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## **Resource Costs, Resettlement Costs, and Political Constraints in the Choice of Dam Locations**

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# **Resource Costs, Resettlement Costs, and Political Constraints in the Choice of Dam Locations**

**Hasan Ali Bicak, Glenn P. Jenkins and Ali Ozdemirag**

## **Abstract**

This study evaluates three alternative locations for building a fresh water dam in the Yesilirmak valley of North Cyprus. Each of the three sites has different investment costs, storage capabilities, and socio-political repercussions.

An integrated financial-economic and stakeholder analysis is conducted in order to evaluate the trade-offs between these three potential dam locations. The opportunity cost of the fertile land that would be covered by the third location is compared with the economic rents associated with the additional water which would be provided by a dam at this location. The economic cost of not being able to build at the first site because of international political constraints is also estimated. These kinds of trade-offs have in recent years characterized much of the world-wide debate surrounding the construction of electricity and irrigation dams. This paper demonstrates how an integrated analysis can provide the inputs needed by decision-makers to make rational political and economic choices in such situations.

**Keywords:** North Cyprus, breakeven price, dam, potable water, resettlement, stakeholder impacts.

**JEL codes:** H43, H54, Q25

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## **1. Introduction**

As a shortage of fresh water worsens in North Cyprus, efforts are intensifying to find a solution to this problem. These efforts can be classified as (i) demand-side management policies and (ii) supply-side management policies. Supply side management solutions involve transporting water from Turkey by using tankers or water balloons (bags), by bringing water via a sea pipeline from the southern coast of Turkey, by treating municipal wastewater at the Haspolat Wastewater Treatment Plant and by building a dam in the Yesilirmak Valley. As a demand side management solution, the government of North Cyprus has started a project which aims to convert the traditional flood irrigation methods into drip irrigation systems in the Guzelyurt area. To date, the government has not considered implementing economically rational water pricing policies in order to curb the demand for water.

An analysis of dam-building in the Yesilirmak valley is interesting and unique in at least three ways. First, the river on which the dam is to be placed is an underground river. Hence, the dam will bring to the surface water that is now running underground and draining into the sea. Second, depending on where in the valley the dam is built, it will end up flooding a bigger or smaller area containing some of the most fertile land in North Cyprus. There is a relationship between the amount of land flooded, the construction cost of the facilities, and the volume of water that could potentially be stored by the dam at these three sites. Resettlement costs and opportunity costs of the dam site are higher for each location that is progressively further from the border with South Cyprus. Third, in the comparison of the costs and benefits of this facility with the other sources of supply, such as tanker haulage or water via a pipeline from Turkey, the uncertainty associated with the volume of annual rainfall is a factor that must be correctly evaluated when measuring these alternatives<sup>1</sup>.

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<sup>1</sup> Discounted net cash flow models of the dam and their net present values (NPVs) are used in evaluating the financial costs and revenues of the three alternative sites. The average financial cost of water per cubic meter for each site is calculated by setting the present values of the projected stream of annual net cash flows of each alternative site to zero. The average financial cost of water is the break-even price of the water where the required rate of return on equity by the owners of the project is satisfied. In order to measure the impact of different variables on the net present value of the cash flows, a sensitivity analysis is carried out as well. The detailed Excel spreadsheet model is available from the authors.

## **2. Project Description**

### **2.1 The Project and the Three Sites**

The project area is located at the western side of North Cyprus in the Yesilirmak Valley. The dam could be built on one of three alternative sites in the valley. The villagers in the area support the first site for the project and oppose the third site for the project, because at the latter the stored water would cover almost all of their fertile land and wells from which they obtain their water at its pumping cost. The government, on the other hand, does not want to build the dam at the first site, since a portion of the stored water would lie in the buffer zone along the border with South Cyprus (Map 1). Given the current levels of hostilities between North and South Cyprus, this could have political repercussions in the future. The second location is in the middle of the other two and reflects a compromise position, as the catchment area will be completely in North Cyprus. It requires a larger capital input than the first site, while not capturing much more water. It would not, however, displace as many villagers or cover as much fertile land as the third location. The length of the dam at this site (330 m) is considerably longer than the length at the first site (170 m), while the average volume of water trapped rises by only about 5 percent from  $6.2 \text{ mm}^3$  to  $6.5 \text{ mm}^3$ .

This increases the unit cost of water at the second site, as it would require a significantly larger investment for a very small increase in the amount of water to be held. The third site is proposed as a better alternative than the first site, since the volume of water to be trapped is nearly 50% greater than at the other two locations. The water that would be trapped by the second and third sites would all be on the North Cyprus side, but it would cover more of the land owned by the villagers. Since this land is very fertile, the villagers object to the second and third sites. If site I is ruled out for compelling political reasons, the central question of the analysis is to determine the cost of water per  $\text{mm}^3$  at site II and at site III. It is also interesting to know how much North Cyprus is losing by not building the dam at site I. Furthermore, it is necessary to evaluate the marginal costs and benefits, including the cost of the land, of locating the dam at site III rather than site II.

Map 1. Three Alternative Sites for Building the Dam on the Yesilirmak Valley.

