Water Balances in the Eastern Mediterranean

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TRANSPORTING WATER BY TANKER FROM TURKEY TO NORTH CYPRUS: COSTS AND PRICING POLICIES

Hasan Ali Biçak and Glenn Jenkins

Introduction

North Cyprus is in a semi-arid region where average annual rainfall varies from 200 to 600 mm. From the beginning of the century, it has experienced a reduction in average annual rainfall: from 440–450 mm at the beginning of the century, to 402 mm from 1941 to 1972, to 382.4 mm from 1975 to 1993 (Biyikoglu 1995). In addition, overextraction of water from aquifers has resulted in seawater intrusion all over the island. Seawater intrusion in Gazimagusa and Gecitkale aquifers has been so severe that the water is no longer potable, and water stations had to be set up to sell fresh water. Also, because of water shortages and the use of saline water for irrigation, a large number of citrus trees have died, and the land they grew on is no longer irrigated. Between 1976 and 1996, land used for citrus production fell from 74 710 donums (1 donum [dn] of land is equal to 0.1338 ha) to 47 700 dn. In the same period, total irrigated land fell from 116 400 dn to 74 044 dn (MOAF 1997a, b).

The land area of North Cyprus is 2 465 552 dn, of which 1 392 123 dn (57%) is agricultural. About 881 481 dn (63.05%) of this land is cultivated, of which 805 437 dn (91.6%) is rain fed and 74 044 dn (8.4%) is under irrigation (MOAF 1997b).

NB: The authors would like to thank Ali Özdemirag for his extensive assistance in completing the quantitative aspects of this study.

Previous studies, which did not take account of the sharp fall in irrigated area, estimated demand for water in North Cyprus at between 190 and 197 Mm^3 and the actual supply of water at between 110 and 125 Mm^3, without explaining how, in practice, the deficit was made up (Numan and Agiralioglu 1995; TCW 1996[1]). If one does take into account the sharp fall in irrigated land, distinguishing between land irrigated with traditional and that irrigated with modern methods, demand for water in North Cyprus can be estimated at 106.6 Mm^3 for 1996 (Biçak and Özdemirag 1997). In the study by Biçak and Özdemirag, water demand was estimated as 87.5 Mm^3 (82.1%) for agricultural use, 17.1 Mm^3 (16.1%) for household consumption (including the armed forces, seasonal workers from Turkey, students and the tourists), 1.3 Mm^3 (1.2%) for animals, and 0.7 Mm^3 (0.7%) for commercial and industrial use, giving a total demand of 106 Mm^3.

As for the potential supply of water, no reliable figure will be available until research currently conducted by the Mines Investigation and Search Institute of Turkey is completed. Previous data show that about 74.1 Mm^3/year can be extracted from the aquifers without depleting them, but it is estimated that overextraction of water from the aquifers could be as high as 28.9 Mm^3/year, giving a total yearly extraction of 103 Mm^3. Guzelyurt aquifer is the biggest on the island, with 37 Mm^3 of safe-yield capacity, and it is believed that 20 Mm^3/year is overextracted from this aquifer alone.[2] An alternative would be to consider rivers and existing dams as providing annually about 13 Mm^3 and 7 Mm^3 of water, respectively, depending on rainfall. On this basis, total potential water supply of North Cyprus is 94.1 Mm^3 (74.1 + 13 + 7). This makes the water deficit about 12.5 Mm^3 (106.6 – 94.1), and the deficit is now being filled by overextraction from aquifers.

Water shortage for domestic and agricultural use in North Cyprus is evident. Various measures are planned, and others have been implemented to increase the supply of water and use it more efficiently. Projects have been proposed to import water from Turkey by tanker, in large water bags or by pipeline. The water-bag option has been tried, starting from 25 July 1998 (Kibris 1998a). It is estimated that water bags with a 10 000-m^3 capacity can bring 3 Mm^3 of water in

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[1] TCW (Technical Committee on Water). 1996. Summary report on the studies carried out by the Committee. TCW, Nicosia, North Cyprus. Unpublished report, 31 Jan.

[2] State Planning Organization of the Turkish Republic of North Cyprus, Prime Ministry, Nicosia, North Cyprus, 1992.

1 year. The water comes from the Soguksu River in Anamur, Turkey. An increase in the capacity of the water bags to 30 000 m^3 would enable 7 Mm^3 of water to be imported annually. This is the maximum amount that the system in North Cyprus can allow to be pumped. It is pumped from Kumkoy to Serhatkoy, and then on to Dikmen (where the main reservoirs are situated), and from there to Nicosia and Gazimagusa.

