Economic Considerations Regarding Markets for Water in the Maltese Islands

A Report prepared for FAO on Water Resources Review for the Maltese Islands

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1. Objectives of Study and Methodology

This study is an integral part of a Water Resources Review for the Maltese Islands. It presents the findings on the economic significance of water in the Maltese economy. The results are submitted under three general headings, every section incorporating several related issues. The three sections are the following:

i) Water: Use, Value and Price Elasticity

a. The main uses of water in the Maltese Islands;
b. The economic contribution of water to output and income;
c. The relationship between water demand and water tariffs.

ii) Current water supply policies and allocation of groundwater.

iii) An assessment of water management policy options.

The study was carried out during January and February 2004. It draws on national statistical sources – such as Input /Output data for the industrial sector, Aggregate Households' Consumption Patterns and Implicit Price Deflators; and data provided by the Malta Resources Authority. The Water Services Corporation, the Ministry for Rural Affairs and the Environment and the respective departments/Authorities involved in Agriculture and Fisheries, Manufacturing and Tourism also supplied statistical and qualitative information that supported the research.

Given the time constraints, the evaluation is primarily based on existing data and reports. Further ground research is needed to develop new data bases that could guide decision making on the various components that, altogether, make up the future integrated Water Resource Management policy that will reflect the EU's Water Directive coming in force in 2010 (Directive 2000/60/EC of the 23 October 2000).

The Directive's main thrust is based on one basic tenet, namely: Surface water and ground water are renewable natural resources. The task of ensuring good status of groundwater requires early action and stable long term planning of protective measures owing to the natural time lag in its formation and renewal. Such time lag for improvement is to be accounted for when establishing measures for the achievement of good status of ground water and when revising any significant and sustained upward trend in the concentration of any pollutants in groundwater.

EU member states are to ensure that by 2010 water pricing policies provide adequate incentives for users to make efficient use of water resources. An adequate contribution by the respective water users will reflect the utility of this commodity in industry, household consumption and agriculture. Costs of water services have to be recovered and account for the 'polluter pays' principle. In structuring this pricing policy, member states consider the social and economic effects of the recovery mechanism as well as the geographical and climatic conditions of the region.

This report contributes to the establishing of a 'gap analysis' between the present state of water resources and their management in the Maltese Islands and the overall objective set out in the Water Directive of the European Union, as outlined above.

2. Water: Use, Value and Price Elasticity

2.1a Water Consumption by Client

Water consumption can be conditioned by various factors that influence the demand for the commodity and also by the availability of supply. If supply cannot meet the demand, then users of water – personal or industrial – will have to accommodate the given supply and make do accordingly. In this latter case, supply of water determines the amount of water consumed.

Analysts of issues related to water generation and consumption in Malta are presently faced with a data reliability problem. They have to use official statistical sources to obtain continuity and time series information. Demand patterns are usually identified from data on billed water consumption. ***It now appears that these data sets underestimate by a wide margin the actual consumption of water in the Maltese Islands***. The aggregate water consumed approaches the total amount of water produced and extracted, the former supply coming from reverse osmosis plants that generate more than half the total volume available in Malta and Gozo at any one time. These discrepancies mean that there are wide gaps in the markets for water: on the supply side, total production exceeds by far the billed consumption; on the demand side, total consumption again exceeds billed consumption. The discrepancy in supply data may be interpreted to reflect water losses; the discrepancy in demand data distorts costs structure in industry and households' preferences.

Official data suggest that the supply of water, inclusive of water produced by the reverse osmosis plants, exceed demand. Indeed, a substantial amount of water pumped is lost in the distribution system. However, a recent estimate of what may be termed a 'comprehensive measurement of water demand' shows that the ***actual consumption is more than double the amount recorded by billed consumption.*** Besides, the allocation of consumption by client changes radically. Official data indicate domestic users as the prime consumers, accounting for around 60% of total billed consumption. Under the 'comprehensive' definition, which includes an estimate for water used in Agriculture, this latter sector is identified as the prime source of demand, with 43% of total estimated water consumed when the water consumed by farms is included. Domestic users come second with 34% (Vide Table 2.3 below). According to this estimate of demand, consumers – both private and industrial – are exerting a consistent and heavy pressure on the limited natural supplies of water and, consequently, this source is being depleted fast. This conclusion does not emerge from official data, which, as observed, puts billed water consumption at around a half the estimated amount.

This discrepancy is bound to affect all observations regarding policy measures, water demand and water supply. In turn, water supply data refer to two sets of information. One refers to the volume of ground water extracted by the Water Services Corporation and water produced by RO plants, henceforth referred as water supply Table 3.2 below). The second includes the volume of water derived from both public and private sources of which a portion is recorded as 'lost' by the Water Services Corporation(Table 2.3b below); in official documents this data set is referred to as Water Consumption (Sapiano, 2004). For analytical purposes, certain standard parametric measurements, which rely on time series data, have to be based on the official statistical series. But such conclusions have to be qualified all the time in order to account for the demand for water discrepancy examined below.

The commentary that follows refers to the various components of demand as this emerges from billed water demand data. In turn, the redefined water consumption pattern is introduced and related observations entered. Water supply conditions and policy measures are assessed in section 3.

2.1a.1 Water Consumption as derived from Official Data

Published statistics suggest that over the past few years, water consumption reached a high of 21million m^3 in 1997, falling thereafter to 17.2million m^3 in 1998 and edging upwards to 18.7million m^3 in 2000.

The demand for water consumption arises from households, manufacturing industry, tourism, government organisations, commercial enterprises, and a series of other units classified as manual/industrial and other. Households consume around 11million m^3 annually, although a high of 14million m^3 was registered in 1997. Industry absorbs 1.7million m^3, though in the years 1997-1999 industry's demand amounted to 1.1million m^3. The tourist sector consumes another 1.5million m^3 while another 1.3million m^3 are taken up by government entities. Farms take up around 1million m^3, although they registered a higher consumption in the three-year period 1997-1999, between 1.1million and 1.3million m^3. The units consumed by the respective sectors for 1995 to 2000 are presented in Table2.1.

Table 2.1

Billed Water Consumption by Sector (millions m^3)

Year	Domestic	Industry	Tourism	Government	Commerce	Farms	Other	Manual/ industry	Total
1995	11.984	1.785	1.451	1.516	1.693	0.614	-	0.211	19.256
1996	13.079	1.702	1.487	0.659	1.691	0.968	0.041	0.207	19.837
1997	14.002	1.149	1.460	1.206	1.369	1.327	0.307	0.182	21.005
1998	10.730	1.129	1.502	1.313	1.130	1.066	0.274	0.096	17.244
1999	11.320	1.141	1.509	1.037	0.938	1.245	0.220	0.001	17.415
2000	11.594	1.736	1.543	1.649	1.048	0.938	0.222	0.001	18.731

Source: National Statistics Office, Malta, 2002, ***Environment Statistics***; Table 21.

Table 2.2

Average relative share of billed water consumption for the years 1995-2000

	Domestic	Industrial	Tourism	Government	Commerce	Farms	Other	Manual/ Industrial
%	64	7	8	7	7	5	1	1

2.1a.2. A ‘Comprehensive’ Estimate of Water Consumption in the Maltese Islands

The impressions formed from the data sets examined in section 2.1a.1 above are completely recomposed following an exercise to derive a comprehensive consumption and supply record. The term ‘comprehensive” includes private and unconventional water sources in addition to the estimated water use as this emerges from billed consumption determined by the Water Services Corporation. This all-inclusive measure indicates that, based on year 2000 records, total water consumed reached 38.6million m^3 and not the 18million m^3 given by the billed demand. Besides, the relative composition of demand is altered dramatically. Official data give domestic use as the prime user of water, with circa 60% of demand; the comprehensive approach puts agriculture as the prime user of water in the Maltese Islands. Agriculture accounts for 37% of water use. Another 6% is consumed by animal breeders; a total of 43% of the comprehensive water consumption for the farming and animal breeding sectors. The domestic sector falls to second place with 34%.

The undisclosed consumption of water by the Agricultural sector amounts to 81% of the total billed water demand, namely, 14.5million m^3 compared to 18million m^3. The greater part of water consumption is therefore not accounted for properly in industrial production. This implies that either unit profits are higher than warranted or losses are lower than they would be if water were to be priced correctly.

Table 2.3

A “Comprehensive” Water Consumption Estimate – based on year 2000 data

Categories	***WSC***	***Non-Conventional***	***Total***
	Billed Consumption	***Sources***	***(m^3)***
Domestic	11,435,000	2,000,000	13,435,000
Tourism	1,448,000	1,500,000	2,948,000
Farms	1,139,000	1,100,000	2,239,000
Agriculture		14,500,000	14,500,000
Commercial	1,028,000		1,028,000
Industrial	1,333,000	1,500,000	2,833,000
Government	1,391,000		1,391,000
Others	228,000		228,000
Total	***18,002,000***	***20,600,000***	***38,602,000***

Source: M. Sapiano, 2004.

Table 2.3b

'Water Consumption' (inclusive of water losses)

Categories	WSC Billed Consumption m3	WSC Apparent Losses M3	Private Water Production m3	TOTAL
Domestic	11,435,000		2,000,000	13,435,000
Tourism	1,448,000		1,500,000	2,948,000
Farms	1,139,000		1,100,000	2,239,000
Agriculture			14,500,000	14,500,000
Commercial	1,028,000			1,028,000
Industrial	1,333,000		1,500,000	2,833,000
Government	1,391,000			1,391,000
Other	228,000			228,000
		7,300,000		7,300,000
TOTAL	18,002,000	7,300,000	20,600,000	**45,902,000**
WSC Real Losses				11,300,000
TOTAL				**57,202,000**

Source: M. Sapiano, 2004.

