Quantifying Water Consumption as a Basis for Determining its Impact on Groundwater Resources in the Maltese Islands

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Preamble

This report has been commissioned by the Food and Agriculture Organisation of the United Nations as part of the context of a wider project that it is sponsoring to the Malta Resources Authority. The author has bee appointed on a three-week equivalent period as a National Water demand Consultant with the following Terms of Reference.

Under the operational supervision of REU, and the technical supervision of AGLW, and in close collaboration with the national groundwater management consultant, and the national economist consultant, the national demand consultant will contribute to the preparation of the Water Resources Review, and in particular, will:

a) Assess groundwater demand by sector and identify current and future uses for groundwater sources focusing primarily on:

i) *Potable demand*

- Assess and review projected use of groundwater as part of the global drinking water demand projections.
- Identify groundwater quality constraints that limit its availability for drinking needs.

ii) *Irrigation demand*

- Quantify demand for irrigation water in respective localities.
- Forecast the irrigation demand.
- Identification of possible sources of irrigation water. (groundwater , treated effluent and surface run-off.)
- Analyse environmental constraints on the application of non-conventional sources of irrigation.

iii) *Industrial demand*

- Assessment of groundwater demand for industrial purposes (soft-drinks, canneries, batching plants etc)
- Identification of present sources of supply and alternate sources.

b) Assess the implication of different water policy scenarios in terms of water balance and implication for groundwater

C) Write a report with the findings of the study to be inserted in the Water Resources Review report

D) Participate as a Resources person in the two workshops organised by the project.

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1.0 Introduction

The human impact on water resources is the main factor that determines the quantity of water that is required in order to satisfy the demands by the various sectors from which it is derived. Water consumption is therefore based on the amount of water that is drawn by the various sectors.

Water production in Malta is derived from the two currently established traditional major sources namely:

- groundwater through the exploitation via galleries and boreholes, of the mean sea level aquifer and perched aquifer; and

- desalination of sea water from the three RO plants.

According to the Water Services Corporation Report 2001-02, the production of potable water in the Maltese islands between 1st August 2001 and 31st July 2003 amounted to 34,136,669 m^3 with 31,786,157 m^3 for Malta and 2,350,512 m^3 for Gozo. This volume of water was derived from the abstraction of groundwater via galleries and boreholes and through desalination. The amount of groundwater harvested via galleries and boreholes amounted to 16,211,812 m^3 whilst that portion produced through desalination amounted to 17,924,857 m^3.

It is evident that the demand for water is mainly satisfied through production that occurs through water derived from desalination, an amount that constitutes around 52.5% of total water production as opposed to the 47.5% that is derived from groundwater sources.

The following sections aim to review the impact of the demand on water resources on groundwater, taking into account particular characteristics that may be applicable both on a local as well as on a national scale. It must be noted that most of the analysis that follows is based on that data which is available in the public domain. The collation of data for the production of this report has not been an easy task essentially because the different sources of data seem to differ in the figures that are quoted. Thus, for example, figures quoted in the Water Services Corporation's annual report differ from those that are produced by the National Statistics Office. Furthermore, Malta still lacks an appropriate database in which data related to the water industry are made available to researchers and interested parties thereby making studies in this area more taxing to undertake.

2.0 Water Demand Assessment by Sector

The demand for water may be classified as originating from three main sectors namely:

- potable demand;
- irrigation demand; and
- industrial demand.

Each of these three sectors have their own characteristics and therefore these need to be spelt out in order to place the demand for water resources in the right perspective.