Another important project (currently implemented in the Guzelyurt area) aims to prevent the excessive use of water by converting traditional irrigation systems to modern ones. A large amount of water will be conserved, salination will be prevented, and the productivity and quality of agricultural output will improve. Production costs will decrease because less fertilizer will be needed. Currently, of all irrigated land (74 044 dn), some 66 084 dn (89.2%) is irrigated by traditional methods, and 7 960 dn (10.8%) is irrigated by modern methods, with sprinklers (2 989 dn, or 37.6%) and drip irrigation (4 971 dn, or 62.4%) (MOAF 1997b). The project started by converting 10 000 dn from traditional to modern irrigation practices on citrus farms in the Guzelyurt area. Authorities are planning to convert 10 000 dn of citrus land every year to modern irrigation practices, so that all crops will be irrigated this way by 2001 (Sevki 1997). Considering that 1 dn of citrus land uses 1 420 m^3 of water annually with traditional methods, but only 710 m^3 with modern methods, this is expected to save a large amount of water, potentially as much as 46.9 Mm^3 (710 × 66 084), if the project is implemented successfully.

To ease the water shortage of North Cyprus, there is a proposal to import water by pipeline from Anamur or Manavgat, Turkey. If this project is implemented, 75 Mm^3 of water could be brought to Kumkoy, North Cyprus, from where it would be further distributed. The Council of Ministers of Turkey has decided to implement the project through the Turkish firm, ALARKO Holding Company. This project appears to be financially infeasible for Turkey if the project's revenues are limited only to those gained from selling water in North Cyprus. It might become financially feasible if more water is sold to South Cyprus or to other Middle Eastern countries (Biçak 1996). It might be worthwhile, in political terms, for Turkey to build a permanent pipeline supply link to North Cyprus. Once the capital investment is made, the marginal pumping costs and operating expenses would be very low.

Another project to supply water to Nicosia and Gazimagusa is to build a dam in the Yesilirmak area, where, depending on precipitation, about 8–12 Mm^3

of water flows underground into the sea (Özdemirag 1998). This project is now on hold because of a conflict between the views of the government and those of local villagers affected by the project.

Rehabilitation of the Haspolat Sewage Treatment Plant is expected to be completed by the end of 1998. Once it is completed, it will provide 3.5 Mm^3 of water for agricultural use. Although the plant has been operating since 1980, it provides a very limited amount of water for agricultural use because much of the proposed infrastructure is not in place (Oznel et al. 1997; Kibris 1998b).

Setting aside all these projects either proposed, planned, under construction, partially implemented, or fully completed, this chapter will now turn to its main purpose, a feasibility study of importing water by tanker from Turkey to North Cyprus. The model chosen enables us to separate the effects of various components likely to have an impact on the unit cost of water and the financial outcome of the project. These components include inflation, billing cycle, payment terms, and a system for adjusting tariffs for inflation. A sensitivity analysis will enable us to identify the key variables that may affect the outcome of the project.

Methodology

To analyze the financial feasibility of importing water from Turkey to North Cyprus by tanker, a proforma cash-flow statement was constructed. Cash flow considers all revenues and expenditures throughout the life of the project. Net cash flow is projected from two points of view: equity (the owner) and total investment (the banker). Net cash flow projected from the equity point of view includes loans and repayment of the principal and interest, whereas net cash flow projected from the total-investment point of view excludes these items. The total-investment point of view analyzes the strength of the project in the absence of such financing arrangements (Harberger and Jenkins 1998). In this study, net present value (NPV) is calculated from the point of view of the owner (equity), using a real (inflation-free) discount rate of 12%.

North Cyprus, not having a currency of its own, uses the Turkish lira (TRL) as its medium of exchange and, along with Turkey, experiences annual inflation rates of about 80%. In such an inflationary environment, the length of the billing and payment cycle, as well as the system for adjusting water tariffs for inflation would play a significant role in the financial performance of the project.

The impact of inflation on the project is incorporated into the model by constructing 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 (Harberger and Jenkins 1998).