Table 2.4

Relative Demand for Water as measured from Billed and Estimated Comprehensive Data presented in Table 2.3

Categories	Billed Data (WSC)	Non-Conventional Sources
Domestic	64	34
Tourism	8	8
Farms	6	6
Agriculture		37
Commercial	6	3
Industrial	7	7
Government	8	4
Others	1	1
Total	**100**	**100**

Domestic households are heavy consumers of water. They also generate wastewater that flows through the sewerage system. The same consideration applies for farms; breeders dispose the waste generated on their farms through the sewage system. For the industrial sectors, namely, manufacturing, agro-industry and tourism, water is generally an intermediate input that enters into production and, consequently, has to be accounted for in cost considerations. An examination of water input in various economic sectors is carried out below, introducing the necessary qualifications to account for the water observations entered in Table 2.3 where Agriculture is concerned.

2.1.b The economic contribution of water to output and income

Water is a scarce economic asset and a valuable input in production. Its use is limited by physical, economic and spatial conditions. When used under controlled circumstances, it may have significant effects on output and hence on producers' revenue

Using input-output data for the Maltese industry for years 1994-1996, the last information available, one can obtain the share of water cost in total production. Table 2.5 gives a three-year average percentage water requirement per Lm100 worth of output for the various industrial sectors. The share of Agriculture is based on billed data; it refers primarily to consumption by Farms and excludes the cost of water consumed by the sector for irrigation (the 14.5million m^3 noted in Table 2.3).

Even when the large volumes of water consumed by farmers are not accounted for, the biggest consumer of water for production purposes remains agriculture (2.4 % of total input value). Electricity (Lm1.63) and the service and the tourist industry (Lm1.46) per Lm100 worth of output come second. 'Other production and trade' includes transport services, communications, the distribution trade, insurance, banking and finance and other services. This sector consumes Lm0.79. Beverages consume Lm0.78. In the leather, food and the rubber and shipyards industries, water accounts for 0.44%, 0.43% and 0.40% of inputs respectively.

However, though water is an essential input, other costs should be also considered when deciding what to produce. When making such decisions e.g. in agriculture, the farmer takes other factors such as the cost of infrastructure and labour and marketing risks into account. Farmers are, therefore, not only guided by the volume of water used for growing their crops but also by the net benefit they get from crops. A reliable production account for the agricultural sector is imperative for policy formation. This reflection holds also for the other industrial sectors. The comments below refer to Agriculture because a fairly extensive data set is available on several factors relevant to this analysis. But similar exercises have to be carried out for manufacturing and the leisure industries before comprehensive evaluations can be implemented.

Table 2.5
Cost of Output, Average for Years 1994-1996

	Water requirement per Lm100 of output	
Industry	**3 year average output in Lm'000s**	**3 year average water requirement per Lm100 of output**
Agriculture	1097	2.40
Mining and quarrying	14	0.37
Food	118	0.43
Beverages	183	0.78
Tobacco	1	0.19
Textiles	22	0.32
Footwear	2	0.17
Wearing Apparel	25	0.19
Furniture/Fitting	22	0.19
Printing	18	0.14
Leather	13	0.44
Chemicals	30	0.20
Non-Metallic Minerals	45	0.15
Metals	14	0.18
Machinery	60	0.05
Rubber, Transport & shipyards	110	0.40
Miscellaneous	73	0.32
Construction	82	0.30
Gas	5	0.36
Electricity	507	1.63
Services and Tourism	3076	1.46
Other production and trade	3539	0.79
Other industries	/	0.20

Source: National Statistics Office, Malta, **National Accounts of the Maltese Islands, Input Output Tables**.

The absence of a detailed production account has significant implications not only for water management but also for the directional policy that the farming community will adopt following membership of the EU. There is urgency to remedy such an information gap for several reasons.

Firstly, farmers and breeders have to be guided in order to make optimal use of water in terms of value per unit of output. While precautionary measures have to be adopted to use water efficiently, at the same time water use has to be directed to those crops that generate the highest value added, or to breeding animals that combine water consumption and value on the market. This relationship is examined below; figures 2.1, 2.2 and 2.3 refer to water consumption by crops at different times, and to the profitability per unit. By combining these two sets of information, policy makers can plan water and agriculture management more effectively.

Secondly, the prices obtained to date for agricultural products were the outcome of a sheltered market, one in which quotas and tariffs had a strong contribution to protect local produce. EU membership will lead to the removal of such tariff and non-tariff restrictions. Hence local produce must compete on quality, timeliness, and price. The absence of proper water charges means that the true cost configuration for agricultural output is unknown. Therefore, the real competitive prices remain a matter of conjecture.

Thirdly, water consumption in agriculture has not been regulated by prices. Any realistic price introduction will therefore have both a psychological as well as an accounting shock on the producers. How will demand react is open to question. But one cannot refer to Price elasticity in the circumstances. Evidently, much more work on this subject is necessary in order to prepare for the introduction of a thorough pricing mechanism in agriculture. Present data sets are not comprehensive enough to permit a thorough analysis.

However provisional impressions may be formed from data referring to water absorption per crop throughout the year, the profitability per crop after accounting for prices fetched on the market and total costs, and combining these two factors, namely, water consumption and net benefit per crop. Such an exercise has been carried out on a 'one off' basis, and therefore, its conclusions are dated (Borg, Victor E. 1997). Yet the results are very useful for illustrating the argument at hand.

The relationships may be established under three scenarios:
i) ***Low*** water requirement, yield, and income.
ii) ***Average*** water requirement, yield, and gross income.
iii) ***High*** water requirement, yield, and gross income.

In turn, gross income may be changed into net benefit per crop by deducting the cost of water and other expenses.

Finally, the two sets of data can be combined and expressed percentage wise in terms of the highest unit in the respective data set. The highest value is set at 100%. These relationships are presented in Figures 2.1, 2.2 and 2.3 below. The results for the 'Average' scenario are presented in Annex 1.

Figure 2.1a: Water consumption (litres) per kg of crop (low)

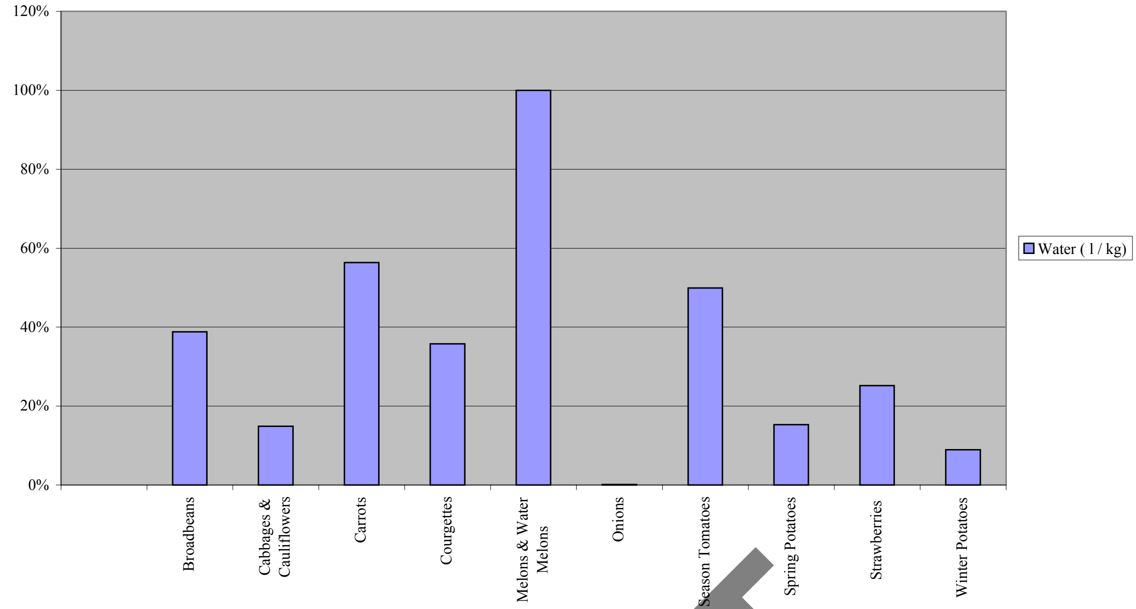
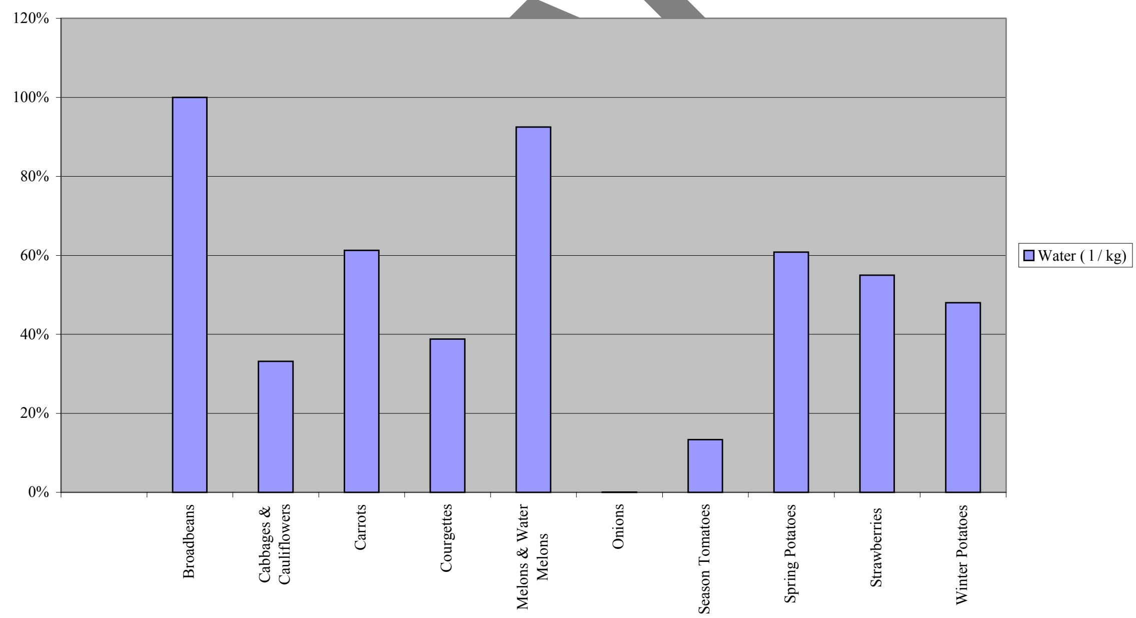


Figure 2.1b: Water consumption (litres) per kg of crop (high)



Figures 2.1a and 2.1b relate the consumption of water per crop. They express this relationship in percentage terms, by setting the highest water amount absorbed by one crop at 100%. Onions are seen to consume the least amount of water. Broadbeans consume the largest quantity under the "High" scenario; melons and watermelons come first under the "Low" conditions.