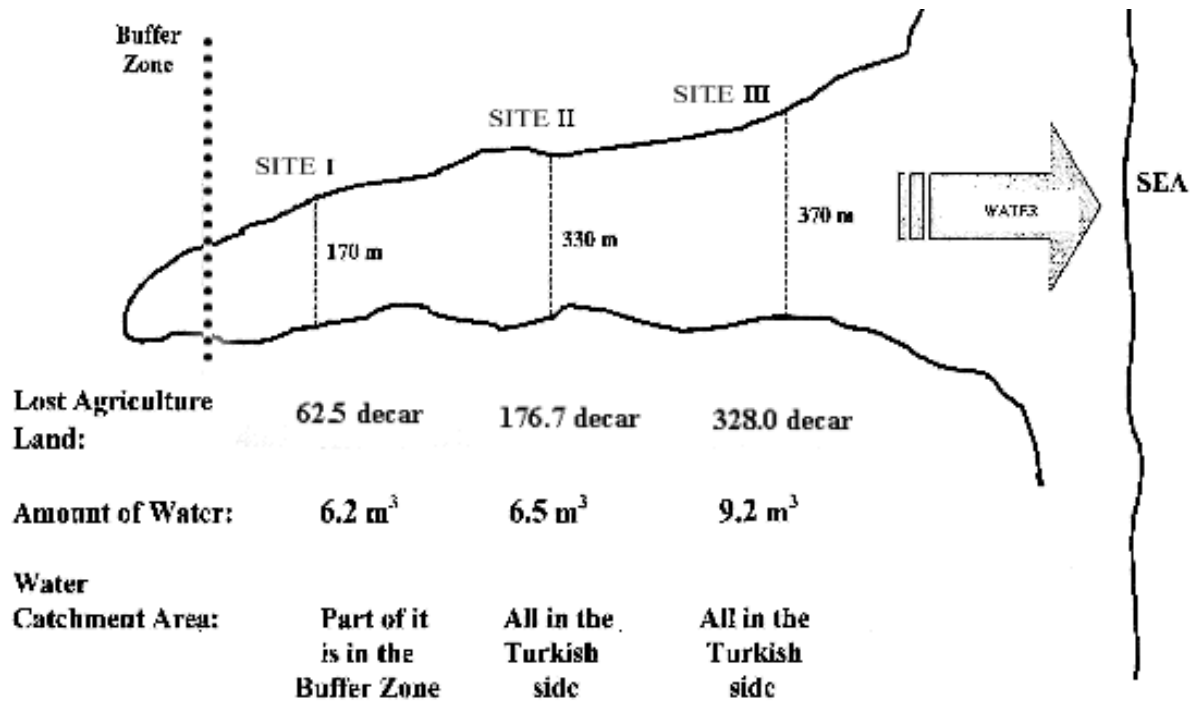


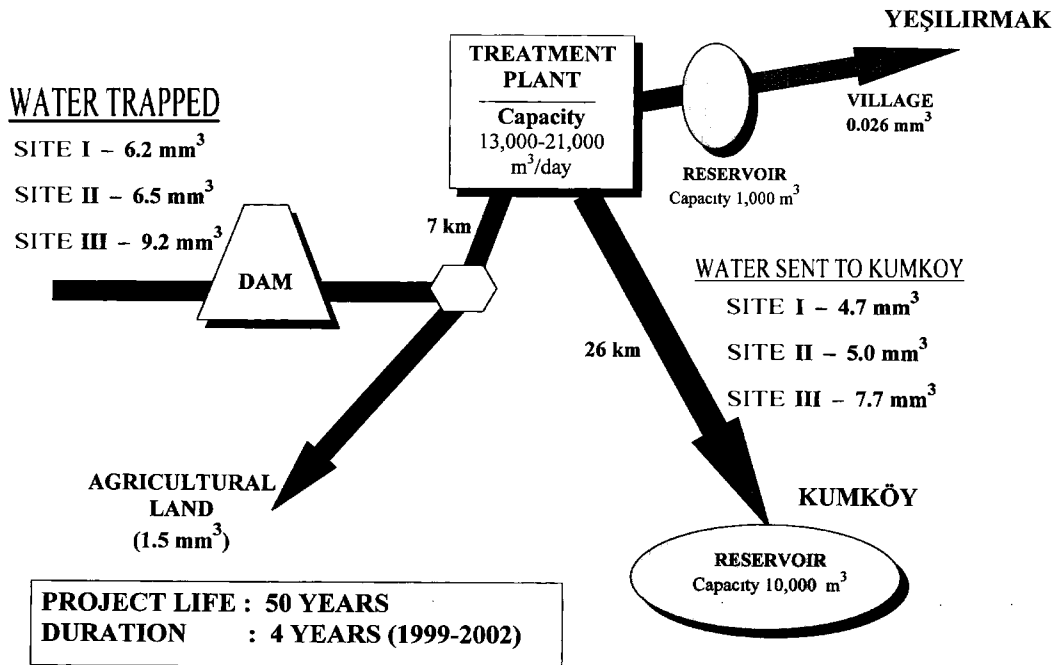
Table 1. Distribution of Water Accumulated by the Dams at the Three Sites.

	Site I	Site II	Site III	
<b>A. Yesilirmak</b>				
Supply of Water for Drinking Purposes	25,940	25,940	25,940	m <sup>3</sup>
Supply of Water for Agricultural Purposes	1,500,000	1,500,000	1,500,000	m <sup>3</sup>
<b>B. Kumkoy</b>				
Supply of Water for Drinking Purposes	4,674,060	4,974,060	7,674,060	m <sup>3</sup>
<b>TOTAL</b>	<b>6,200,000</b>	<b>6,500,000</b>	<b>9,200,000</b>	<b>m<sup>3</sup></b>

## 2.2 Structure and Technical Details of the Project

Building a dam in the Yesilirmak Valley requires that a treatment plant for water be situated in the Yesilirmak village, near the Kumkoy reservoir, with related pipelines. The capacities of these structures and some basic information about them are given in Chart 1. The capacity of the treatment plant could vary between 13,000 and 21,000 m<sup>3</sup> per day, depending at which site the dam is built.

Chart 1. Structure of the Project.



