Manavgat 500 million m^3 of fresh water is flowing annually into the sea. Once the infrastructure is completed, it would be possible to export water to other Mediterranean countries. Manavgat and Kumkoy are 248 km away from each other. Considering the amount of water that the distribution system in North Cyprus can handle (6.57 million m^3/year), a tanker with a capacity of 40,000 m^3 making 175 trips per year could transport 7 million m^3 of water per year. The tanker is assumed to operate 320 days a year, staying non-operational for 45 days to undertake maintenance and repair including these times when the weather conditions are unsuitable for sailing (Table 2).

Table 2. Capacity of the Tanker and Volume of Water to be Imported.

Non-operational days	45
Operational days	320
Distance between Manavgat and Kumkoy (km)	248
Tanker's speed (km/hour)	20.8
Time taken to travel (one way), hours	12
Time for loading (10000 m^3/hr)	5
Time for connection-disconnecting & formalities (Manavgat)	3
Time for discharging (4000 m^3/hr)	10
Time for connecting-disconnecting and formalities (Kumkoy)	2
Total time for one round trip (hr)	44
Total number of trips	**175**
Total Volume of Water (m^3) (per trip)	**40,000**
Total Volume of Water (m^3) (annual)	**7,000,000**

3.2 Total Investment and Operating Costs

For the analysis it is assumed that the tanker will be owned and operated under normal private financial arrangements. Although the installations in Manavgat, Turkey, are almost built, the government of North Cyprus needs to start constructing the necessary installations both in the sea and on land. For the tanker to anchor at North Cyprus, the installation of a mooring system is sufficient. A port is not required. A sea pipeline followed by a land pipeline will lead the water into the reservoirs at Kumkoy. The existing system at Kumkoy will pump the water to Serhatkoy. In order to meet the increasing capacity of water sent from Kumkoy, the pumping system in Serhatkoy will need to be supported with two additional pumps. The total investment cost of the project composed of infrastructure investments, including the tanker will be $16.725 m. (Table 3)[4].

[4] Data on issues related to tanker are obtained from the Undersecretary's and the Ports General Directorate's offices of the Transportation Ministry, while the date on issues related to pipeline are obtained from the Water Works

Table 3. Total Investment Costs (1998 Prices).

TANKER	
Price of the tanker	**$8,000,000**
Price of shamandra (mooring system)	**$2,000,000**
Price of boat for anchoring and connecting pipes	**$250,000**
SEA PIPELINE (SHAMANDRA-SHORE)	
Distance from shamandra to land (km)	1.5
Cost per km	$750,000
Total cost of sea pipeline	**$1,125,000**
LAND PIPELINE (SHORE-KUMKOY)	
Distance from shore to Kumkoy (km)	2
Cost per km	$500,000
Total cost of land pipeline	**$1,000,000**
RESERVOIR AT KUMKOY	
Capacity of the reservoir (2 x 20,000 m^3)	40,000
Cost of the reservoir (per m^3)	$90
Cost of the reservoir ($90/$m^3$ x 40,000)	**$3,600,000**
ADDITIONAL PUMPS AT SERHATKOY	
Number of pumps (new)	2
Capacity of the pumps (m^3 water/hour)	750
Capacity of the pumps (m^3 water/day)	18000
Capacity of the pumps (average horsepower)	375
Price of two new pumps ($500,000 per pump)	**$1,000,000**
Total investment costs (excluding the in-use values)	**$16,725,000**

The operating costs of the project are the crew expenses, additional employment at Kumkoy, fuel and diesel oil consumption of the tanker and its maintenance. Annual total crew expenses are expected to be $493,200 and the annual wage bill for the workers at Kumkoy will be approximately $76,800, while the fuel and oil consumption of the tanker will cost $1,304,926 annually. Maintenance costs are expected to be around $147,250. All such expenditures (with an additional 1% to cover miscellaneous items add up to $4,138,545 per year (1998 prices) (Table 4).

Office of the Interior Ministry of the Turkish Republic of Northern Cyprus.