Figure 2.2a: Malta: cost of water, other costs and benefits, for selected crops (low)

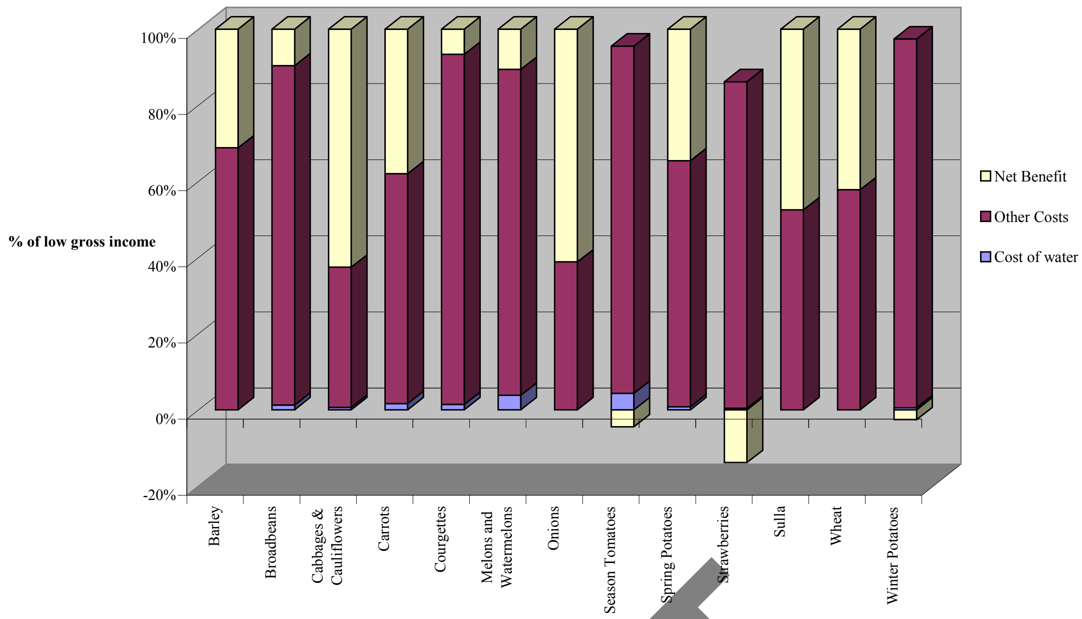


Figure 2.2a presents the relationship between costs of water, other costs and net benefit per crop under the 'low' assumption. Cauliflowers and onions are seen to yield the better value for the efforts undertaken; strawberries are grown at a loss while the return on winter potatoes is small.

Figure 2.2b: Malta: cost of water, other costs and benefits, for selected crops (high)

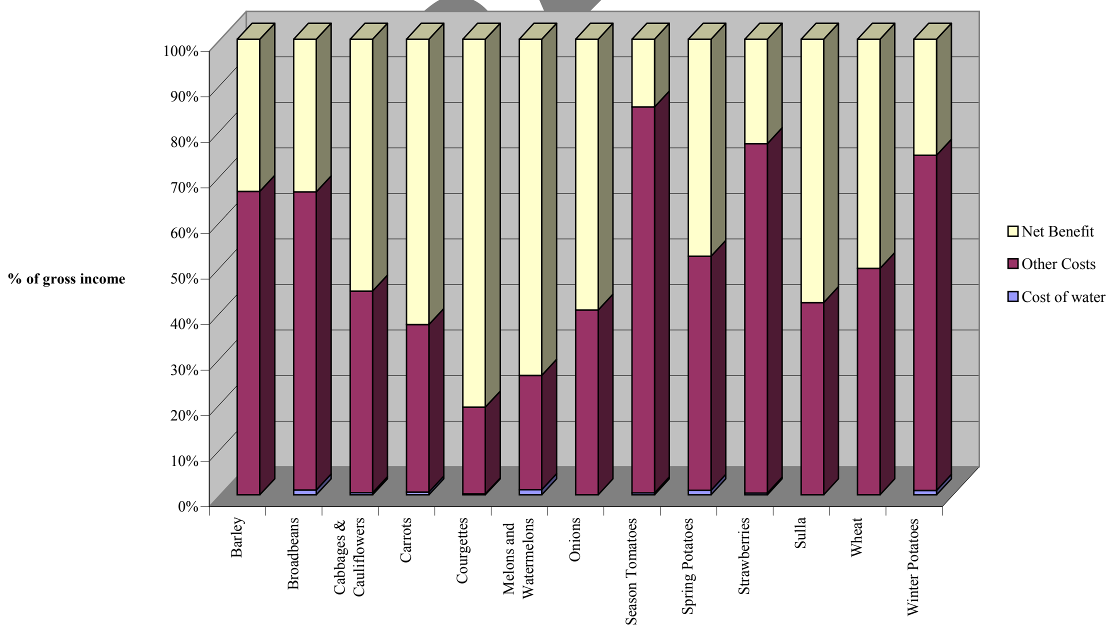


Figure 2.2b presents the results under the 'high' scenario. Courgettes, melons and watermelons, onions and cabbages and cauliflowers give the best value. It is seen that the choice of produce depends on the set of conditions that affect output cost composition and market prices.

Figure 2.3a: Valuing irrigation water (low)

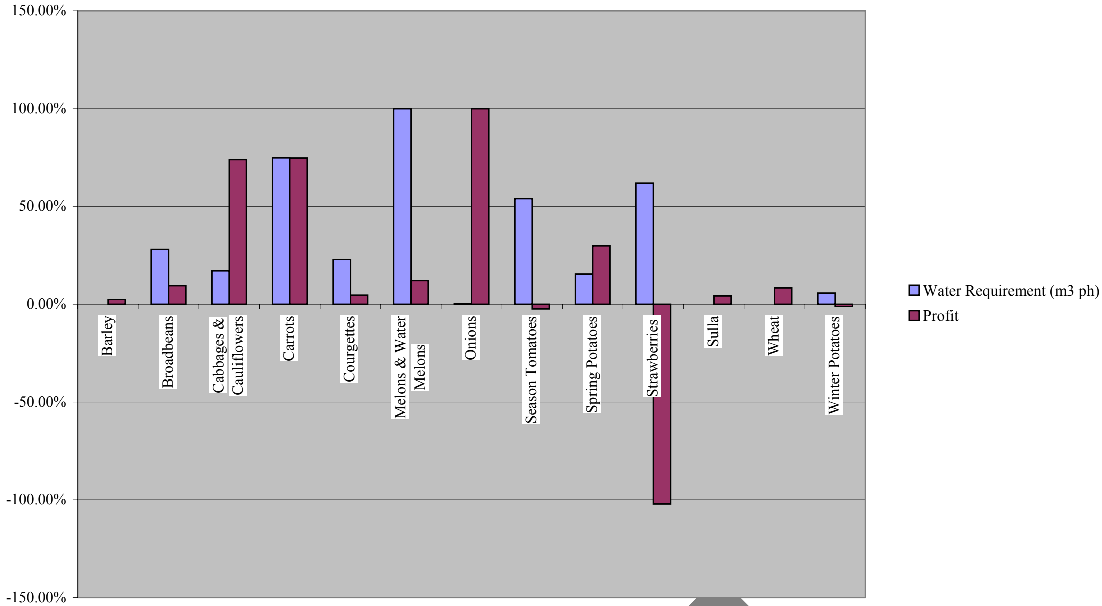
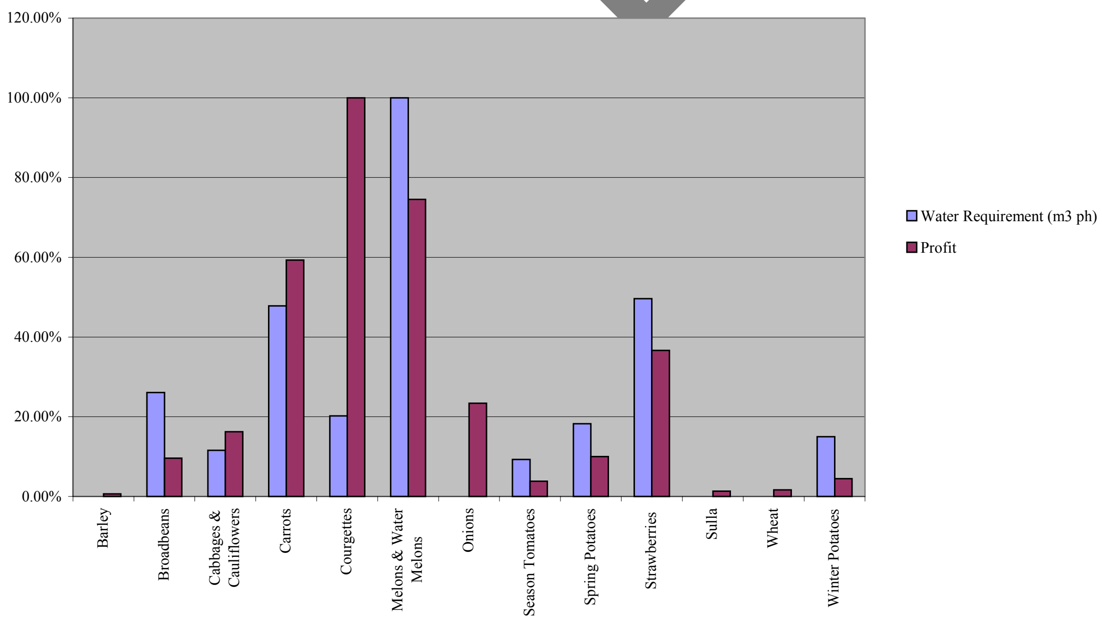


Figure 2.3b: Valuing irrigation water (high)



Figures 2.3a and 2.3b combine water consumption and net benefits by crop. In terms of the "low" scenario, the net benefit of onions in unquestionable. But considered in terms of the conditions described by the "high" scenario, this supremacy does no longer hold. This result applies to the other commodities considered. Therefore, specific analysis per time period has to be undertaken before a combined water management and agriculture policy can be defined.