When net cash flow is calculated in this way, we can estimate the transportation cost per cubic metre of water from Turkey to North Cyprus, excluding all infrastructure investments and operating costs in North Cyprus itself. The cost per unit of delivered water, evaluated at its point of entry in Kumkoy, excludes the cost of leakage in the system, the financial effects of time lags in billing and payment for the water, and administrative lags in adjusting nominal tariffs for inflation. Next, we estimate the unit cost of the water, including the cost of water leakage in the distribution system, and, finally, the last set of cost calculations introduces alternative scenarios or combinations of administrative ways of handling accounts receivable, accounts payable, and lags in adjusting the nominal prices of water for inflation. These calculations will show the financial implications of various alternative pricing policies as used by municipalities in North Cyprus.

Project description

Objective and scope of the project

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

Currently, fresh water is pumped from Kumkoy to Serhatkoy and from there to the main reservoir in Dikmen. Then the water is distributed to Nicosia and Gazimagusa. Kumkoy is supported by 14 wells and sends 9 000 m^3/day of water to Serhatkoy. Adding 3 500 m^3 of water from four nearby wells, Serhatkoy pumps a total of 12 500 m^3 /day. Of this amount, 3 500 m^3 is sent to the Turkish part of Nicosia through South Cyprus, and 9 000 m^3 is sent to Dikmen, from which point 3 000 m^3 is sent to Gazimagusa and 6 000 m^3 is sent to Nicosia. This amount of water is insufficient, and the quality of the water is very poor. The pipes have a

Table 1. Distribution of water and existing infrastructure.

Capacity of existing infrastructure	
From Kumkoy and Serhatkoy to Dikmen (m^3/hour)	750
From Kumkoy and Serhatkoy to Dikmen (m^3/day)	18 000
From Kumkoy and Serhatkoy to Dikmen (m^3/year)	6 570 000
Sources and distribution of water	375
From 14 wells to Kumkoy (m^3/hour)	
From 14 wells to Kumkoy (m^3/day)	9 000
From Kumkoy to Serhatkoy (m^3/hour)	375
From 4 nearby wells to Serhatkoy (m^3/hour)	145
Total amount of water arriving in Serhatkoy (m^3/day)	12 500
From Serhatkoy through South Cyprus to Nicosia (m^3/day)	3 500
From Serhatkoy to Dikmen (m^3/day)	9 000
Total amount of water distributed from Serhatkoy (m^3/day)	12 500

Source: Data on the tanker project were obtained from the Undersecretary's and the Port General Directorate's offices of the Transportation Ministry, and data on the pipeline project were obtained from the Water Works Office of the Ministry of the Interior of the Turkish Republic of Northern Cyprus.

diameter of 18 inches (1 inch = 2.540 cm), and they cannot transport more than 18 000 m^3/day, or 6.57 Mm^3/year (Table 1).

Manavgat, on the south coast of Turkey, was chosen from a number of possible sources for water to ship to North Cyprus because it already had the necessary infrastructure on land, and some of the sea structures were expected to be completed shortly. Currently, at Manavgat, 500 Mm^3 of fresh water flows annually into the sea. Once the land and sea infrastructure is completed, it would be possible to export water to other Mediterranean countries. Manavgat, Turkey, and Kumkoy, North Cyprus, are 248 km apart. Considering the volume that the distribution system in North Cyprus can handle (6.57 Mm^3/year), one tanker with 40 000-m^3 capacity, making 175 trips a year, could transport 7 Mm^3 of water. The tanker is assumed to operate 320 days a year, staying nonoperational 45 days a year for maintenance and repairs and for days when weather conditions are unsuitable for navigation (Table 2).

Table 2. Capacity of tanker and volume of water to be imported.

Number of nonoperational days per year	45
Number of operational days per year	320
Distance between Manavgat, Turkey, and Kumkoy, North Cyprus (km)	248
Tanker's average speed (km/hour)	20.8
Time to travel one way (hours)	12
Time for loading in Manavgat (10 000 m^3/hour)	5
Time for connecting, disconnecting, and formalities in Manavgat (hours)	3
Time for discharging in Kumkoy (hours at 4 000 m^3/hour)	10
Time for connection, disconnection, and formalities in Kumkoy (hours)	2
Total time for one round trip (hours)	44
Total number of trips per year	175
Total volume of water per trip (m^3)	40 000
Total volume of water per year (m^3)	7 000 000

Source: Data on the tanker project were obtained from the Undersecretary's and the Port General Directorate's offices of the Transportation Ministry, and data on the pipeline project were obtained from the Water Works Office of the Ministry of the Interior of the Turkish Republic of Northern Cyprus.