Some of the basic technical information about the dams to be built on the three sites is given in Table 2. Differences in the technical specifications of the dams are also reflected in the different investment and operating costs.

### 2.3 Financing of the Project and the Assumptions of the Model

The total investment costs in 1998 prices for the first, second, and third sites are \$18.4 m., \$25.6 m. and \$31.3 m., respectively (Table 3). It is assumed that the project will be undertaken by Water Works Department of the Ministry of Interior of the government of North Cyprus, hence, the project is exempt from corporate income tax. It is also assumed that the nominal tariff rate per m<sup>3</sup> of water is increased at the rate of inflation for each period, which is assumed to be 60%. The key question is to determine the real price (break-even price) of water (in 1998 prices) that will allow the water authority to recover its investment and operating costs. The project life for the dam is assumed to be 50 years, at the end of which it is considered to have no salvage value. Leakages in the water distribution cycle are not taken into consideration, as the point of sale of the water from the dam is the entrance to the distribution system (Kumkoy).

**Table 2. Basic Technical Information about the Dams.\***

	<i>Site I</i>	<i>SiteII</i>	<i>Site III</i>
<i>Project Life (Years)</i>	50	50	50
<i>Net Reservoir Volume (m<sup>3</sup>)</i>	6,200,000	6,500,000	9,200,000
<i>Volume Of Dam Filling</i>			
<i>Volume of Filling Embankment:</i>			
<i>Height from Foundation (m)</i>	91.5	78.5	73.5
<i>Height from Riverbed (m)</i>	57	45	40
<i>Height of Embankment (m)</i>	34.5	33.5	33.5
<i>Length of Embankment (m)</i>	170	330	370
<i>Volume of Filling of Embankment(m<sup>3</sup>)</i>	586,000	1,066,200	1,200,000
<i>Volume of Filling of Foundation (m<sup>3</sup>)</i>	117,200	213,240	240,000
<i>Total Filling Volume (m<sup>3</sup>)</i>	703,200	1,279,440	1,440,000
<i>Volume Of Impervious Wall</i>			
<i>Depth (m)</i>	30	30	30
<i>Length (m)</i>	170	330	370
<i>Width (m)</i>	0.64	0.64	0.64
<i>Total Volume (m<sup>3</sup>)</i>	3,273	6,364	7,091
<i>Bottom Outlet</i>			
<i>Length (m)</i>	234	229	229
<i>Capacity and Type of Spillway</i>			
<i>Capacity (m<sup>3</sup>/Sec)</i>	116	130	150
<i>Spillway Excavation (m<sup>3</sup>)</i>	35,000	35,000	35,000
<i>Spillway Concrete Construction (m<sup>3</sup>)</i>	4,500	4,500	4,500
<i>Riprap (m<sup>3</sup>)</i>	7,000	9,500	9,750

\* Engineering Division, WaterWorks Department, Ministry of the Interior, Government of North Cyprus, Lefkosa, 1998.

It is assumed that about 80% of the investment cost will be financed initially by foreign sourced US dollar-denominated debt at a 10.2 % real interest rate<sup>2</sup>. The remaining 20.0 % should be met by equity from the public sector. The drawdown of debt and equity funds would occur on a pro rata basis. The construction plan covers four years (1999 – 2002).

<sup>2</sup> The nominal rate of borrowing and the rate of inflation of the US dollar are taken as 13.5% and 3.0%, respectively. The real rate of borrowing is calculated as  $(13.5 - 3.0) / (1 + 0.03)$ , giving 10.2%.

The financial cash flow from the equity perspective (government) is discounted by an average required real rate of return on equity of 12.0 %.

**Table 3. Basic Financial Information about the Dams to be Built on the Three Sites.\***

	<i>Site I</i>	<i>Site II</i>	<i>Site III</i>
<b>1. Yesilirmak Dam Cost (US \$)</b>	5,334,791	11,407,500	13,913,000
<b>2. Treatment Plant</b>			
<i>Daily Capacity (m<sup>3</sup>)</i>	13,000	14,000	21,000
<i>Total Cost (US \$)</i>	2,600,000	2,800,000	4,200,000
<b>3. Reservoir In Yesilirmak</b>			
<i>Capacity (m<sup>3</sup>)</i>	1,000	1,000	1,500
<i>Total Cost (US \$)</i>	60,000	60,000	90,000
<b>4. Yesilirmak - Kumkoy Pipeline</b>			
<i>The Length of Pipeline (km)</i>	26.0	25.3	25.0
<i>Cost Per km (US \$)</i>	300,000	300,000	300,000
<i>Total Cost (US \$)</i>	7,800,000	7,575,000	7,500,000
<b>5. Reservoir In Kumkoy</b>			
<i>Capacity (m<sup>3</sup>)</i>	10,000	10,000	15,000
<i>Total Cost (US \$)</i>	600,000	600,000	900,000
<b>6. Yesilirmak Water Distribution System</b>			
<i>The Length of Pipeline (km)</i>	7	7	7
<i>Cost Per km (US \$)</i>	200,000	200,000	200,000
<i>Total Cost (US \$)</i>	1,400,000	1,400,000	1,400,000
<b>7. Land Cost</b>			
<i>Total lost land (decar)</i>	62.5	176.7	328.0
<i>Cost per decar (US \$)</i>	10,000	10,000	10,000
<i>Total Cost (US \$)</i>	625,000	1,767,000	3,280,000
<b>Total Investment Cost (US \$)</b>	<b>18,419,791</b>	<b>25,609,500</b>	<b>31,283,000</b>

\* Engineering Division, WaterWorks Department, Ministry of the Interior, Government of North Cyprus, Lefkosa, 1998.