Table 4. Total Operating Costs.

CREW EXPENSES		**DIESEL OIL CONSUMPTION**	
Monthly Salaries		As tanker sails, one round trip (12 hrs+12 hrs), tonnes	2
Number of captains	4	Discharging (10 hrs), tonnes	8
Payment to one captain	$2,000	Total diesel oil consumption	10
Payment to captains	$8,000	Price of diesel oil ($ per ton)	$220
Number of engineers (3 mech. & 1 elec. engineer)	4	Total payment for diesel oil per trip ($)	$2,200
Payment to one engineer	$1,800	**Annual payment for diesel oil**	**$385,347**
Payment to engineers	$7,200		
Number of communication officer	1	**Annual total fuel oil and diesel oil consumption**	**$1,304,926**
Payment to one communication officer	1300		
Payment to a communication officer	$1,300	Manavgat part handling charges ($5000 per trip)	$875,789
Number of labor on the board (4 front & 4 back)	8	**Annual total port handling charges**	**$875,789**
Payment to one labor on the board	1200	**Annual insurance expenses (2% of the tanker price)**	**$160,000**
Payment to labor on the board	$9,600		
Number of labor in the ship	8		
Payment to labor in the ship	1200	**COST OF WATER**	
Payment to labor in the ship	$9,600	Price of Water in Manavgat	$0.15
Number of the cooks	2	Total annual water bought	7,000,000
Payment to a cook	900	**Annual total cost of water bought**	**$1,050,000**
Payment to cooks	$1,800		
Number of the steward	4	**MAINTENANCE COSTS**	
Payment to a steward	900	Tanker (1% of the initial purchasing value)	$80,000

(Table 4 cont).

Payment to stewards	$3,600
Monthly total payment to the crew	$41,100
Annual total payment to the crew	**$493,200**
STAFF AT KUMKOY INSTALLATIONS	
Monthly Salaries	
Payment to Captain	$800
Payment to Mechanical engineer	$800
Number of labor for boat	2
Payment to a labor for boat	$600
Payment to labors	$1,200
Number of labor for water resources department	6
Payment to a labor for water resources department	$600
Payment to labors water resources department	$3,600
Monthly total payment to the staff	$6,400
Annual total payment to the staff	**$76,800**
FUEL OIL CONSUMPTION	
Total fuel oil consumption, one round trip (12 hrs+12 hrs),tons	35
Price of fuel ($ per ton)	$150
Total payment for fuel per trip ($)	$5,250
Annual payment for fuel	**$919,579**

Sea pipeline(1% of the initial cost)	$11,250
Land pipeline Shore-Kumkoy(1% of the initial cost)	$10,000
Reservoir (1% of the initial cost)	$36,000
Pumps at Booster (new) (1% of the initial value)	$10,000
Annual total maintenance costs	**$147,250**
Sub-total of operating costs	**$3,057,966**
Miscellaneous (1% of the operating costs)	**$30,580**
Total operating costs (Annual)	**$4,138,545**

3.3 Sources of Finance

It is planned that 70 % of the total investment costs ($11,707,500) would be borrowed in US$ either directly from Turkey or from international financial institutions with guarantees from Turkey. The rest of the investment costs ($5,017,500) will be financed by the equity. The real interest rate on the debt (before risk adjustment) is taken as 4%. In addition there will be a 5% risk premium associated with Turkey. Hence, the loan would be made to Turkey at a 9% real interest rate. Taking into account the assumed expected annual inflation rate for the US $ of 3%, the loans are expected to carry a nominal interest rate of at least 12%. The real rate of return on equity for this type of project is taken as 12%. Thus the weighted average real cost of capital financed through 70% borrowed money and 30% from equity is calculated to be 10%. The domestic inflation rate in North Cyprus is taken as 80% and the end of the year exchange rate (Lira/US$) is recorded as 290,050 TL for 1998 (Table 5).