2.1.c Price and Income Elasticity

As noted already, the impact of price changes on demand for water in agriculture cannot be established with the available data. The large amount of water consumed – 14 million m^3 - is not even billed and accounted for by the Water Services Corporation. For farmers, the cost of water will represent the costs incurred in the drilling of boreholes, installing pumping equipment, and the running and maintenance of such capital. Government considers the revenue foregone a 'social contribution' to the sector. At minimal /zero price, the value of water consumed will be given by the entire area bounded by the demand function for water, where such value will represent the entire consumer surplus of the farming community.

However, the demand for water by Maltese households can be assessed for policy implications. There is information on Domestic Water Price Indices and domestic consumption.

Pricing of water has always been a sensitive political and social issue. Successive Maltese governments have persistently followed a policy of supporting water consumption by households and of maintaining such water tariffs stable for several years at a stretch. This policy measure meant that the actual consumption of water by households was not directly conditioned by changes in water tariff, because prices were held constant for successive periods. Thus, in the eleven year period, 1987-1999, prices were changed four times; there were no price changes between 1987 and 1993 (Price Index = 117.82 with 1995=100). Again, prices remained unchanged during 1994 to 1996 (Index equals 100 at 1995 prices). Tariffs were raised to 109.03 in 1997 and to 154.17 in 1998 and 1999.

Over the 1989 – 1999 period, annual consumption per head of population increased from $28m^3$ in 1989 to a high of $34.7m^3$ in 1996 thereafter falling again to $28m^3$ in 1998 and 1999. Two econometric tests were carried out to identify the response of household demand to price changes in the short run and in the long run. The primary aim is to establish whether the impact of a tariff change on demand can be identified in past consumption patterns on the introduction of a price change and after some time has elapsed. Another exercise relates water demand to price and income changes. There seems to be enough information, from the data at hand, to pronounce on this policy parameters, although more work is required on this subject.

The price elasticity of demand in the short run is estimated to be –0.28, and –0.37 in the long run. These results suggest two policy indications. At –0.28, the short term price elasticity of household demand for water falls in the elasticity range observed for other countries (Thomas and Syme, 1988; Bachrach and Vaughan, 1994). The higher value of –0.37 in the long run implies that there was a higher response to price change after households were given time to adapt. Tariff changes will be expected to induce a change in consumption behaviour. But, the demand for water remains relatively inelastic, water being a necessity. The relevant logarithmic equation is presented below; the data and statistical coefficients are given in Annex 2.

$$\text{Ln } D_{water\ t} = 3.2209 - 0.2784 \text{ Ln } P + 0.2433 \text{ Ln } D_{water\ t-1} \qquad \text{(Eq.2.1)}$$

$$(2.972) \quad (-1.951) \qquad (0.8252)$$

R^2 (Adj) = 0.259 F =2.7485 n=11 (1989 – 1999)

Where

D water = Domestic demand for water per head

P = Price Index for water charged to households, derived from the series of Consumer Price Deflators published by the National Statistical Office

T, t-1 = Time periods

( ) = t statistics

The response of households' demand for water following price and income changes over time may be gauged from the logarithmic function presented as Equation 2.2. The price elasticity remains in the –0.2 to -0.4 range while the income elasticity is 0.2435. The two parameters 'explain' around 35% of the changes in water demand recorded in the nineties in the bills issued by the Water Services Corporation.

$$\text{Ln D water}_t = 3.220 - 0.3646 \text{ Ln Price} + 0.2435 \text{ Ln Income} \qquad \text{(Eq.2.2)}$$

(2.3351) (-2.9451) (1.3530)

R^2 (Adj) = 0.3457 F = 3.6424 n =11 (1989 – 1999)

Where:

D_{water} = Demand for water by Households

P = Price Index

Income = Income per head

T, = time

( ) = t statistics

2.2 Summary

The main policy considerations that emerge from the above discussions are the following.

1. Official data on water consumption in the Maltese Islands underestimates by a wide margin, the true volume of water consumed annually. Billed data give total consumption in the region of 18million m^3, while an estimate of 'comprehensive consumption', a statistic which includes non-conventional sources, give 38 million m^3.

2. Official data indicate Domestic consumers as the main component in the aggregate demand for water, with 60% of consumption. This situation is not supported by the distribution of water consumption as per the 'comprehensive' estimate. The latter identifies Agriculture as the prime source of demand with an aggregate of 43%, i.e. 37% for Agriculture and 6% for Farms. Domestic consumers come second with 34%. This classification is in line with the distribution of water consumption in many countries.

3. Policy should focus on water use and related market value of a commodity. Since the large volume of water consumed in Agriculture is excluded from billing, the information content of input-output relationships, as these emerge from published official data, tend to understate the real cost composition. This situation has to be rectified if lasting policies on efficient water usage are to be devised.

4. Policies on water management and agricultural products need to be integrated. Such policies will encourage the identification of crops and animals bred in terms of the input of water costs in total costs, and the net contribution per unit of the respective commodities on the market. One critical policy consideration refers to the fact that up to now, the prices fetched arose in a sheltered environment. These protective tariffs are being removed; therefore the inclusion of proper water charges for agricultural produce will affect directly the competitiveness of Malta produced agricultural produce.

5. Similar exercises have to be carried out for Industry and the Services sectors, especially for tourism. Such research will help identify the use and corresponding cost of water in the respective units in these sectors.

6. Household demand for water is price inelastic. Estimates set the ***demand price elasticity*** at –0.28 in the short run and –0.37 in the long run. These statistics suggest that price movements influence households' demand for water. The ***income elasticity of demand*** is given at 0.2435.

3. Management of Water Supply

3.1 Water Supply Policies

The supply policies of the Maltese government aim at

- conserving ground water supplies
- guaranteeing a good supply of water which is sufficient to meet the demands of the various domestic and economic sectors
- ensuring affordability of water and hence the progressive water tariff structure
- improving the quality of water for drinking, irrigation and other uses.

Water is a most important economic resource and it is a prerequisite for progress. Its scarcity may constrain economic activity and may impede the development of agriculture, tourism and industry.

Over the last decades, there has been a drastic reduction in the natural water supply coupled with the concurrent increase in demand. Demand was boosted by increased industrial development, the growth of the tourism and concomitant improvement in living standards. All together these factors have led to the full utilisation and over-exploitation of the available traditional water resources. Illegal extraction for irrigation and other purposes has continued to deplete this scarce resource.

This situation is clearly illustrated in Table 3.1. The data in this table clearly indicates that most of the aquifers are being extracted to the very limit with extraction figures being dangerously close to the mean annual recharge. The perched aquifer springs used to contribute an annual volume ranging between 400,000 and 500,000m^3 of groundwater towards the potable water supply. The springs have however been decommissioned from the public supply network due to the high nitrate contamination (where nitrate content values recurrently exceeding 200mg/L NO3- have been registered) and regular recurrence of microbiological contamination. Groundwater from these sources is currently either being distributed by WSC for secondary purposes (such as irrigation) or left to flow naturally down the valley beds. The total non-potable water production by the WSC amounted to just over 230,000m^3 during 2002/03.

Table 3.1
Basic Quantitative Characteristics of the Main Aquifer Blocks in the Maltese Islands

Aquifer Code	**Name**	**Size** Km^2	**Recharge** Hm^3	**Extraction** Hm^3	**Major Extraction**	**Balance** Hm^3
MT001	Malta (Main) LCL	216.6	34.27	37.01	P , A	-2.74
MT002	Rabat-Dingli UCL	22.6	4.64	3.92	A	0.72
MT003	Mgarr-Wardija UCL	13.7	2.86	2.56	P , A	0.29
MT004	Pwales UCL	2.8	0.70	1.29	A	-0.59
MT005	Mizieb UCL	5.2	1.11	0.97	P , A	0.14
MT006	Mellieha Ridge UCL	4.5	0.75	0.41	A	0.34
MT007	Mellieha Bay UCL	2.9	0.69	0.53	A	0.17
MT008	Marfa Ridge UCL	5.5	0.89	0.75	A	0.14
MT012	Comino UCL	2.7	0.52	0.26		0.22
MT013	Gozo LCL	65.8	10.02	8.07	P , A	1.94
MT014	Ghajnsielem UCL	2.7	0.85	0.31	A	0.54
MT015	Nadur UCL	5.0	1.33	0.69	A	0.64
MT016	Xaghra UCL	3.0	0.86	0.43	A	0.43
MT017	Zebbug UCL	0.4	0.16	0.02		0.14
MT018	Victoria-Kercem UCL	1.5	0.58	0.10		0.48

(P: extraction for potable purposes; A: extraction for agricultural purposes)

Source: M. Sapiano,2004

The shortfall in supply and the consequent deterioration in the quality of this important resource prompted the Maltese government to supplement water from natural resources with expensive desalination of seawater. A further attempt to guarantee supply and to simultaneously ease the pressure on the natural water resource as well as to reduce the cost of desalination was the treatment and recycling of wastewater. The idea was to use this treated effluent for irrigation and industry. Since 1983, the Sant'Antnin recycling plant has helped to irrigate previously dry agricultural land. Some of the treated effluent is used in industry.