Total investment and operating costs

For this analysis, it is assumed that the tanker will be owned and operated under normal private financial arrangements. Although the installations in Manavgat, Turkey, are near completion, the government of North Cyprus needs to start building the necessary facilities on land and offshore in Kumkoy. A port is not required for the tanker in North Cyprus; rather, an offshore mooring system is sufficient. The water will be pumped through a sea-to-land pipeline to the reservoirs at Kumkoy. The existing system at Kumkoy will pump the water to Serhatkoy. To handle the increased capacity of water sent from Kumkoy, the pumping system in Serhatkoy will need to be augmented with two additional pumps. Table 3 shows that the

Table 3. Total investment costs (1998 prices) (USD).

Tanker	
Cost of tanker	8 000 000
Cost of offshore mooring system	2 000 000
Cost of boat for anchoring tanker and connecting–disconnecting pipes	250 000
Offshore pipeline (mooring station to shore, 1.5 km)	
Cost per km	750 000
Cost of offshore pipeline	1 125 000
Land pipeline (shore to Kumkoy: 2 km)	
Cost per km	500 000
Cost of land pipeline	1 000 000
Reservoir at Kumkoy (capacity, 2 x 20 000 m^3)	
Cost per Mm^3	90
Cost of reservoir (90 x 40 000)	3 600 000
New pumps at Serhatkoy (number, 2; capacity, 750 m^3/hour, or 18 000 m^3/day; average horsepower, 375)	
Cost of new pumps (2 x 500 000)	1 000 000
Total investment costs	16 725 000

Source: Data on the tanker project were obtained from the Undersecretary's and the Port General Directorate's offices of the Transportation Ministry, and data on the pipeline project were obtained from the Water Works Office of the Ministry of the Interior of the Turkish Republic of Northern Cyprus.
Note: USD, United States dollar.

total investment cost of the project, including infrastructure and the tanker, will be 16.725 million United States dollars (USD).[3]

Operating costs of the project include crew salaries, salaries for additional employees at Kumkoy, fuel and diesel-oil consumption, and maintenance. Annual total for the salaries of the crew is expected to be 493 200 USD; and for workers at Kumkoy, 76 800 USD. Costs of fuel and oil consumption will be 1 304 926 USD annually. Maintenance costs are expected to be around 147 250 USD. Table 4 gives an itemized breakdown of total annual operating costs (with an additional

[3] Data on the tanker project were obtained from the Undersecretary's and the Port General Directorate's offices of the Transportation Ministry, and data on the pipeline project were obtained from the Water Works Office of the Interior Ministry of the Turkish Republic of Northern Cyprus.

Table 4. Total operating costs (USD).

Monthly crew salaries on tanker	
Four captains at 2 000	8 000
Four engineers at 1 800	7 200
One communications officer at 1 300	1 300
Eight above-deck and eight below-deck crew members at 1 200	19 200
Two cooks and four stewards at 900	5 400
Total monthly crew salaries on tanker	41 100
Total annual crew salaries on tanker	493 200
Monthly personnel salaries at Kumkoy	
One captain at 800	800
One mechanical engineer at 800	800
Two boat crew members at 600	1 200
Six Water Resources Department employees at 600	3 600
Total monthly personnel salaries at Kumkoy	6 400
Total annual personnel salaries at Kumkoy	76 800
Fuel oil consumption — 35 t per round trip at 150/t	5 250
Total annual cost of fuel oil	919 579
Diesel oil consumption: 10 tons per round trip at 220/t	2 200
Total annual cost of diesel oil	385 347
Port handling costs at Manavgat at 5 000 per trip	875 789
Annual insurance costs at 2% of the tanker's initial price	160 000
Water cost — 7 million m^3 at 0.15/m^3	1 050 000
Cost of maintenance at 1% of initial price	
Tanker	80 000
Offshore pipeline	11 250
Land pipeline	10 000
Reservoir	36 000
Pumps	10 000
Total annual cost of maintenance	147 250
Miscellaneous (1% of operating costs)	30 580
Total annual operating costs	4 138 545

Source: Data on the tanker project were obtained from the Undersecretary's and the Port General Directorate's offices of the Transportation Ministry, and data on the pipeline project were obtained from the Water Works Office of the Ministry of the Interior of the Turkish Republic of Northern Cyprus.
Note: USD, United States dollar.