The objective of this feasibility study is to estimate the minimum real price in the initial year that has to be paid per cubic meter of water in order to deliver commercially this raw water to North Cyprus. This will be a function of both the costs of the project as well as the efficiency of the authorities in the management of the water systems.

Table 5. Exchange Rates, Inflation Rates and Financing.

Inflation and Exchange Rates			
Domestic Inflation Rate		80%	
Foreign Inflation (US) (Avg. of the last 5 years)		3.0%	
Real exchange rate(TL/US$) (149000*1.8/1.03)		290,050	in yr. 1998
Financing in US$			
Turkey US$ Credit		$11,707,500	
From Equity (30% of Total Inv. Costs)		$5,017,500	
Interest Rates	**Real**	**Nominal**	
Interest Rate	4.0%	-	
Risk of Turkey	5.0%	-	
Borrowing Rate for Turkey ($)	9.0%	12.0%	
Return on Equity (in US$)	12%	-	
Financing			
Percentage use of Equity	30%		
Percentage of borrowing	70%		
Number of years for repayment	15		

Note: Exchange rate (TL/$) is the end of year figure.

4. RESULTS OF THE ANALYSIS

4.1 Various Unit Costs of Water

The real net cash flow constructed from the owner's point of view enables us to derive the financial cost per cubic meter of water (m^3). The costs per m^3 of water computed at the various stages of the delivery process are the break even average real prices evaluated as of the beginning of the project (December 1998) from the equity perspective using a 12% real discount rate. The first calculated cost per unit m^3 of water is the cost of transportation excluding any installation costs on both ends, leakage and any financial aspects (delays in reading the meter, billing and payments, and adjusting water tariff for inflation). The cost of transportation of the water is found to be 46 cents per m^3. This cost does not include any payment for the raw water to Turkey. As a comparison, the cost of water brought from Anamur to Kumkoy in water bags, a distance of 84 km, is estimated to be 55 cents per m^3. [5] This price also does not include any payment for water in Turkey and it is solely to cover the cost of the transportation.

The cost of water by tanker to Kumkoy increased to 79 cents per m^3 when the cost includes the investment in the infrastructure required in North Cyprus (Table 6). This price includes port handling charges in Turkey, operating costs in North Cyprus, but excludes any payment for water to Turkey, the cost of leakages in the distribution system and any financial losses due to pricing policies.

Another cost incurred in the delivery of water to households is the leakage of water from the distribution system. Adding the actual 30% leakage from the system (including the unpaid deliveries) to the transportation and infrastructure costs the cost of delivering a m3 of water to households would be $1.13 cents per m^3, excluding any payment for water in Turkey, and excluding any treatment costs (Table 6).

[5] "Contract on Transporting Water from Turkey to the TRNC", 30th December 1997, p.3, Art.3.

Table 6. Cost of Water at Various Delivery Processes (per m^3).

Transportation Cost of Water	$0.46
Cost of Water to Kumkoy	$0.79
Cost of Water to Households (30% leakage)	$1.13
(20% leakage)	$0.99

Note: Costs given in the above table do not include any payment for raw water to Turkey which could be around $0.15 per m^3.

All of the above analysis involves an evaluation of the real net cash flow from the equity point of view. The cash flow statements for selected cases expressed in constant (1998) prices are shown in the Appendix.

4.2 Some Financial Aspects in Determining the Unit Cost of Water

In North Cyprus it is the responsibility of the Water Works Department of the Interior Ministry to distribute the water to the municipalities and other local authorities. They are also responsible for the repairing any of breakdowns and the general maintenance of the distribution system. Municipalities read the water meters, bill the amount of water used and collect the money to meet their own budget. It would be somewhat of an exaggeration to say that the municipal authorities are efficient in reading, billing and collecting the money on the water used. In an inflationary environment such lags in reading, billing and payment have a great impact on the net cash flow of the utility. The meters are read in every two months. In Gazimagusa, the bill is written and given on the spot as the meters are read, and the consumers are expected to pay in two months time before the meter is read the next time. Otherwise the consumer is charged a penalty at an increasing rate related with the delay in payment. In Nicosia, rather than writing the bill on the spot, it is written in the office and brought to the consumer in two months, which is the next time the meter is read.