Table 3.2

Potable Water Production

Year	Groundwater Mm^3	R.O. Production Mm^3	Total Production Mm^3
1994/95	20.570	32.725	53.295
1995/96	20.360	28.767	49.127
1996/97	21.985	24.502	46.487
1997/98	18.322	22.450	40.772
1998/99	18.562	19.401	37.963
1999/2000	19.262	17.341	36.603
2000/01	17.082	16.610	33.692
2001/02	16.212	17.925	34.137
2002/03	15.755	18.226	33.983

Source: Sapiano E., 2004: Table 1.3.

The supply of this type of water may increase when the Maltese government implements the Sewerage Master Plan to comply with the Barcelona Convention to which Malta is a signatory. Three other sewage treatment plants, Gozo STP, The Malta North and the Malta South are planned to produce 6,000m3/d, 6,500m^3/d and 53,000m^3/d of treated effluent respectively, a total effluent production of 23.54Mm^3/p.a. The North and the Gozo plant will include tertiary treatment with sand filtration and chlorination. The Malta South plant will allow for anaerobic sludge digestion with energy recovery. Part or all of the water may be reused rather than just be discharged into the marine environment. However, what volume of such effluent will be used, depends on the real and perceived health considerations, the cost of production, storage and distribution, the quality of water produced and the demand for such water supplies by the industrial and agricultural sectors. More information about the potential demand and the willingness to pay for this effluent is not available to-date. But most important, the demand for such water will be determined by the tariffs charged. Of course, farmers do not voluntarily buy treated effluent and stop extracting underground water. However, given the precarious state of the aquifer and the costly generation of potable water and water for irrigation, all measures have to be taken in time to comply with the water framework directive.

3.2 Water tariffs.

Malta operates a rising block water tariff system where successive blocks of water are sold at a higher price. Pre-1994, the first block of 27m^3 was free of charge. A service charge is paid independent of the amount of water consumed. The different water tariffs and the meter rent that are charged to the various economic sectors are listed in Table 3.3.

Table 3.3

Water Tariffs

Type of consumer	Meter rent	Consumption charge	1998
Domestic	Lm4	0 –11m^3/person >11m^3/person	16c5/m^3 110c/m^3
Social Assistance	Free	0 –5.5m^3/person -11m^3/person >11m^3/person	Free 16c5/m^3 110c/m^3
Agriculture and agro food	Lm8	0 –2270m^3 >2270m^3	18c/m^3 35c/m^3
Personal Health Use in field	Lm4	0-5m^3 >5m^3	22c5/m^3 60c/m^3
Industrial	Lm8		85c/m^3
Food and beverage	Lm8		60c/m^3
Tourist Flats	Lm8	0 –84m^3 >84m^3	75c/m^3 Lm1.10/m^3
Hotels	Lm8	0 – 14m^3/bed >14m^3/bed	90c/m^3 Lm1.10/m^3
Laundry	Lm8	0 – 2270m^3 >2270m^3	75c/m^3 Lm1.10/m^3
Sea Craft	Lm8		Lm1.10/m^3
Government	Lm8		Lm1.10/m^3
Boat house, Garden & garages	Lm4	0 – 10m^3 >10.m^3	85c/m^3 Lm1.10/m^3
Non-Commercial	Lm4	0 –57m^3 >57m^3	Free 35c/m^3
Commercial & other	Lm8	0 –57m^3 >57m^3	50c/m^3 Lm1.1/m^3

Domestic, industrial and commercial consumers can apply for rebates as explained in Annex 3. Additional subsidies are available to vulnerable consumers such as person receiving social assistance and pensioners. Such a policy measure is in line with the Water Framework Directive Art.12a, which requires an affordable water price to guarantee a basic level of domestic water supply.

The average consumption charge in Maltese liri per cubic meter of billed water consumed for the years 1999/2000 for the various sectors is given in Table 3.4.

Table 3.4

Breakdown of Consumption for the years 1999/2000 by sector

Consumer type		Average consumption charge	Average consumption per account m^3
Domestic	Residential	0.34	65.81
	Social Assistance	0.24	55.51
	Other	0.96	11.39
Industrial		0.56	1264.40
Farms		0.21	625.05
Tourist		0.85	725.31
Government		1.11	718.96
Commercial			
	Bars and restaurants	0.84	186.77
	Other	0.69	44.96
Other		0.37	344.45
Total		0.47	84.20

Source: WSC Annual Report 2000/2001:Table 36 pg. 49.

Comparing the water tariffs with the cost of water production may be useful for policy evaluation and future recommendation.

3.3 The Cost of water

In 1999/2000, the total volume of water billed by the WSC covers only 46.6% . ($18.00Mm^3/38.6Mm^3$) of the estimated non-conventional total water consumed and 49.2% ($18Mm^3/36.603Mm^3$) of total RO and groundwater produced. The financial data used to estimate the unit cost of water includes the total operating cost, the higher of debt service or depreciation, and the net working capital requirements for year t minus those needed in the previous year divided by the quantity of water produced in m^3 in year t. Algebraically, the unit cost of water is represented by equation 1. The information used was taken from the Audited Financial Statements of the WSC for the years 1998 –2002. The unit cost of water for the years 2003 to 2005 could not be calculated for the WSC Business Plan and the Water Quality Project did not include estimates of working capital requirements.

The Balance Budget Method derives the full cost of water. It is expressed by equation 3.1.

$T_t = [\ TOE_t + \text{Higher of [Debt Service or depreciation]} + WC_t - WC_{t-1}\ ] / Q_t$ .. (Eq.3.1)

Where

T_t = unit cost of water in the year of analysis t in Lm/m^3

TOE_t = total operating expenses in the year t in Lm
T = year of analysis (base year
Q_t = quantity of water in year t in m^3
WC_t = Working capital requirement in Lm in year t

The average unit cost for the five-year period is 52c6. However, this value is influenced by the low result obtained for year 2000. If this value is removed, the average for the remaining four years works is around 54c5 with a tendency to rise. So in the circumstances, a value of (rounded) 55cents is taken for computational purposes (See Annex 4). Table 3.5 presents the cost of water production for the average consumption per account for each sector compared to the average bill including the service charge. The resulting subsidies/mark up and the subsidies/mark up as a percentage of imputed costs are also estimated.

Table 3. 5

Breakdown of Consumption by Sector for the year 1999/2000

Consumer type		Average consumption per account M^3	Average consumption bill including service charge (a)	Cost calculated at 55c per m^3 (b)	Subsidy/ mark up (b) – (a) =(c)	Subsidy /mark up as % of total cost (c)/(b)
Domestic	Residential	65.81	34.08	36.196	(2.116)	(5.846)
	Social Assistance	55.51	13.52	30.531	(17.011)	(55.72)
	Other (domestic garages)	11.39	22.84	6.264	16.576	264.6
Industrial		1264.40	728.54	695..42	33.12	4.76
Farms		625.05	154.81	343.778	(188.97)	(54.97)
Tourist		725.31	642.46	398.920	243.94	61.05
Government		718.96	825.13	395.428	429.70	108.67
Commercial	Bar & Restaurants	186.27	180.8	102.448	78.35	76.48
	Other	44.96	54.68	24.728	29.95	121.12
Other		344.45	141.59	189.447	(47.86)	(25.261)
Total		84.20	52.32	46.31	6.01	12.98

Source: WSC Annual Report 2000/2001 Table 36, page 49.

The data in Table 3.5 clearly indicates that the industrial and the commercial sectors are cross subsidizing the farming and the domestic sectors. Consumers who are pensioners or who receive social assistance receive the highest subsidy, 55.7%. Farms come second with 55% and ‘others’ with 25.3%. Only 5.8% of the average residential household bill is subsidised. However, a reclassification by household size (Table 3.6) shows that while only 12.3% of the water cost is subsidised for the median family, the reduction in cost for household with 3, 4, 5 and 6 persons amounts to 41.7%, 47.2%, 56.3% and 62.6% of the total cost of water consumed

Table 3.6

Consumption and Bill for that Consumption issued for Domestic Households

	50 percentile	**Cost of water at 55c**	**Service Charge**	**(Subsidy)/Excess**	**(Subsidy)/cost of Water %**
Domestic					
1 person	23.38m^3 Lm15.86	Lm12.859	Lm12.00	Lm3.001	23.30
Domestic					
2 persons	49.22m^3 Lm20.12	Lm27.071		(Lm6.951)	(25.73)
Domestic					
3 persons	77.12m^3 Lm24.72	Lm42.416		(Lm6.951)	(41.72)
Domestic					
4 persons	95.56m^3 Lm27.77	Lm52.558		(Lm24.788)	(47.16)
Domestic					
5 persons	115.62m^3 Lm27.78	Lm63.591		(Lm35.811)	(56.31)
Domestic					
6 persons	132.12m^3 Lm27.20	Lm72.666		(Lm45.466)	(62.57)
Domestic all	44.22m^3 Lm21.34	Lm24.321		(Lm2.981)	(12.26)

Source: WSC Annual Report 2000/2001, Table 38, pg. 50.

3.4 Unit cost of treated effluent.

The unit cost of treated effluent cannot be estimated since the financial data required to compute this parameter is incomplete. But estimates made available by the Drainage Department now part of WSC indicate that the cost of producing such effluent will range between 17cents and 38 cents per cubic metre if 100% and 50% of such effluent is billed respectively. More research needs to be carried out before pronouncing on any policy measure. However, the agriculture Department seems to believe that farmers will not be willing to pay more than a maximum of 25 cents per cubic metres of treated effluent. They may be willing to purchase the effluent if the flow is constant and of a good quality with low salinity value. Thus this second class water will not negatively affect the plant growth and hence the farmers' yield.