1% to cover miscellaneous items), for a grand total of 4 138 545 USD (1998 prices).

Sources of financing

Plans are that 70% of the total investment costs (11.707 5 million USD) would be borrowed in US dollars, directly from Turkey or else from international financial institutions with guarantees from Turkey. The rest of the investment costs (5.017 5 million USD) will be equity financed. The real interest rate on the loan (before risk adjustment) is assumed to be 4%. In addition, there will be a 5% risk premium associated with Turkey. Therefore, the loan would be taken out at a 9% real basic interest rate. Taking into account an expected 3% annual inflation rate for the US dollar, 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 investment is taken as 12%. Therefore, the weighted average real cost of capital financed through 70% borrowed money and 30% equity financing is calculated at 10%. The domestic annual inflation rate in North Cyprus is assumed to be 80%, and the end-of-1998 exchange rate is set at 290 050 TRL = 1 USD (in 1999, 429 900 Turkish lira [TRL] = 1 United States dollar [USD]) (Table 5).

Analysis results

Various unit costs of water

The objective of this part of our feasibility study is to estimate the minimum that must be charged per cubic metre of water to make water shipment by tanker from Turkey to North Cyprus feasible. This is a function of (1) the costs of the project; and (2) the efficiency of authorities in managing the water systems. The real net cash flow constructed from the owner's point of view enables us to derive the financial cost per cubic metre of water. The cost per cubic metre of water, computed at various stages of the delivery process, is the break-even average real price evaluated at the implementation stage of the project (December 1998) from the equity point of view, using a 12% real discount rate. The first calculated cost per cubic metre of water is the cost of transportation, which excludes installation costs at both ends, leakage in the system, and ongoing financial management (delays in reading the meter, billing, and payments, and adjusting water tariffs for inflation). The cost of transporting the water is found to be 0.46 USD/m^3; this figure does not include payment for raw water to Turkey. As a comparison, however, the cost

Table 5. Exchange rates, inflation rates, and financing.

Inflation and exchange rates			
Domestic inflation rate (%)			80
US inflation rate (average over last 5 years) (%)			3.0
Real exchange rate (TRL/USD) (149 000 × 1.8/1.03)			290 050 (year end 1998)
Financing (amounts)			
From Turkish or Turkish-guaranteed USD credit (70% of total investment costs) (USD)			11 707 500
From equity (30% of total investment costs) (USD)			5 017 500
Interest rates (%)	Real	Nom	
Interest rate (%)	4.0	inal	
Risk for Turkey (%)	5.0	—	
USD borrowing rate for Turkey (%)	9.0	—	
USD return on equity (%)	12	12.0	
		-	
Financing (terms)			
Percentage from equity (%)	30		
Percentage borrowed (%)	70		
Number of years for repayment	15		

Source: Data on the tanker project were obtained from the Undersecretary's and the Port General Directorate's offices of the Transportation Ministry, and data on the pipeline project were obtained from the Water Works Office of the Ministry of the Interior of the Turkish Republic of Northern Cyprus.
Note: TRL, Turkish lira (in 1999, 429 900 Turkish lira [TRL] = 1 United States dollar [USD]); USD, United States dollar.

of transporting 1 m^3 of water in water bags from Anamur to Kumkoy, a distance of 84 km, is estimated at 0.55 USD.[4]

The unit cost of water by tanker to Kumkoy increases to 0.79 USD/m^3 when the cost includes investment in the infrastructure required in North Cyprus (Table 6). This price also includes port handling charges in Turkey and operating costs in North Cyprus but excludes any payment to Turkey for the raw water (perhaps 0.15 USD/m^3), cost of leakage in the country's distribution system, and financial losses resulting from inefficient pricing or collection policies.

Leakage of water from the distribution system to households is also a cost. Adding the present 30% leakage, as well as unpaid deliveries, to the transportation

[4] See "Contract on Transporting Water from Turkey to the Turkish Republic of Northern Cyprus, Between the Mediterranean Water Supply A.S. (Mr. Akif Alpar) and the Ministry of the Interior of the TRNC, the Water Works Department (Mr. Mustafa Can)," 30 Dec 1997, p. 3, art. 3.

Table 6. Cost of water at various stages in the delivery process (USD/m^3).