Given the levels of initial investment for the three sites, we can compare them in regard to the additional amount of water provided by a higher level of investment cost. Tables 1 and 3 reveal that constructing the dam at site II, rather than at site I, entails an additional investment of \$7,189,709 and gives 0.3 mm<sup>3</sup> additional water per year. On the other hand, choosing site III instead of site II implies some \$5,673,500 in extra costs and allows for 2.7

mm<sup>3</sup> of additional water per year. If site III substitutes for site I, the amount of additional costs will be \$12,863,209, and 3.0 mm<sup>3</sup> more water per year will be obtained. Choosing among the three investment alternatives allows us to consider the trade-offs that are being made between the marginal cost of water at the different sites and the different socio-political issues that are present at the various sites.

### 3. Financial Analysis

#### 3.1 Break-Even Prices of Water per m<sup>3</sup>

The average financial costs per m<sup>3</sup> are estimated for each of the three sites by finding the break-even price – i.e., the price at which the NPV of the discounted net cash flows from the owner's perspective is equal to zero. The amount of water on which the price is applied is the quantity delivered at Kumkoy. This quantity is obtained by deducting the water supplied to the local residents at Yesilirmak at a price equal to their current pumping costs of \$0.07 per m<sup>3</sup>. These break-even cubic meter prices of water for the three sites are summarized in Table 4. The break-even price of water is found to be lowest for site I (at \$0.56 per m<sup>3</sup>) and highest for site II (at \$0.73 per m<sup>3</sup>) while it is in the middle (at \$0.59 per m<sup>3</sup>) for site III. In other words, these are the breakeven water charges that would yield the required rate of return of 12% on public sector equity.

**Table 4. Break-Even Price of Water per m<sup>3</sup> Delivered to Kumkoy.**

	<i>Site I</i>	<i>Site II</i>	<i>Site III</i>
<i>Volume of Water to Kumkoy (mm<sup>3</sup>)</i>	4.7	5.0	7.7
<i>Cost of Treated Water at Kumkoy (\$/m<sup>3</sup>)</i>	0.56	0.73	0.59

*Note: Average exchange rate for \$1 is taken as 290,050 TL in 1998.*

#### 3.2 Incremental Analysis

The amount of water trapped at the three sites is different, increasing as we move from site I to site III. The additional water obtained by moving from site I to site II is only 0.3 mm<sup>3</sup> (5%), while it increases by 3 mm<sup>3</sup> (48%) if the dam is moved from site I to site III (Map 1).

The marginal financial cost of the additional water is calculated. The marginal financial costs are calculated by subtracting the net cash flow of the site capturing less water from the site capturing more water. The incremental break-even price per cubic meter of water is estimated by solving for the price that will make the NPV of the incremental cash flow equal to zero. This estimated price is equal to the cost of the additional water that will be obtained by shifting from one site to the other. In estimating the cost per cubic meter of water, the required minimum rate of return on public sector equity is set at 12 %. The additional water obtained and the incremental break-even prices of water per m<sup>3</sup> at the different dam locations are given in Table 5.

Moving from site I to site II would increase the amount of water trapped by 0.3 mm<sup>3</sup> and investment costs by \$7.2 m, resulting in an incremental financial cost of \$3.48 per cubic meter. Moving from site I to site III would increase the cost of water to \$0.64 per cubic meter. It is interesting to note that the additional water that would be trapped in site III versus site II would have an incremental financial cost of only \$0.32 per cubic meter, clearly justifying the selection of site III versus site II, when only financial costs and benefits are considered. The relatively low incremental cost of water reflects the large increase in the volume of water trapped versus the moderate increase in investment costs for site III versus site II. At this site, however, the government expects to face the resistance of villagers who are going to lose their land. The question we will address in the economic analysis is - what is the value of the economic rents created at site III compared with site II? This is the implicit value the country potentially receives unless the villagers can be induced to give up their objections against building the dam at site III.

**Table 5. Incremental Break-Even Price of Water per m<sup>3</sup> at Different Locations of the Dam.**

	<i>Site I → Site II</i>	<i>Site I → Site III</i>	<i>Site II → Site III</i>
<b><i>Additional Annual Water Captured (mm<sup>3</sup>)</i></b>	0.3	3.0	2.7
<b><i>Increase in Investment Costs (m \$)</i></b>	7.2	12.9	5.7
<b><i>Cost of Incremental Water (\$/m<sup>3</sup>)</i></b>	3.48	0.64	0.32

### **3.2 Sensitivity Analysis**

Carrying out a sensitivity analysis on the financial net cash flow provides us with a better understanding of the likely outcomes of the project. It helps us to identify important variables which can affect the outcome (viability and performance) of the project. Some variables whose accuracy is not certain are also included in the sensitivity analysis.

The sensitivity analysis carried out in this section tries to assess separately the impact of water availability and of investment cost overrun factors on the NPV of the dam at alternative sites, if the break-even prices from the previous analysis are used. We also check the financial sensitivity of the project to the price paid to the villagers for their land which would be covered by the water. This is done by estimating the impact on the break -even price of water at the various sites, if the price of the land is varied. The results of the analysis are summarized in Tables 6, 7, 8, and 9.

In the base case for each site, the current estimates of the annual amount of water captured by the dam are given in Table 1. We refer to these quantities as being equal to 100% of the availability factor. For all three sites, the water availability factor is found to be a critical determinant of the financial NPV of the project. At site I, a 10% decrease in the water availability factor will decrease the NPV by 512,766 m. TL (\$1.768 m), which is equal to 9.6% of the initial investment costs (Tables 3 and 6). By comparison, a 10% increase in investment costs will decrease the NPV by 398,499 m (\$1.374 m), which is equal to 7.5% of the initial investment costs (Tables 3 and 7). Rainfall has been decreasing for the last two decades, and there has not been a proper measurement made of the water flowing through the Yesilirmak valley. The water availability factor is expected to change. It is, therefore, an important risk variable that will affect the outcome of the project. Initial investment costs are less likely to vary in real terms, as they reflect values that would be determined as a result of a procurement tender and are fixed once the contract is given.