3.5 Summary

1. The majority of the aquifers are being over-extracted, with extraction figures dangerously close to the mean annual recharge.

2. Groundwater in the perched aquifer springs is highly contaminated with nitrate. These aquifer springs had to be disconnected from public supply.

3. Malta has to abide by the Barcelona Convention. The number of sewage treatment plants will rise to four. However, the volume of such treated water utilised will reflect the demand by agriculture and industry. Such utilisation will critically depend on costs per unit, social perception regarding the quality of such water, and the availability of a distribution network. Information on users' willingness to pay is lacking.

4. Malta operates a rising block tariff system and applies rebates to support specific users.

5. Full cost of water, based on the Balanced Budget Method, gives a (rounded) cost per unit of 55c per m^3. This statistic is based on audited accounts of the Water Services Corporation for the five-year period 1998-2002. Producers in the manufacturing, tourist, and commercial sectors cover unit costs. Domestic users and farms are charged subsidised rates.

6. Households, made up of two persons and over, are subsidy recipients. Single person households do not benefit from such subsidies.

4. Assessment of Water Policy Options

The traditional supply expansion is insufficient on its own to secure a sustainable supply of water. Demand management options should complement these supply measures to ensure that a good quality supply of water is available at a reasonable price to satisfy the various domestic, industrial and agricultural water needs. Measures should be holistically applied after considering the various economic and social impacts on the various sectors and should complement each other to be effective.

In view of this, various policy options may be considered:

- To secure additional non-conventional sources of supply
- To ensure the efficient use of available water
- To build up strategic water reserves
- To maintain and enhance the quality of water
- To introduce new and effective management procedure.

4.1 Additional sources of water supply

The present supply of water may be increased in various ways: collecting surface run-off, saving from leakage reduction and by recycling the effluent water.

4.1.1 Collecting Surface Run-off

A practical way of augmenting supply is by enforcing present legislation and ensuring the existence of cisterns to collect and store rainwater in the home or other private or public buildings. The surplus rainwater should not be directed to the drainage system but to specially designated local catchments areas e.g. reservoirs strategically built to collect the water which may later be used for irrigation purposes within or outside the said localities.

More dams should be strategically built across valleys. The Department of Agriculture agrees that such dams may be constructed in areas such as Wied il-Qlejja, Wied il-Kbir, Qormi, Wied Qannotto, Burmarrad and at Tal-Hzejjen, limits of Mgarr between Zebbiegh and Bidnija. Such dams may help collect some of the present surface water runoff amounting to 4,006,946m^3 and prevent it from being lost into the sea. At present only 154,000m^3 or 3% of total surface run off is saved. To the author’s knowledge, no accurate scientific information is presently available on the potential storage capacity of these valleys. An economic impact assessment should be undertaken to estimate such capacity and to determine whether such stored water could be used directly by local farmers for irrigation or allowed to infiltrate into the aquifer thereby increasing the annual recharge. Controlling the surface runoff also helps to mitigate the environmental damage such as floods, soil erosion, crop destruction and the consequent negative impact on supply of agricultural crops, farmers’ yield and potential price increases. Moreover, it has to be ensured that rainwater flows freely along the watercourses especially during heavy rainfalls. The cost-effectiveness of the above schemes have yet to be established.

4.1.2 Savings from leakage

A substantial volume of water annually leaks out of the system. Part of this water may find its way as recharge to the aquifer. Some may be attributed to theft. Whatever the cause of this annual loss in the supply of water, such leakages are damaging the Water Services Corporation financially to the tune of Lm3.196million, Lm2.524m and Lm1.919m if the estimated targets set by the Water Services Corporation to adopt the Infrastructure Leakage Index (ILI) which calculates the ratio between the Current Annual Real Losses (CARL) and the unavoidable leakage background leakage level (UARL) for the years 2004, 2005 and 2006 respectively are met. (Table 4.1)

Table 4.1

Saving from Leakage Control

Year	**2003**	**2004**	**2005**	**2006**
ILI	3.06	2.47	1.96	1.49
Annual Leakage Mm^3	7.18	5.81	4.59	3.49
Cost @55c/m^3 Millions Lm	3.949	3.196	2.524	1.919
Increase in supply of water over t-1	/	1.37	1.22	1.10

As indicated in Table 4.1 if the WSC targets are to be met, the annual water supply for the years 2004, 2005 and 2006 will have to increase by 1.37million m^3, 1.22million m^3 and 1.10million m^3, respectively, over the years 2003, 2004 and 2005. In 2003, the WSC succeeded in reducing the leakage to 1000$m^{3/}$p.h. or 8.76Mm3/p.a. There is a shortfall of 1.58Mm3/p.a. or 180m3/p.h. from the projected target of 7.18Mm3/p.a. This costs the corporation an additional Lm869, 000 p.a. or Lm99 per hour.

4.1.3 Recycling of Effluent

Recycled water may provide sufficient additional reliable amounts of water. It may therefore help to the conservation of groundwater resources. The water thus produced is rich in nutrients that may increase productivity. Recycled water also contributes to the reduction of chemical fertilizers and, hence, helps minimise the environmental damage and the contamination of soil and groundwater. A lower demand on groundwater increases recharge and helps control the saline water intrusion in the coastal aquifers.

The setting up of Sant'Antnin sewage treatment plant in 1983 introduced this concept in Malta. The treated effluent from the plant is used to irrigate about 240 hectares of land. Government plans to set three new sewage treatment plants producing a total of

23.9Mm^3 of treated sewage. 4.56Mm3 will be available in 2006 whilst 19.345Mm3 in 2007. Water from these plants could potentially be used for landscaping, industrial use or for irrigation purposes. Assuming that 12,000m^3 /p.a. of water are needed for irrigating one of hectare of agricultural land, this supply of recycled water may be used to irrigate about 2,000ha.of agricultural land.

Some of this water may be used in the near future. However, to the author's knowledge no plans are available of a distribution network that is essential to transfer this second class water to the end user. Other limitations that may deter the transfer of this resource to the farmers include the problem of access to fields, the size and fragmentation of farm holdings, and sufficient number of farmers. Moreover, the recycled water cannot be used on agricultural land located in aquifer sensitive areas. Besides, the drainage department, presently part of the WSC, estimates the cost of producing this second class water to be between 18c/m^3 to 38c/m^3 exclusive of any distribution cost. The true cost may be close to the cost of RO water. Therefore a more detailed cost benefit analysis has to be carried to evaluate the feasibility or otherwise of such a project taking into account the readiness to pay by potential users of such water.

4.2 Water demand

4.2.1 Use of tariffs:

Malta has a system of tariffs with rising blocks with variable prices in cubic meters. All users except social assisted cases pay an additional fixed service charge. The tariffs charged to residential users cover only a fraction of total cost .The cost of domestic water in Malta is subsidised. The subsidy varies inversely with the size of household. In the short run, a measure of the price elasticity of demand for households suggests that an increase in price of 1% leads to a fall in quantity of water consumed of around 0.27% In the long run, the sensitivity to price changes rises as consumers adjust their consumption to increased prices. Hence a gradual rise in prices to reflect the full cost of water as required by the Water Framework Directive will contribute to a more economical water use by households.

The effects of such tariffs on the socially disadvantaged household should not be ignored when water prices are determined. Household such as those who have low incomes and those who have high level of essential water use e.g. large families and persons with poor medical conditions are more vulnerable to water metering and water pricing. The tariffs paid by these sub-groups will continue to be subsidised.

The price elasticity of demand for the other economic sectors is not known. More research work is needed to establish such parameters. When setting tariffs, it is important to ensure that production and operating costs are minimised. Water leaking out of the system is very costly to produce. It contributes to unnecessary increases in prices and loss of purchasing power and consumer surplus. Water leakages have negative impact on the environment. 1m^3 of water produced by reverse osmosis consumes 7.05kWH of electricity at 2c47/Kwh whilst 1m^3 of groundwater consumes 0.854Kwh of electricity. Therefore, systematic investigation as is presently undertaken by the WSC for leakage in the public distribution system, pipeline renovation techniques and constant testing of new methods of renovation techniques help minimise such water loss. Besides, maximum supervision and monitoring of costs and unpaid bills are needed. Otherwise, tariffs will be paid to cover inefficiency and waste and therefore will not be economically viable.

4.2.2 Water Use efficiency

European environmental data indicates that only 5% of the total water used domestically are needed for drinking and cooking. About 25% to 30 % are used for toilets and the rest is used for washing clothes and for personal use. The demand for water may be contained if both households and industry use this important resource more efficiently and serious measures are taken to minimise waste and contain both private and social cost. Recycling of grey water could reduce household demand for potable water (Angelakis, 2003).

Water may be saved by fitting water efficient equipment and new water saving sanitation appliances such as installing toilet flushing that contain 7.5 litres rather than 9.5 litres of water, or use one spout electronic taps. Showers are also more water efficient.

4.3 Water conservation measures – public awareness

Demand for water may be further reduced if people change their water use habits. Regular information campaigns should emphasise the dire need to conserve water and highlight the cost of wasting it. Information should be made available to all users and professionals. Advice on practical water saving devices should be made available to plumbers, consulting engineers, shops, and other clients that provide water saving devices when construction work takes place. Letters should be sent to domestic users giving them practical advice on how to decrease their consumption of water. Educational programs for schoolteachers and schoolchildren as are presently being done by the Institute of Water technology may help, in the long run to change the culture of water use. Ideally, teachers are given dossiers containing information and teaching materials suitable for different age groups.

The agriculture sector is the larger consumer of water in Malta. The use of advanced irrigation system, e.g. the use of drip irrigation system rather than sprinklers or hosepipes, also help to cut down the water demand. Moreover, the Department of Agriculture can induce a better water use by advising farmers on irrigation patterns directed to the value added contribution by plants. Such practical advice not only helps farmers to improve crop output but also helps in the conservation of water especially if this water is extracted from groundwater.