Transportation cost of water	0.46
Cost of water to Kumkoy	0.79
Cost of water to households	
(20% leakage)	0.99
(30% leakage)	1.13

Source: Calculations from data in Tables 1–5.
Note: Costs do not include any payment for raw water to Turkey, which could be around 0.15 USD/m^3. USD, United States dollar.

and infrastructure costs, the cost of delivering 1 m^3 of water to households would be 1.13 USD/m^3, excluding any payment for water in Turkey and any water treatment costs (Table 6).

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 real (1998) prices are shown in Tables 7 and 8.

Some financial management aspects in determining the unit cost of water

In North Cyprus, the Waterworks Department of the Ministry of the Interior has responsibility for distributing water to municipalities and other local authorities, repairing breakdowns, and general maintenance of the distribution system. Municipalities read the water meters, bill the customers, and collect payments to meet their own budgets, but they have not been very efficient at it. In an inflationary environment, lags in reading meters, billing, and payment have a great impact on the net cash flow of the utility. Meters are read every 2 months. In Gazimagusa, bills are filled in and given to customers on the spot, and consumers are expected to pay within the 2-month period before the meter is read again. A graduated surcharge is added for delays in payment. In Nicosia, rather than filling in the bill on the spot, it is prepared in the municipal office and brought to the consumer the next time that the meter is read, which results in a 2-month time lag in billing.

In this section, the cost of water is calculated for various scenarios, putting the following factors into relation: billing period, payment lag after billing, and frequency in adjusting nominal prices for inflation. For this analysis, rather than using annual cash flow, we construct monthly cash flow for any year of operation and use the value of sales at the end of 1998 to find the break-even price of water (P^*_0) that would yield equal revenues (in present-value terms) under the various

Table 7. Cash flow statement (1998 prices) total investment point of view (million TRL).

	1998	1999	2000	2005	2010	2013	2014
Inflation index	1.00	1.80	3.24	61.22	1 156.83	6 746.64	12 143.95
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
Mooring system	0	0	0	0	0	0	69 571
Boat	0	0	0	0	0	0	8 696
Sea pipeline	0	0	0	0	0	0	58
Land pipeline	0	0	0	0	0	0	58
Reservoir (Kumkoy)	0	0	0	0	0	0	208
New pumps (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
Expenditures							
Investment costs							
Tanker	2 782 835	0	0	0	0	0	0
Mooring system	695 709	0	0	0	0	0	0
Boat	86 964	0	0	0	0	0	0
Sea pipeline	391 336	0	0	0	0	0	0
Land pipeline	347 854	0	0	0	0	0	0
Reservoir (Kumkoy)	1 252 276	0	0	0	0	0	0
New pumps (Serhatkoy)	347 854	0	0	0	0	0	0
Total investment costs	5 904 828	0	0	0	0	0	0

(continued)

Table 7. Concluded.

	1998	1999	2000	2005	2010	2013	2014
Operating costs							
Crew salaries	0	176 327	181 225	207 833	238 348	258 767	0
Boat staff salaries	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 and oil	0	453 924	453 924	453 924	453 924	453 924	0
Manavgat handling charges	0	304 647	304 647	304 647	304 647	304 647	0
Miscellaneous							
Annual cost of water	0	8 922	8 922	8 922	8 922	8 922	0
Total operating costs	0	0	0	0	0	0	0
	0	1 078 156	1 083 817	1 083 817	1 114 568	1 173 433	0
Working capital							
Change in accounts payable							
Change in cash balances		–60 686	–26 971	–26 971	–26 971	–26 971	33 714
Total change							
		44 308	19 925	20 506	21 172	21 617	–26 791
		–16 738	–7 046	–6 466	–5 800	–5 354	6 924
Cash outflow							
Net cash flow	5 904 828	1 061 778	1 076 770	1 108 102	1 144 034	1 168 079	6 924
	–5 904 828	865 590	865 598	819 266	783 334	759 289	349 983

Source: Calculations from data in Tables 1–5.
Note: TRL, Turkish lira (in 1999, 429 900 Turkish lira [TRL] = 1 United States dollar [USD]); USD, United States dollar.

Table 8. Cash flow statement (1998 prices) owner's point of view (million TRL).

Year	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						
Equity return rate (real)	12%						

Source: Calculations from data in Tables 1–5.
Note: NPV, net present value; TRL, Turkish lira (in 1999, 429 900 Turkish lira [TRL] = 1 United States dollar [USD]); USD, United States dollar.

scenarios. The first year's revenues in the annual formulation of the model are given in equation [1]:

$$\frac{P_o \times (1 + gP_A) \times Q}{(1 + gP_A) \times (1 + r_A)} \qquad [1]$$

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 (estimated at 0.7915 USD, when the NPV is set to zero); Q is the amount of water sold in a year; gP_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%). For the case under study, the value of equation [1] is 4 970 462 USD in the first year of operation.