**Table 6. Sensitivity Analysis of Water Availability Factor on the NPV of Net Cash**

Flow from the Equity Point of View (m. TL).

	<i>Site I</i>	<i>Site II</i>	<i>Site III</i>
<b>60%</b>	-2,051,063	-2,851,884	-3,227,066
<b>70%</b>	-1,538,297	-2,138,913	-2,420,300
<b>80%</b>	-1,025,531	-1,425,942	-1,613,533
<b>90%</b>	-512,766	-712,971	-806,767
<b>100%</b>	0	0	0
<b>110%</b>	512,766	712,971	806,767
<b>120%</b>	1,025,531	1,425,942	1,613,533
<b>130%</b>	1,538,297	2,138,913	2,420,300
<b>140%</b>	2,051,063	2,851,884	3,227,066

**Table 7. Sensitivity Analysis of Investment Cost Overrun Factor on the NPV of Net Cash Flow from the Equity Point of View (m. TL).**

	<i>Site I</i>	<i>Site II</i>	<i>Site III</i>
<b>-20%</b>	796,998	1,108,086	1,353,571
<b>-15%</b>	597,748	831,065	1,015,178
<b>-10%</b>	398,499	554,043	676,786
<b>-5%</b>	199,249	277,021	338,393
<b>0%</b>	0	0	0
<b>5%</b>	-199,249	-277,021	-338,393
<b>10%</b>	-398,499	-554,043	-676,786
<b>15%</b>	-597,748	-831,065	-1,015,178
<b>20%</b>	-796,998	-1,108,087	-1,353,571

At the present time, the villagers are not willing to sell their land at the prices at which they expect to be compensated<sup>3</sup>. In the case of site I, when it is assumed that the government pays \$10,000 for a decay of land to the villagers, the break-even average cost of water is \$0.555 (Table 8). In case the government is obliged to increase the payment to the villagers from

<sup>3</sup> In North Cyprus the government has not always compensated the landowners for properties obtained through its eminent domain powers at full market prices. This has resulted in a number of eminent domains disputes. For the purpose of our analysis the price of \$10,000 per decar (\$ 100,000 per hectare) represents a land price that is above any reported sales of agricultural land in the area.

\$10,000 to \$20,000 per decar, it would have to raise the price of water to \$0.577 (i.e. by 2.2 cents). For site II and site III, the increase required to support such an increase in the per decar payment for land is 5.7 cents (\$0.789 - \$0.732) and 6.9 cents (\$0.657 - \$0.588), respectively. This is due to the fact that the increase in the amount of land to be covered by water would be more than the increase in water, as one moves from site I to site II to site III. These are important observations, because it is likely that a price of \$20,000 per decar or \$200,000 per hectare is far above any opportunity cost the farmers can reasonably expect to have for this land. At the same time, even if the government gives them a high price to settle the matter, the break-even price of water would be affected, in most cases, by less than 10%. Even if at site III the government had to double the price of land (to \$20,000 per decar) in order to meet with the acceptance of the villagers, the break-even price of water could be lower than at site II - with land being priced at half as much (\$10,000 per decar).

**Table 8. Sensitivity Analysis of Cost of Land per Decar on the Break-Even Price of Water (\$/m<sup>3</sup>).**

	<i>Site I</i>	<i>Site II</i>	<i>Site III</i>
<b>6,000</b>	0.546	0.709	0.560
<b>8,000</b>	0.551	0.720	0.574
<b>10,000</b>	0.555	0.732	0.588
<b>12,000</b>	0.559	0.743	0.601
<b>14,000</b>	0.564	0.755	0.615
<b>16,000</b>	0.568	0.766	0.629
<b>18,000</b>	0.572	0.778	0.643
<b>20,000</b>	0.577	0.789	0.657

A similar sensitivity analysis is carried out in order to find the trade off between the cost of land and the cost of incremental water by moving from one site to the other. Moving from site I to site II, if the government pays \$20,000 per decar rather than \$10,000, the cost per cubic meter of additional water to be captured will increase from \$3.48 to \$4.10 (18 % increase; see Table 9). Under the same circumstances, going from site I to site III and from site II to site III, the cost of the additional water will rise by 22 % or 14 cents (\$0.78 - \$0.64)

and 9 cents (\$0.41 - \$0.32), respectively. Doubling the cost of land will lead to the smallest increase in the cost of additional water when moving from site II to site III, as the additional amount of water will be very large compared to the cost of land.

**Table 9. Sensitivity Analysis of Cost of Land per Dekar on the Incremental Break-Even Price of Water (\$/m<sup>3</sup>).**

	<i>Site I to Site II</i>	<i>Site I to Site III</i>	<i>Site II to Site III</i>
<b>6,000</b>	3.24	0.58	0.29
<b>8,000</b>	3.36	0.61	0.30
<b>10,000</b>	3.48	0.64	0.32
<b>12,000</b>	3.61	0.67	0.34
<b>14,000</b>	3.73	0.70	0.36
<b>16,000</b>	3.85	0.72	0.38
<b>18,000</b>	3.98	0.75	0.39
<b>20,000</b>	4.10	0.78	0.41

From the financial analysis it appears that site I is the least expensive source of water, but it is likely to be impossible to build on that site, for political reasons. On the other hand, site III is the second most attractive from a financial perspective, but might also be politically difficult to implement. Finally it appears that the cost of the water is not critically sensitive to the value given as land compensation within a reasonable range of land prices.