In this section the cost of water is calculated for various scenarios combining the billing period, payment lag after billing and the frequency in the adjustment of nominal prices for inflation. For this analysis rather than using the annual cash flow, the monthly cash flow is constructed for any year of operation and the present value of the sales at the end of this year is used to find out the breakeven price of water (Po^*) that will give equal revenue (in present value terms) under various scenarios. The first year's revenues in the annual formulation of the model is given below:

$$\frac{p_o(1+gI_A)*Q}{(1+gI_A)*(1+r_A)} \qquad \text{expression (1)}$$

Where, P_o is the end of year price of water for 1998 (break even price for the initial year) obtained from the annual net cash flow statement. It is estimated to be equal to $ 0.7915, when the NPV is set to zero, gI_A is the annual inflation rate (80%) and r_A is the annual discount rate, which is the real rate of return on equity (12%).

The first set of scenarios assumed that there is monthly billing and an instantaneous adjustment of the water prices for inflation, while the payment lag after billing is let to vary as "zero", "one month lag" and "3 months lag" in payment after billing. For equivalence between the value of the annual cash flows and the monthly cash flows, for the revenues of each year, we have the corresponding expression (2) (calculating the break-even prices of water when payments are made more frequently than once a year):

$$\sum_{k=1}^{Bc} \frac{\left[p_o^*(1+gI_m)^{w-L} * Q/Bc\right]_k}{\left[(1+gI_m)^{(12/Bc)*k} * (1+r_m)^{(12/Bc)*k}\right]} = \frac{p_o(1+gI_A) * Q}{(1+gI_A) * (1+r_A)}$$

expression (2)

Where: P_o^* is the initial price if payments are made monthly

Q is the amount of water sold in a year

gI_m is the monthly inflation rate

r_m is the monthly discount rate

L is the payment lag after billing expressed in number of months

Bc is the number of billing cycles in a year

w is the number of months of adjustments of nominal prices that correspond to the particular billing period (see Table 7 below)

k refers to the particular billing cycle in the year

Table 7. Value of w for Alternative Frequencies for Adjustment of Nominal Prices for Inflation

For Instantaneous Adjustment

N	1st Month	2nd Month	3rd Month	4th Month	5th Month	6th Month	7th Month	8th Month	9th Month	10th Month	11th Month	12th Month
W	1	2	3	4	5	6	7	8	9	10	11	12
For quarterly adjustment,												
W	1	1	1	4	4	4	7	7	7	10	10	10
For 6 months adjustment,												
W	1	1	1	1	1	1	7	7	7	7	7	7
For annual adjustment,												
W	1	1	1	1	1	1	1	1	1	1	1	1

Where L is equal to:

1	1 month payment lag after billing
2	2 months payment lag after billing
3	3 months payment lag after billing

And where B_C is equal to:

12	Monthly billing
4	Quarterly billing
	Six months billing

We now wish to solve expression (2) for the value of Po*, which is the initial real price that must be set at the end of 1998 in order for the periodic system of payments to yield the same revenue in present value terms as was obtained under the assumption that water is all used and sold at the end of each year. This analysis is applicable to all sources of water supply. It is not a feature of only the tanker project. It is equally applicable to water obtained from wells, dams, water bags, pipeline or desalination plants. The results obtained are given in Table 8.

At a zero rate of leakage from the distribution system, and billing carried out monthly with no lag in payment and instantaneous adjustment of price for inflation, the break-even price is \$0.751. In case of 1 or 3 months of payment lag after billing, the break-even price of water rises up to \$0.789 and \$0.870 respectively. This is caused simply by the time value of money. Households are financially equally well off if they pay \$0.751 per m^3 with no payment lag after billing or \$0.789 per m^3 with one-month payment lag after billing or \$0.870 per m^3 with three months payment lag after billing.