Efficient use of water in industry also helps to minimise the cost of production and increase profitability. Subsidies for the use of second class water may boost the demand for treated effluent whether this is produced in-house or whether it is purchased from public sewage treatment plants.

4.4 Modification of irrigation water allocation

Different crops consume varying quantities of water depending on the type of plant, the weather conditions, the soil type and the season. Moreover, the water input may not be reflected in the output or the profit earned by farmers. Lack of such knowledge results in growing crops which consume huge quantities of water but which earn very meagre returns. The Department of Agriculture especially the personnel working the department's experimental farms should teach farmers to substitute water intensive crops and summer vegetables with low water intensive aromatic plants and winter crops with new profitable crops. Such measures improve the economic returns of farmers as well as help to minimise the negative externalities e.g. the depletion and the deterioration of the water quality as a result of the excessive water extraction.

4.5 Build up strategic reservoirs

Demand for landscaping and irrigation may also be diminished if reservoirs are built in strategic places. Some of these reservoirs can be constructed in catchment areas to collect the surface run-off during storms and heavy rainfall. Such a measure saves water from being permanently lost into the sea. It also mitigates, possibly eliminates, the risk of recurrent flooding, soil erosion and destruction of roads, residential houses and farms. These social costs are very high to individuals and to society at large. The money thus saved could be invested to improve the water quality or may be passed on to the consumer in the form of a lower water tariff. Some of these reservoirs may also be used to collect water, some of which is allowed to infiltrate into the soil and to help recharge the much-depleted aquifers.

Other reservoirs may be used to store treated effluent. The water may eventually be sold for irrigation or for industrial use.

4.6 Maintenance and enhancement of water quality

The water framework directive does not only demand that member states simply ensure a good supply of water. It also emphasizes the importance of maintaining a body of good quality water. In Malta, abstraction of ground water has over the years resulted in groundwater that is highly contaminated with nitrates and chlorides. The indicator parametric values are 50mg/ltr and 250mg/ltr of water respectively. The values of chlorides and nitrates observed in our aquifers are listed in Table 4.2 and Table 4.3 below.

Table 4.2

Average Chlorides mg/lt.

Aquifer	1995	1996	1997	1998	1999	2000	Average
Bingemma perched	194.00	232.35	457.69	173.64	183.33	183.33	237.44
Gozo MSL	485.94	495.23	480.00	567.71	475.00	475.00	485.47
Malta MSL	1476.50	1018.69	1177.12	816.11	1030.06	1030.06	1069.73
Mizieb	356.00	310.00	267.00	251.00	252.00	252.00	282.83

Source: National Office of Statistics, 2002 ***Environment Statistics***; Malta Resource Authority, Kevin Gatt, Table 4, p9.

The chlorides level found in the Malta MSL and the Gozo MSL Aquifers are 3.6 and 1.6 times the mandatory limits respectively. The high levels of chlorides result from over- abstraction of groundwater. To reduce the chloride level and hence to improve the quality of groundwater, the competent authority (MRA) should have a register of all the boreholes. All such boreholes should be metered to measure and monitor the volume of water being extracted. Boreholes where the water quality is very contaminated should be closed down. Consumers who are not authorized to pump water or who extract more than the permissible limits established from time to time should be fined.

However, to ensure that sufficient water is available at all times for irrigation, incentives such as tax rebates or subsidies should be given to farmers who take steps to conserve rainwater, for example, through the construction of cisterns or reservoirs. Similar incentives should be given to those who upgrade infrastructure technology to irrigate crops. At the same time, educational programmes for farmers will instruct farmers in identifying the ideal combination of crops that have a high value on the market and consume the least amount of water.

Table 4.3 gives the average nitrate levels.

Table 4.3

Average Nitrate (mg/lt.)

Aquifer	1995	1996	1997	1998	1999	2000	Average
Bingemma perched	114.47	107.01	101.02	105.68	109.94	107.28	107.56
Gozo MSL	29.71	23.50	26.61	46.20	42.12	43.80	37.23
Malta MSL	65.03	67.97	63.88	68.46	67.88	68.12	66.94
Mizieb	45.50	43.30	41.40	40.50	40.50	44.30	42.58

Source: NSO, 2002, ***Environment Statistics***.

The average nitrate level as illustrated in Table 4.3 also exceeds the values established by Directive EC/98/83. It is highest in the Bingemma perched aquifer at 107.56 or over twice the established parameters. This may reflect the leeching of nitrate that occur from intensive agricultural activities, high use of fertilizers, leakage from the sewerage system and animal husbandry.

The nitrate level may be reduced if there is a more controlled use of fertilisers. The use of second class water, which is rich in nutrients, may also help reduce the nitrate level. Systematic investigation for leakage in the drainage system will decrease the possibility of drainage leakage. Hence it improves the nitrate level.

Biological control of pests and insects reduces the need of insecticides or pesticides. These substances are very harmful to the environment. They leach into the soil and deplete the quality of groundwater. .

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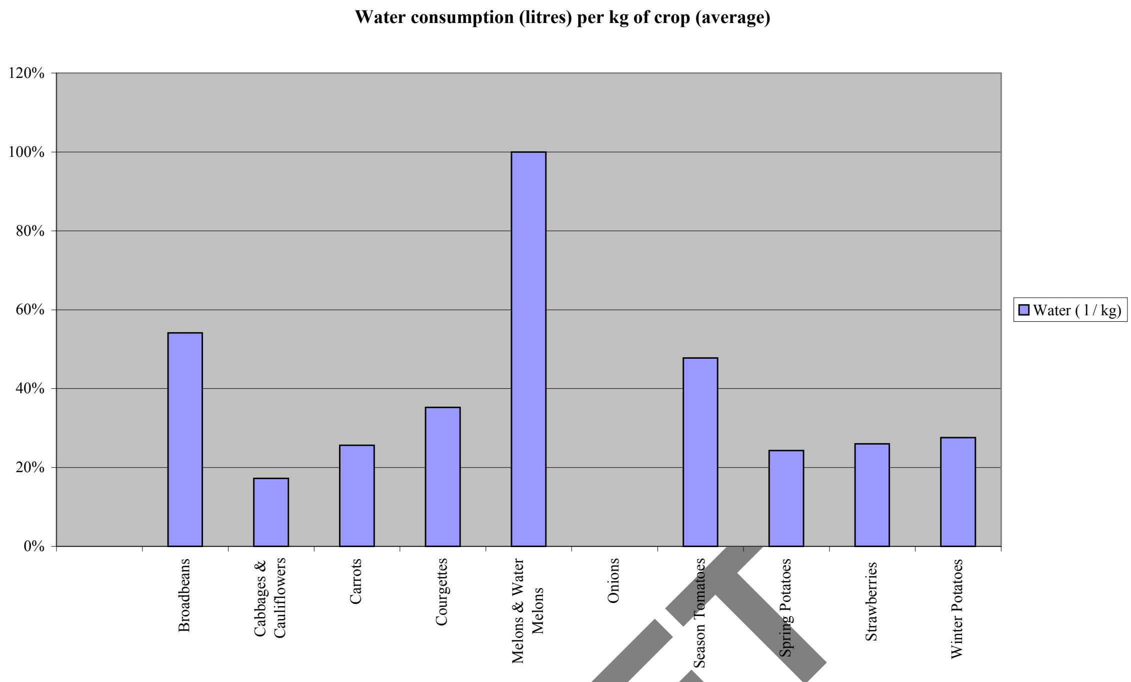
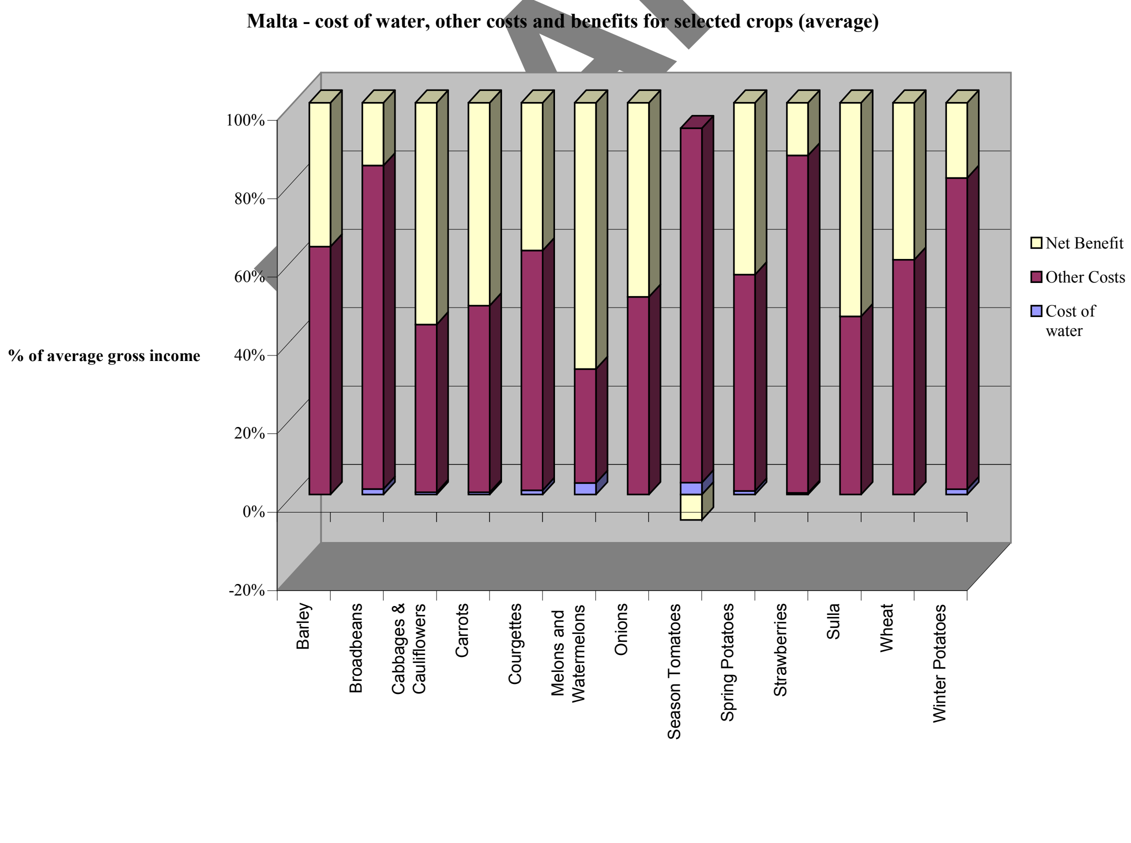
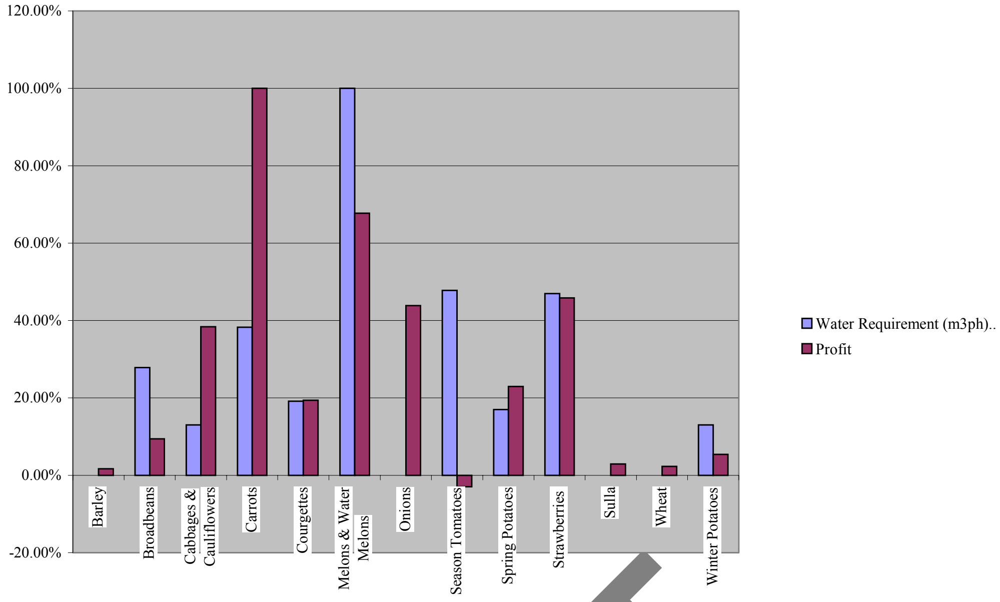
Annex 1