#### **4. Economic Analysis**

The economic analysis considers the benefits and the costs accruing during the course of the project from the perspective of the total economy. It uses the economic values of all the inputs and outputs of the project which are different than the market prices in cases of domestic and foreign distortions. For public projects such as dams, it is essential to assess the net economic benefits for the entire economy.

## **4.1 Economic Opportunity Cost of Water and Economic Parameters**

### **Economic Opportunity Cost of Water**

The economic value of water in the study is taken as \$0.79 per m<sup>3</sup>. This value reflects the economic cost of obtaining water via tanker from Manavgat (Turkey). This price is the delivery price to Kumkoy, from where it is distributed other parts of North Cyprus. The price includes all the costs of infrastructure to be developed onland and in the sea in North Cyprus, as well as port handling charges in Turkey, but excludes any payment for water to Turkey and the cost of treatment of the water in Cyprus. While other lower cost sources of water might become available in the future, the economic cost of water delivered to North Cyprus by tanker is less than the cost of (\$0.84 per m<sup>3</sup>) for the desalination facilities recently built in South Cyprus (Hatem-Moussallem, 1999: 4-13).

For the economic analysis, two national economic parameters and the economic prices of the main inputs and outputs of the project have to be calculated. The national economic parameters include the economic cost of the foreign exchange and the economic opportunity cost of capital.

### **Economic Cost of the Exchange Rate**

The economic foreign exchange values each unit of foreign currency from the perspective of the economy rather than from its market value. Since 1976, the Turkish Republic of Northern Cyprus (TRNC) has been using the the Turkish Lira (TL) as its official currency for its accounting and as a medium of exchange.

In most countries, the market exchange rate does not reflect the economic cost of foreign exchange. In the case of North Cyprus (TRNC), because it uses the Turkish Lira (TL) - which is issued by Turkey and is convertible to any type of foreign exchange - there is no reason to include a premium for foreign exchange. TRNC is very small as compared to the Turkish economy, hence, any external cost associated with conversion of the TL into foreign exchange to be used for buying imports will be borne largely by Turkey. As a consequence, there is therefore no premium on foreign exchange from the perspective of the TRNC.

## **Economic Opportunity Cost of Capital**

The economic opportunity cost of capital is taken as 12% in the study. This parameter has been estimated previously and reflects the economic cost of either not using capital resources elsewhere in the economy or the real cost to the TRNC of the foreign investment it receives from abroad (Ozdemirag, 1998: annex 23).

## **4.2 Results**

The results of the economic analysis put site III in first position, with the highest economic NPV of 2,371,923 m TL (\$8.2 m). Site I, which has the lowest financial break even price, is ranked second, with an economic NPV of 1,677,810 m TL (\$5.8 m) - or almost 30% less than the NPV of site I. Site two has the lowest economic NPV, at 443,313 m TL (\$1.5 m). Site III appears to be the most viable economically, if the true economic opportunity cost of water is \$0.79 per m<sup>3</sup> for the relatively large amount of water captured by this site.

These results clearly illustrate that the economic analysis and the maximum economic net present value are the most important criteria for project selection. Although site I has the lowest per unit cost, it does not create as much net wealth for North Cyprus as site III. The economic analysis also tells us that if site III cannot be built due to domestic political pressure, the country will lose \$8.2 m compared with supplying water by tanker. If the dam cannot be built at site III due to domestic political opposition, but has to be built at site II instead, then the country will lose \$6.7 m. Given that only about 25 families are involved in the resettlement problem, this will lead to an economic loss to the country of over \$250 thousand per family requiring resettlement. With this much at stake, if the dam is to be built at all, it would seem prudent to attempt to negotiate a politically acceptable settlement with these families and build the dam at site III.

## **4.3 Sensitivity Analysis**

A number of sensitivity analyses carried out in this section examine the effect of investment cost overruns and water availability factors from the economic point of view. Other analyses study the effect of variation in the estimated economic value of the water on the project's

economic NPV and on the maximum amount of money that might be paid to villagers per decar of land before this project becomes economically unfeasible for the other residents of North Cyprus.

As in the financial analysis, the NPV of the economic analysis is sensitive to the water availability factor. A 10% fall in water availability will reduce the economic NPV by 44% from 1,677,810 m TL to 942,488 m TL (Table 10). In a similar fashion, a 10% increase in investment costs will decrease the economic NPV by 24% from 1,677,810 m TL to 1,279,311 m TL in site I (Table 11).

**Table 10. Sensitivity Analysis of Water Availability Factor on the NPV of Net Cash Flow from the Economic Point of View (m. TL).**

	<i>Site I</i>	<i>Site II</i>	<i>Site III</i>
<b>60%</b>	-1,263,479	-2,640,295	-1,992,569
<b>70%</b>	-528,157	-1,869,393	-901,446
<b>80%</b>	207,165	-1,098,491	189,677
<b>90%</b>	942,488	-327,589	1,280,800
<b>100%</b>	1,677,810	443,313	2,371,923
<b>110%</b>	2,413,132	1,214,216	3,463,047
<b>120%</b>	3,148,454	1,985,118	4,554,170
<b>130%</b>	3,883,776	2,756,020	5,645,293
<b>140%</b>	4,619,098	3,526,922	6,736,416

**Table 11. Sensitivity Analysis of Investment Cost Overrun Factor on the NPV of Net Cash Flow from the Economic Point of View (m. TL).**