In the first set of scenarios, it is assumed that there is monthly billing and instantaneous adjustment in the prices for inflation, and the payment lag after billing is allowed to vary as "no lag," "1-month lag," and "3-month lag" in payment after billing. For equivalence between the value of annual cash flows and monthly cash flows yielding annual revenues for any given year, we have equation [2], calculating the break-even prices of water when payments are made more frequently than once a year:

$$\frac{\sum_{i=1}^{B_c} \{[P^*_o \times (1 + gP_m)^{NPA_\Pi - P_L}] \times Q/B_c\}}{\sum^{B_c} \{[(1 + gP_m)^{(12/B_c) \times k}] \times (1 + r_m)^{(12/B_c) \times Q/B_c}\}} = \frac{P_o \times (1 + gP_A) \times Q}{(1 + gP_A) \times (1 + r_A)} \qquad [2]$$

where P^*_o is the initial price if payments are made monthly; gP_m is the monthly inflation rate; r_m is the monthly discount rate; NPA_Π is the period representing the month that the adjustment of nominal price for inflation is made; P_L is the payment lag after billing expressed in number of months; B_c is the number of billing cycles in a year; n is $(12/B_c) \times k$; and k refers to the particular billing cycle in the year (see Table 9).

Table 9. Value of water for alternative frequencies in adjusting nominal prices for inflation.

	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
For instantaneous adjustment												
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 semiannual 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

Source: Calculations from data in Tables 1–5.
Note: Based on equation 2, where P_L is equal to 1 (1-month payment lag after billing), 2 (2-month payment lag after billing), and 3 (3-months payment lag after billing); and B_c is equal to 12 (monthly billing), 4 (quarterly billing), and 2 (semiannual billing).

We now solve equation [2] for the value of P^*_o, which is the initial real price that must be set at the end of 1998 for the periodic system of payments to yield the same revenue in present-value terms as obtained under the assumption that water is all used and all sold at the end of each year. This analysis is applicable to all sources of water; it is not just a feature of the tanker project. It is equally applicable to water obtained from wells, dams, water bags, pipelines, or desalination plants. The results obtained are given in Table 10.

At a zero rate of leakage in the distribution system, with billing carried out monthly, no lag in payment, and instantaneous adjustment of price for inflation, the break-even price is 0.751 USD. In the event of 1 or 3 months of payment lag after billing, the break-even price of water rises to 0.789 USD and 0.870 USD, respectively, because of the time value of money. Households are equally well off financially if they pay 0.751 USD/m^3 with no payment lag, 0.789 USD/m^3 with a 1-month payment lag, or 0.870 USD/m^3 with a 3-month payment lag.

Results from the annual cash-flow statements are used to determine the equivalent break-even price for billing periods of 1 and 2 months when nominal prices are adjusted instantaneously for inflation. The payment lag after billing is taken also with "zero," "1-month," and "3-month" lags after billing. The results

Table 10. Break-even real prices of water per cubic metre for various scenarios from end of 1998.

Billing cycle	Payment lag after billing	Time lag to adjust for inflation	Break-even price of water at various levels of leakage (USD)			
			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
2 months	1 month	Instantaneous	0.7925	0.8806	0.9906	1.1322
2 months	2 months	Instantaneous	0.8323	0.9248	1.0404	1.1890
2 months	3 months	Instantaneous	0.8740	0.9712	1.0926	1.2487
2 months	1 month	Quarterly	0.8314	0.9238	1.0392	1.1877
2 months	1 month	6 months	0.9139	1.0155	1.1424	1.3056
2 months	1 month	Annually	1.0429	1.1588	1.3037	1.4900
2 months	2 months	Quarterly	0.8731	0.9702	1.0914	1.2474
2 months	2 months	6 months	0.9598	1.0665	1.1997	1.3712
2 months	2 months	Annually	1.0952	1.2170	1.3691	1.5648
2 months	3 months	Quarterly	0.9169	1.0189	1.1462	1.3100
2 months	3 months	6 months	1.0079	1.1200	1.2599	1.4400
2 months	3 months	Annually	1.1502	1.2781	1.4378	1.6433

Source: Calculations from data in Tables 1–5.
Note: USD, United States dollar.

are presented in Table 10. It was found that billing for water consumption every month, rather than once every 2 months, does not have a great impact on the price of water, less than 1% per cubic metre, or 0.789 USD versus 0.793 USD/m^3 (assuming a zero level of leakage from the distribution system).