Table 8. Break-even Real Prices of Water per Cubic Meter for Various Scenarios as of December 1998.

Billing Cycle	Payment Lag After Billing	Nominal Price Adjustment for Inflation	Breakeven Price of Water With Different levels of Leakage ($US)			
			0%	10%	20%	30%
Annual	0	Instantaneous	0.7915	0.8795	0.9894	1.1308
Monthly	0	Instantaneous	0.7510	0.8345	0.9388	1.0730
Monthly	1 Month	Instantaneous	0.7887	0.8764	0.9860	1.1269
Monthly	2 Months	Instantaneous	0.8283	0.9204	1.0354	1.1834
Monthly	3 Months	Instantaneous	0.8699	0.9666	1.0874	1.2428
Monthly	1 Month	Quarterly	0.8274	0.9194	1.0343	1.1821
Monthly	1 Month	6 Months	0.8872	0.9858	1.1090	1.2675
Monthly	1 Month	Annually	1.0124	1.1250	1.2656	1.4464
Monthly	2 Months	Quarterly	0.8690	0.9656	1.0863	1.2415
Monthly	2 Months	6 Months	0.9317	1.0353	1.1647	1.3311
Monthly	2 Months	Annually	1.0633	1.1815	1.3291	1.5191
Monthly	3 Months	Quarterly	0.9126	1.0140	1.1408	1.3038
Monthly	3 Months	6 Months	0.9785	1.0873	1.2231	1.3980
Monthly	3 Months	Annually	1.1166	1.2408	1.3958	1.5953
Two Months	1 Month	Instantaneous	0.7925	0.8806	0.9906	1.1322
Two Months	2 Months	Instantaneous	0.8323	0.9248	1.0404	1.1890
Two Months	3 Months	Instantaneous	0.8740	0.9712	1.0926	1.2487
Two Months	1 Month	Quarterly	0.8314	0.9238	1.0392	1.1877
Two Months	1 Month	6 Months	0.9139	1.0155	1.1424	1.3056
Two Months	1 Month	Annually	1.0429	1.1588	1.3037	1.4900
Two Months	2 Months	Quarterly	0.8731	0.9702	1.0914	1.2474
Two Months	2 Months	6 Months	0.9598	1.0665	1.1997	1.3712
Two Months	2 Months	Annually	1.0952	1.2170	1.3691	1.5648
Two Months	3 Months	Quarterly	0.9169	1.0189	1.1462	1.3100
Two Months	3 Months	6 Months	1.0079	1.1200	1.2599	1.4400
Two Months	3 Months	Annually	1.1502	1.2781	1.4378	1.6433

The results from the annual cash flow statements are used to determine the equivalent break-even prices for billing periods of one month and two months, when the nominal prices adjust instantaneously for inflation. The payment lag after billing is taken also with “zero lag”, “one month” and “three months” lags after billing. The results are presented in Table 8. It is interesting to note that billing water consumption every month rather than once in every two months does not have a great impact on the price of water that must be charged. Its impact is less than one cent per cubic meter, 78.9 cents vs. 79.3 cents (with a zero level of leakage from the distribution system).

Billing every two months and getting paid with a two months lag in payment is now the case of Gazimagusa, except that at the present time the nominal prices are not adjusted to inflation instantaneously but annually. Billing every two months but getting paid after three months describes the application of Nicosia. In this case the break-even price of water for Nicosia is $1.150 with an annual adjustment for inflation, which is about $0.055 greater than the break-even price for Gazimagusa ($1.095).

The break even prices given above for Nicosia and Gazimagusa assume no leakage from the distribution systems. In North Cyprus the officials estimate a leakage of 25% to 30% from the distribution systems. Thus in case of a 30 % leakage from the distribution system, the households in Gazimagusa would have to pay $1.565 rather than $1.095 and the households in Nicosia would have to pay $1.643 rather than $1.150 per m^3 of water. This is compared to a real landed cost of $0.751 when delivered at Kumkoy by the tanker.