	<i>Site I</i>	<i>Site II</i>	<i>Site III</i>
<b>-20%</b>	2,474,808	1,551,400	3,725,495
<b>-15%</b>	2,275,558	1,274,379	3,387,102
<b>-10%</b>	2,076,309	997,356	3,048,709
<b>-5%</b>	1,877,059	720,335	2,710,316
<b>0%</b>	1,677,810	443,313	2,371,923
<b>5%</b>	1,478,560	166,291	2,033,531
<b>10%</b>	1,279,311	-110,729	1,695,138
<b>15%</b>	1,080,061	-387,751	1,356,745
<b>20%</b>	880,811	-664,773	1,018,352

The economic opportunity cost of water used in the study was taken from a previous study of the cost of providing water by tanker for \$0.79 per m<sup>3</sup> (Bicak and Jenkins, 1999: 13). A sensitivity analysis of the effect of variation in the economic opportunity cost of water on the economic NPVs of the three sites is given in Table 12. An increase of 11 cents, from 79 cents to 90 cents, will increase the economic NPVs of the three sites by 785,480 m TL (\$2.7 m), 835,896 m TL (\$2.9 m), and 1,289,634 m TL (\$4.4 m), respectively. The increase in the economic NPV of site III is about 1.5 times more than at each of the other sites.

**Table 12. Sensitivity Analysis of the Economic Opportunity Cost of Water on the NPV of Net Cash Flow from the Economic Point of View (m. TL).**

		<i>Site I</i>	<i>Site II</i>	<i>Site III</i>
<b>Economic Opportunity Cost of Water (\$)</b>	<i>NPV<sup>c</sup><sub>EDR</sub></i>	<b>1,677,810</b>	<b>443,313</b>	<b>2,371,923</b>
	<i>0.40</i>	-1,107,076	-2,520,317	-2,200,414
	<i>0.50</i>	-393,003	-1,760,412	-1,028,020
	<i>0.60</i>	321,071	-1,000,507	144,374
	<i>0.70</i>	1,035,144	-240,601	1,316,769
	<i>0.79</i>	<b>1,677,810</b>	<b>443,313</b>	<b>2,371,923</b>
	<i>0.90</i>	2,463,290	1,279,209	3,661,557
	<i>1.00</i>	3,177,363	2,039,115	4,833,951
	<i>1.10</i>	3,891,437	2,799,020	6,006,345
	<i>1.20</i>	4,605,510	3,558,925	7,178,740
	<i>1.30</i>	5,319,583	4,318,831	8,351,134
	<i>1.40</i>	6,033,656	5,078,736	9,523,528
	<i>1.50</i>	6,747,730	5,838,641	10,695,922

Resettlement of the villagers from the land to be covered by water appears to be one of the main problems to be solved before the implementation of the project at site III. Considering that there is likely to be a price at which the villagers would be willing to give up their lands, a sensitivity analysis is carried out to find the break-even opportunity cost of water at various economic opportunity costs of water in North Cyprus (Table 13). At an economic price of water of \$0.55 per m<sup>3</sup>, all three sites could not support an economic opportunity cost of land of \$10,000 per decar. At an economic price of water of 90 cents, the opportunity cost of land per decar could be as high as \$145,882 at site I, \$34,959 at site II and \$48,487 at site III. At the economic opportunity cost of water used in the study of \$0.79 per cubic meter the break even cost of land per decar is \$102,553 for site I, \$12,719 for site II and \$ 30,000 for site III.

From the analysis, it is clear that the authorities need to have a good measure of the economic opportunity cost of water before determining the acceptable range for the compensation they can give for land, if the project is to benefit both the land owners as well as the consumers of the water.

**Table 13. Sensitivity Analysis of the Break-Even Economic Opportunity Cost of Land versus the Economic Opportunity Cost of Water (\$/decar).**

	<i>Site I</i>	<i>Site II</i>	<i>Site III</i>
<i>0.50</i>	-11,679	-24,348	-,806
<i>0.55</i>	8,016	-16,935	3,248
<i>0.60</i>	27,711	-9,521	10,518
<i>0.65</i>	47,406	-2,108	17,679
<i>0.70</i>	67,102	5,306	23,841
<i>0.75</i>	86,797	12,719	30,002
<i>0.79</i>	102,553	18,650	34,932
<i>0.80</i>	106,492	20,132	36,164
<i>0.85</i>	126,187	27,546	42,326
<i>0.90</i>	145,882	34,959	48,487
<i>0.95</i>	165,577	42,373	54,649
<i>1.00</i>	185,273	49,786	60,811

## **5. Distributive Analysis**

The distributive analysis of the project tries to measure who will bear the majority of the project's cost, who will benefit the most, and by how much. In essence, it seeks to allocate the net benefits/losses to be generated by the project, to the major shareholders on the project (Jenkins, 1999: 87-96). The distribution of positive externalities from the project is obtained by subtracting the financial cash flow statement from the economic benefit/cost statement. In this way, the economic and financial values of inputs and outputs are reconciled. The NPV of the economic net benefits statement is equal to the NPV of the financial net cash flow plus the present value of the total externalities generated by the project, all discounted by the economic opportunity cost of capital. This relationship can be expressed as follows:

$$NPV_{EDR}^e = NPV_{EDR}^f + \sum PV_{EDR} (EXT) \quad (I)$$

where  $NPV_{EDR}^e$  is the net present value of the economic benefits and costs,  $NPV_{EDR}^f$  is the net present value of the financial benefits and costs, and  $\sum PV_{EDR} (EXT)$  is the sum of the present value of all the externalities generated by the project; all discounted using the economic opportunity cost of capital (Jenkins, 1999: 87-96).