Billing every 2 months and getting paid with a 2-month lag is now the case in Gazimagusa, except that at present, nominal prices are not adjusted to inflation instantaneously but annually. Billing every 2 months but getting paid after 3 months describes the application for Nicosia, where the break-even price is 1.150 USD/m^3, with annual adjustment for inflation, which is 0.055 USD higher than the break-even price for Gazimagusa (1.095 USD).

The break-even prices given here for Nicosia and Gazimagusa are based on the assumption of no leakage from the distribution systems. However, in informal communication with the authors, local officials involved in dealing with the issue in North Cyprus estimated leakage at 25–30%. If we factor in 30% leakage, households in Gazimagusa would have to pay 1.565 USD, as opposed to 1.095 USD; and in Nicosia, 1.643 USD, rather than 1.150 USD/m^3 of water, substantially higher than the real landed cost of 0.751 USD, delivered at Kumkoy by tanker.

Sensitivity analysis

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 was carried out. Investment costs may go up because of a rise in the cost of inputs; the amount of physical inputs may increase; or there may be delays in completing construction. Table 11 gives the break-even prices of water per cubic metre for various levels of the NPVs of investment cost overruns. It was found that the break-even annual price of water is somewhat sensitive to investment cost overruns: a 20% increase in the investment cost results in the real price of water rising from 0.792 USD/m^3 to 0.868 USD/m^3, about a 10% increase in price. However, price is not nearly as sensitive to cost overruns as it is to water leakage in the system. Table 10 shows that a 10% level of water leakage would require water prices to rise by 10%, and a 20% level of leakage would cause the price to rise by 20%.

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 12, which shows that the project is sensitive to

Table 11. Sensitivity analysis of investment cost overruns on the break-even price of water.

%	USD
−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

Source: Calculations from data in Tables 1–5.
Note: USD, United States dollar.

Table 12. Sensitivity analysis of real rate of return on equity on the break-even price of water.

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

Source: Calculations from data in Tables 1–5.
Note: USD, United States dollar.

the required rate of return as well, but less so than to investment cost overruns or leakage. If the required rate of return is raised from a real rate of 12% to a real rate of 20% (66% increase), the required increase in the price of water is about 6%.

Conclusion

To solve the water-shortage problem in North Cyprus, various projects are planned for potential implementation. Conversion of traditional irrigation methods to modern irrigation on 10 000 dn 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 Mm^3 of water to North Cyprus from Turkey by a tanker was carried out. Even more importantly, an analysis of alternative pricing policies was formulated, reflecting the various management practices of water-resource authorities in North Cyprus.

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

A monthly net cash-flow statement was used to analyze the effects of various financial aspects on the price of water to the consumer, a method that is applicable to all sources of water supply. In this analysis, break-even prices were calculated to reflect the time value of money (households would be indifferent to this) in present-value terms. It has been observed that billing monthly or billing every 2 months does not significantly affect the price of water to the consumer. However, billing every 2 months with a payment lag of 2 months after billing (the case of Gazimagusa), or a payment lag of 3 months after billing (the case of Nicosia), combined with annually adjusted nominal water prices for inflation, affects the break-even price of water substantially, causing it to rise to 1.095 USD and 1.150 USD, respectively.

By far the most important variable determining the real price of water is the amount of leakage in the system. This variable is directly related to the management and maintenance practices of local water authorities. When water leakage of 30% is taken into consideration, the break-even price of water increases to 1.565 USD for Gazimagusa and 1.643 USD 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 Nicosia would fall to 1.369 USD and 1.438 USD, respectively.

A sensitivity analysis carried out on 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, therefore, the cost of water per cubic metre as well, but they are not as significant as poor water-management practices that account for high rates of leakage in the distribution system and less than efficient billing systems.[5]

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[5] This paper was delivered in October 1998, and, therefore, December 1998 is referred to in the future. At the time of writing, however, April 1999, the project still has not been implemented. But it remains a serious alternative to transporting water in Medusa bags, because existing sea installations, with a little alteration, will permit water transportation by tanker.

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