Water consumption (litres) per kg of crop (average)
120%
100%
80%
60%
40%
20%
0%
Broadbeans
Cabbages & Cauliflowers
Carrots
Courgettes
Melons & Water Melons
Onions
Season Tomatoes
Spring Potatoes
Strawberries
Winter Potatoes
Water (l / kg)


Malta - cost of water, other costs and benefits for selected crops (average)
% of average gross income
100%
80%
60%
40%
20%
0%
-20%
Barley
Broadbeans
Cabbages & Cauliflowers
Carrots
Courgettes
Melons and Watermelons
Onions
Season Tomatoes
Spring Potatoes
Strawberries
Sulla
Wheat
Winter Potatoes
Net Benefit
Other Costs
Cost of water

Valuing irrigation water (average)



Annex 2

Elasticity of Demand: Price and Income

Year	Ln Y	Ln X1	Ln X2
	Water consumption(1989-1999)	Price index	Per Capita Income
1989	3.351551852	4.769158036	7.8043289
1990	3.334665765	4.769158036	7.873544496
1991	3.457514701	4.769158036	7.913447862
1992	3.497416239	4.769158036	7.937963808
1993	3.493077443	4.769158036	7.965041974
1994	3.39802569	4.605170186	7.99639467
1995	3.472587378	4.605170186	8.04503364
1996	3.546912583	4.605170186	8.06990246
1997	3.502579996	4.6998438	8.111568071
1998	3.338044567	5.03805589	8.120671967
1999	3.357280325	5.03805589	8.184881886

Regression Statistics	
Multiple R	0.690367006
R Square	0.476606604
Adjusted R Square	0.345758254
Standard Error	0.062655909
Observations	11

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	0.028598673	0.014299336	3.64243498	0.075043478
Residual	8	0.031406104	0.003925763		
Total	10	0.060004777			

	Coefficients	*Standard Error*	*t Stat*
Intercept	3.220999772	1.379360887	2.335139268
X Variable 1	-0.364605471	0.137842378	-2.645089823
X Variable 2	0.243545701	0.179996321	1.353059327

Elasticity of Demand: Price and Lagged Consumption

Year	ln Y Water consumption(1989-1999)	ln X1 Price index	ln X2 Water consumption (1988-1998)
1989	3.351551852	4.769158036	3.439616492
1990	3.334665765	4.769158036	3.351551852
1991	3.457514701	4.769158036	3.334665765
1992	3.497416239	4.769158036	3.457514701
1993	3.493077443	4.769158036	3.497416239
1994	3.39802569	4.605170186	3.493077443
1995	3.472587378	4.605170186	3.39802569
1996	3.546912583	4.605170186	3.472587378
1997	3.502579996	4.6998438	3.546912583
1998	3.338044567	5.03805589	3.502579996
1999	3.357280325	5.03805589	3.338044567

Regression Statistics	
Multiple R	0.638187704
R Square	0.407283545
Adjusted R Square	0.259104432
Standard Error	0.066676288
Observations	11

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	0.024438958	0.012219479	2.7485894	0.12342068
Residual	8	0.035565819	0.004445727		
Total	10	0.060004777			

	Coefficients	*Standard Error*	*t Stat*
Intercept	3.922387938	1.342938929	2.920749302
X Variable 1	-0.278452206	0.142713711	-1.951124408
X Variable 2	0.24330357	0.294836476	0.825215299

Annex 3

Water and Sewage Charges

Tariff for water consumption:	
Service charge	Lm 8 per 121 days
Water consumption	Lm 1.10/m^3
Subsidy for all domestic consumers:	
4.5/m^3/person/121 days	99c/ m^3
4.5/m^3/person/121 days	88c/m^3

Additional rebate for all domestic consumers: (reached after discussions with unions)			
First Level			
Reduction per person	1998	1999	2000
8 cu/m and under	Lm 1.85	Lm 1.40	85c
10 cu/m and under	Lm 1.5725	Lm 1.18	70c
12 cu/m and under	92c5	70c	43c
Second Level			
Charge per person	1998	1999	2000
First block	5m^3 @ 5c	5m^3 @ 8c	5m^3 @ 11c
Second block	5m^3 @12c	5m^3 @19c	5m^3 @22c
Third block	Lm 1.10/m^3	Lm 1.10/m^3	Lm 1.10/m^3

Note:

- Rebates on water and electricity would be applied according to level 1 so long as total rebates under level 2 are not greater for a household. In that case level 2 rebates would apply, to ensure that households would receive the higher deductions according to consumption limits.
- For the first issue of bills in 1998, a special rebate of Lm 1.40 per person consuming less then 12m^3 will be given.

Additional subsidy for special cases of consumers:

Persons who are receiving social assistance and pensioners who satisfy certain conditions of income and capital assets are exempt from the service charge (and sewage charges).

Additional rebates for non-domestic consumers for 1998:

Industry	Rebate of 75c/m^3 for water consumed in excess of 1000m^3/year
Hotels	Rebate of 40c/m^3 for water consumed below 14m^3/bed/121 days
Restaurants	Rebate of 40c/m^3 for consumption to 47m^3/121 days

Annex 4

Unit Cost of Water – Balanced Budget Method

Basis Year	Total Operating Cost (excluding Depreciation)	Higher of Debt Service or Depreciation	Total	Working Capital Current Year	Working Capital Previous Year	Change in Working Capital	Quantity of Water Produced (m^3) Groundwater	RO	Total	Unit cost of water (Lm/m^3)
	A	B	C = A + B	D	E	F = D - E	G	H	I = G + H	J = (C+F)/I
	Lm	Lm	Lm	Lm	Lm	Lm	M^3	M^3	M^3	Lm
1998	14,587,757	7,009,647	21,597,404	1,310,943	1,665,390	-354,447	18,322,000	22,450,000	40,772,000	0.521
1999	14,210,574	3,992,570	18,203,144	3,314,312	1,310,943	2,003,369	18,562,000	19,401,000	37,963,000	0.532
2000	15,017,122	4,023,727	19,040,849	958,288	3,314,312	- 2,356,024	19,262,000	17,341,000	36,603,000	0.456
2001	14,911,642	3,980,978	18,892,620	1,336,219	958,288	377,931	17,082,000	16,610,000	33,692,000	0.572
2002	14,258,839	3,653,774	17,912,613	2,142,920	1,336,219	806,701	16,212,000	17,925,000	34,137,000	0.548
Average unit cost of water (Lm/m^3)										**0.526**

(Source: Financial information – Annual Audited Financial Statements, Water Services Corporation, The Corporation; Water production – Manuel Sapiano)

Total Operating Costs

	1998	1999	2000	2001	2002
	Lm	Lm	Lm	Lm	Lm
Operating Costs	13,333,106	13,249,951	14,569,368	14,345,361	14,044,143
Administration Costs	3,797,135	3,406,753	3,942,598	3,985,632	3,868,470
Total Operating Costs	**17,130,241**	**16,656,704**	**18,511,966**	**18,330,993**	**17,912,613**
Depreciation charge	2,542,484	2,446,130	3,494,844	3,419,351	3,653,774
Total Operating Costs (excluding depreciation)	**14,587,757**	**14,210,574**	**15,017,122**	**14,911,642**	**14,258,839**

(Source: Annual Audited Financial Statements, Water Services Corporation, and The Corporation)