Reconciliation of the financial, economic and distributive analysis for the three sites is given in Table 15. The financial discount rate and the economic discount rate in this case are assumed to be the same (real 12%). Hence, the net present value of the financial cash flows discounted by the economic discount rates are all equal to zero.

**Table 15. Reconciliation Between Financial, Economic and Distributive Analysis.**

	$NPV_{EDR}^e$	$NPV_{EDR}^f$	$NPV_{EDR}^{ext}$
<i>Site I</i>	1,677,810	0	1,677,810
<i>Site II</i>	443,313	0	443,313
<i>Site III</i>	2,371,923	0	2,371,923

Allocating the present value of the total externalities (net benefits of the project), it is seen that all the benefits go to the consumers in Nicosia and in Gazimagusa. Depending on which site the dam is to be built on, the consumers are expected to benefit by 1,677,810 m TL (\$5.9 m) at site I or 443,313 m TL (\$1.5 m) at site II or 2,371,923 m TL (\$8.2 m) at site III (Table 16). This set of benefits is based on the assumption that the villagers will sell their lands at \$10,000 per dekar. The compensation price may or may not be the true resource cost of the land, but by shifting some of the total net benefits of the project from the consumers to the villagers, the project could be carried out with less resistance by the villagers. If the price of land per dekar is increased from \$10,000 to \$20,000, the benefits to the consumers at the three consecutive sites will fall to 1,523,520 m TL (\$5.253 m), 7,106 m TL (\$0.024 m), and 1,562,211 m TL (\$5.386m), respectively. The villagers whose land will be covered by the water will have an additional total benefit of 154,290 m TL (\$0.532 m), 436,207 m TL

(\$1.504 m) or 809,712 m TL (\$2.791 m), depending on the site at which the dam will be built, if the land prices were raised from \$10,000 per decar to \$20,000 per decar.

**Table 16. Benefits to the Consumers in Nýcosia and Gazimagusa at Two Different Land Prices to be Paid to the Villagers.**

<i>Land Price</i>	<i>Consumers Benefit (m TL)</i>	
	<i>\$10,000 per decar</i>	<i>\$20,000 per decar</i>
<i>Site I</i>	1,677,810	1,523,520
<i>Site II</i>	443,313	7,106
<i>Site III</i>	2,371,923	1,562,211

## **6. Summary of the Findings and Concluding Remarks**

In evaluating the feasibility of building a dam in the Yesilirmak Valley at three mutually exclusive sites, an integrated financial, economic and distributive analysis is carried out. This project represents just one among several different alternatives for supplying water to North Cyprus. Site III has the largest catchment area and initial investment cost (\$31.3 m), but covers a very fertile area that villagers are not prepared to give up at the level of compensation they expect to receive. In such projects, resettlement of land issues is important, as they may later cause severe economic, social and environmental problems. Therefore, these problems must be dealt with at the beginning of the project (International Rivers Network and Human Rights in China, 1998: Report on Three Gorges Dam).

The financial analysis enables us to calculate the break-even prices of water which will be captured, treated and delivered to Kumkoy, from where it is sent to Nicosia and Gazimagusa. Site I will provide 4.7 mm<sup>3</sup> of water at \$0.56 per m<sup>3</sup>, while site II and site III will provide 5.0 mm<sup>3</sup> and 7.7 mm<sup>3</sup> of water at \$0.73 per m<sup>3</sup> and \$0.59 per m<sup>3</sup>, respectively. The cost of additional water obtained by moving from site I to II is found to be \$3.48 per m<sup>3</sup>, from site I to site III, \$0.64 per m<sup>3</sup>, and from site II to site III, \$0.32 per m<sup>3</sup>.

The outcome of the project is found to be sensitive to the annual availability of water. Unlike the initial cost of the investment, this variable is unknown over the life of the project due to rainfall availability. Increasing the price of the land to be paid to the villagers is found to be more sensitive for site III, as that site covers more land than the other sites. Increasing the price of land from \$10,000 to \$14,000 at site III will increase the break even price of water per m<sup>3</sup> from \$0.56 to \$0.62.

The economic analysis shows that once the economic cost of alternative supplies of water is taken into consideration, site III is the most viable project, with the highest economic NPV of 2,371,923 m TL (\$8.178 m). This positive economic benefit obtained at site III reflects the opportunity cost of water versus the alternative cost of long term supply by tankers from Turkey (\$0.79 per m<sup>3</sup>).

The distributive analysis indicates that all the benefits of the project will go to the consumers in Nicosia and in Gazimagusa, and it is 2,371,923 m TL (\$8.178 m) in the case of site III. In order to induce the villagers to sell their lands so that the dam may be built, some of this net benefit could be shifted to them by increasing the price to be paid for their lands. Increasing the price per decar of their land from \$10,000 to \$20,000 would shift 809,712 m TL (\$2.791 m) of the total net benefit of the project to the villagers at site III. This would still leave a net economic surplus of \$5.4 m to be enjoyed by the other residents of the country.

Beyond the boundary problems that site I would create with South Cyprus, site III is found to provide greater net economic benefits to North Cyprus. However, before beginning the dam project, it is important the government should agree on the value for the economic opportunity cost of alternative methods of supplying water, and of the available quantities of water, at the various dam sites.

This integrated financial-economic–stakeholder approach to the analysis of alternative dam locations is an effective way to evaluate the trade off between the different aspects or outcomes of such decisions. The stakeholder analysis points out the possibilities for compensation of these that must be resettled if the dam is to be built at a particular site. As in

the case reported here the levels of compensation that could satisfy these subject to settlement may be only a small fraction of the total net economic benefit created by the dam. The quantification of the financial and economic benefits and costs, and the identification of to whom they accrue, may be a first step to reaching an agreement in such dam location and resettlement of the conflict.

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