4.3 Sensitivity Analysis

In order to determine the effects of an investment cost overrun and the rate of return on equity on the outcome of the project a sensitivity analysis is carried out. Investment costs may go up due to a rise in the prices of inputs, or the amount of physical inputs may increase, or time delays in construction. For various levels of the net present values of investment cost overruns, the break-even prices of water per m^3 is given in Table 9. We find that the break-even annual price of water is sensitive to investment cost overruns with a 20% increase in the investment cost causing the real price of water to rise from $0.792 to $0.868, which is about 10% increase in price. This price is not nearly as sensitive to cost overruns, however, as it is to the water leakages in the system. In the Table 8, we find that a 10% level of water leakages would require water prices to be raised by 10 percent and 20% leakage would cause the price to be raised by 20%.

Table 9. Sensitivity Analysis of Investment Cost Overruns on the Break-even Price of Water.

-0.20	0.7147
-0.15	0.7339
-0.10	0.7531
-0.05	0.7723
0.00	0.7915
0.05	0.8107
0.10	0.8300
0.15	0.8492
0.20	0.8684

The required rate of return on equity is another factor that may affect the outcome of the project. The sensitivity analysis of this variable on the break-even price of water is given in Table 10. The outcome of the project can be said to be sensitive on the required rate of return as well, but not as much as to the investment cost overruns or leakages. If the required rate of return is raised from a real rate of 12 percent to a real rate of 20% (66% increase), the required price of water is increased by about 6%.

Table 10. Sensitivity Analysis of Real Rate of Return on Equity on the Break-even Price of Water.

10%	0.7782
12%	0.7915
14%	0.8052
16%	0.8191
18%	0.8332
20%	0.8476

5. CONCLUDING REMARKS

In order to solve the water shortages of North Cyprus various projects are planned for potential implementation. Conversion of traditional irrigation methods to modern irrigation on 10,000 donums of land in Guzelyurt and the rehabilitation and use of treated wastewater from Haspolat Wastewater Treatment Plant for agriculture are two projects expected to be completed by the end of 1998. In this study, a financial feasibility analysis of importing 7 million m^3 of water to North Cyprus from Turkey by a tanker is carried out. Perhaps of more importance, an analysis of alternative pricing policies has been formulated that reflects the various management practices of the water resource authorities in North Cyprus.

The transportation cost of per m^3 of water imported from Manavgat to Kumkoy by a tanker with a capacity of 40,000 m^3 is found to be on average \$0.46 per m^3. This price does not include any infrastructure to be built in North Cyprus, port-handling charges in Turkey and any payment for water to Turkey. When infrastructure and operating costs in North Cyprus and port handling charges are included, the cost of water in Kumkoy is expected to be \$0.79 per m^3. This price also excludes any payment to Turkey for the raw water. These results indicate that the use of water tanker transportation between Turkey and North Cyprus is highly competitive to other methods of supply, such as desalination, which will cost at least 50% more (Rogers, 1994: 299).

A monthly net cash flow is used in order to analyze the effects of various financial aspects affecting the price of water to the consumer. This analysis is applicable to all sources of water supply. In this analysis the break-even prices are calculated to reflect the time value of money for which the households are indifferent in present value terms. It has been observed that billing monthly or billing every two months does not significantly effect the price of water to the consumer. On the other hand, billing every two months with a payment lag of two months after billing (the case of Gazimagusa), or a payment lag of three months after billing (the case of Nicosia) combined with an annual adjustment of nominal water prices for inflation has a substantial impact on the price of water causing it rise to \$1.150 from \$1.095.

By far the most important variable determining the real price of water is the amount of leakages in the system. This is a variable that is directly related to the management and maintenance practices of the local water authorities. When water leakage rate of 30% is taken into consideration the break-even price of water rises to be $1.565 for Gazimagusa and $1.643 for Nicosia. The model also enables us to predict the price of water if the percentage of leakage is reduced from 30% to 20% and 10%. Under the same circumstances, at a 20 % leakage level, the price of water in Gazimagusa and in Nicosia will be reduced to $1.369 and $1.438 respectively.

Sensitivity analysis carried out of the impact of investment cost overruns and the required rate of return on equity on the break-even price of water, showed that they affect the outcome of the project, and thus the cost of water per m^3. They are not, however, as important as the water management practices that account for the high rate of leakages in the system.

APPENDIX

Table 11. Cash Flow Statement (Real Prices). in 1,000,000 TL

Total Investment Point of View

Years	1998	1999	2000	2005	2010	2013	2014
Inflation Index	1.00	1.80	3.24	61.22	1156.83	6746.64	12143.95
RECEIPTS							
Sales Revenue	0	1,927,368	1,927,368	1,927,368	1,927,368	1,927,368	0
Change in Accounts Receivable	0	0	0	0	0	0	0
Liquidation value							
Tanker	0	0	0	0	0	0	278,283
Shamandra (Mooring System)	0	0	0	0	0	0	69,571
Boat	0	0	0	0	0	0	8,696
Sea pipeline (Shamandra-shore)	0	0	0	0	0	0	58
Land pipeline (shore-Kumkoy)	0	0	0	0	0	0	58
Reservoir at Kumkoy	0	0	0	0	0	0	208
Additional pumps at Serhatkoy	0	0	0	0	0	0	33
CASH INFLOW	0	1,927,368	1,927,368	1,927,368	1,927,368	1,927,368	356,907

(Table 11 cont).

EXPENDITURES							
Investments Cost							
Tanker	2,782,835	0	0	0	0	0	0
Shamandra (Mooring System)	695,709	0	0	0	0	0	0
Boat	86,964	0	0	0	0	0	0
Sea pipeline (Shamandra-shore)	391,336	0	0	0	0	0	0
Land pipeline (shore-Kumkoy)	347,854	0	0	0	0	0	0
Reservoir at Kumkoy	1,252,276	0	0	0	0	0	0
Additional pumps at Serhatkoy	347,854	0	0	0	0	0	0
Total Investment Cost	5,904,828	0	0	0	0	0	0
Operating Cost							
Crew Expenses	0	176,327	181,225	207,833	238,348	258,767	0
Boat Staff Expenses	0	27,457	28,220	32,363	37,115	40,295	0
Insurance	0	55,657	55,657	55,657	55,657	55,657	0
Maintenance	0	51,222	51,222	51,222	51,222	51,222	0
Fuel & Lubrication	0	453,924	453,924	453,924	453,924	453,924	0
Manavgat part handling charges	0	304,647	304,647	304,647	304,647	304,647	0
Miscellaneous	0	8,922	8,922	8,922	8,922	8,922	0
Annual total cost of water bought	0	0	0	0	0	0	0
Total Operating Cost	0	1,078,156	1,083,817	1,114,568	1,149,834	1,173,433	0

(Table 11 cont).

Working Capital							
Change in Accounts payable		-60,686	-26,971	-26,971	-26,971	-26,971	33,714
Change in Cash balances		44,308	19,925	20,506	21,172	21,617	-26,791
Total change in working capital		-16,738	-7,046	-6,466	-5,800	-5,354	6,924
CASH OUTFLOW	5,904,828	1,061,778	1,076,770	1,108,102	1,144,034	1,168,079	6,924
NCF	-5,904,828	865,590	850,598	819,266	783,334	759,289	349,983

Table 12. Cash Flow Statement (Real Prices). in 1,000,000 TL

Owner's Point of View

Years	1998	1999	2000	2005	2010	2013	2014
Loan Inflow	4,072,505						
Net Cash Flow Before Financing	-5,904,828	865,590	850,598	819,266	783,334	759,289	349,983
Net Debt Financing Cash Flow	0	-650,190	-631,252	-544,524	-469,711	-429,852	0
Net Cash Flow After Financing	-1,832,323	215,400	219,345	274,742	313,623	329,437	349,983
NPV	**-0 TL**						
Equity return rate (Real)	**12%**						

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