2.1 Potable Demand

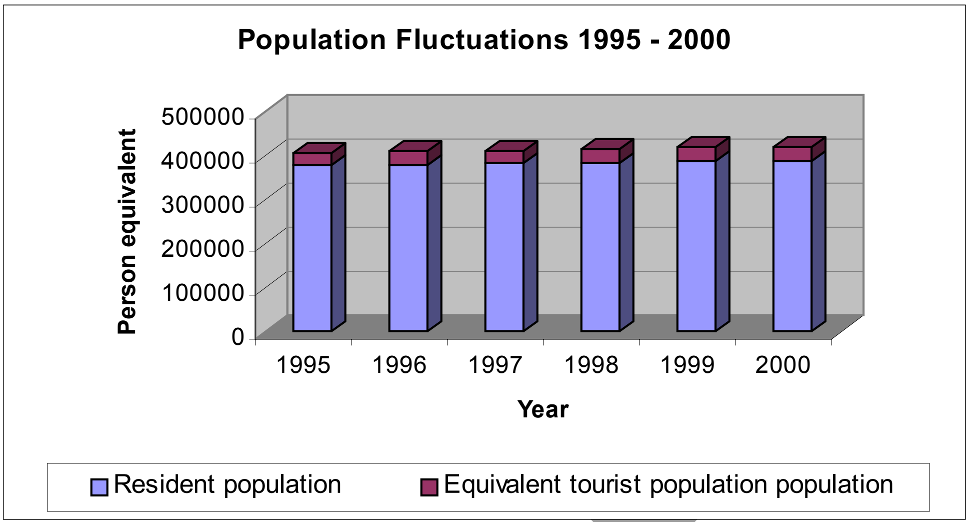
The demand for potable water essentially emanates from the number of people hosted by the country or region thereof. Potable water supplies are often associated, and are in fact typically used, for purposes such as:

- drinking;
- cooking;
- personal hygiene;
- toilet flushing;
- washing (clothes and floors); and
- other ancillary uses.

One of the main characteristics of the Maltese Islands is the seasonal variation that occurs in the resident population. This is principally due to the dependency of the Maltese economy on tourism as well as to other factors such as internal migration. Whilst it may be difficult to quantify the latter, it is useful to demonstrate how the Maltese and tourist population[1] have varied over the past years. The most recent State of the Environment Report quotes that the average stay of tourists visiting the Maltese Islands amounts to 8.4 days. However Transport and Aviation Statistics for the years 1995 to 2000 determine the average stay for each respective year and this value has been used in the computation of the equivalent tourist population.

[1] Tourist population is taken to be equivalent to the number of tourist days stayed in the Maltese Islands. This permits a like-for-like comparison with the resident population. This figure is calculated by multiplying the number of tourist arrivals by the average length of stay and dividing by 365 days.

Figure 1 – Population Fluctuations (Resident + Tourists) 1995 – 2000.
Sources: Environment Statistics, National Statistics Office, 2001
Shipping & Aviation Statistics (1995, 1996, 1997, 1998, 1999, 2000), National Statistics Office, Malta
Tourism 2000 – An Overview News Release 19 February 2001, National Statistics Office, Malta



2.1.1 Water Demand Based Approach

In assessing the pressure exerted by the overall "resident" population on groundwater it is imperative to evaluate the total amount of water that is anticipated to be consumed over the forthcoming years. Statistics for the period 2001 – 2010 estimate the projected water demand to vary according to the quantities in Table 1.

Table 1 – Projected Water Demand for the years 2001 – 2010
Source: Mitigations of Greenhouse Gas Emissions, United Nations Framework Convention on Climate Change

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Projected Demand (million m^3)	33.43	31.36	29.41	27.84	26.74	26.07	25.72	25.59	25.59	25.62

On the basis of the projections in Table 1, and on the latest (2001-2002) production ratio between RO and groundwater of 52.5%:47.5%, and given that this ratio is maintained, it is reasonable to assume that the demand for groundwater for the period 2004-2010 will be as summarized in Table 2.

Table 2 – Projected Demand for Groundwater and RO Water to Satisfy Potable Demand

Year	2004	2005	2006	2007	2008	2009	2010
Groundwater (million m^3)	13.22	12.70	12.38	12.22	12.16	12.16	12.17
RO Water (million m^3)	14.62	14.04	13.69	13.50	13.43	13.43	13.45

It is evident that current projections for water demand show a slight decrease in the pressures that are to be exerted on groundwater resources that are anticipated to fall from levels of 13.22 million cubic metres during 2004 to around 12.16 million cubic metres during the period 2008 – 2010. Naturally, such figures are subject to projections made for tourists arrivals/bed nights and demographic characteristics remaining more or less unaltered. These figures probably also take into account the improvements in leakage control and unaccounted for water volumes that are expected to be achieved over the period in question. Moreover it must also be noted that the RO to groundwater ratio may only be maintained at these levels if groundwater quality is of such a quality that, when blended with RO water, will result in a quality of water that falls within the parameters establishing by the European Union.

2.1.2 Population Based Approach

An alternative approach to predicting the amount of water, and hence groundwater, demand is one that is based on the expected population in the Maltese islands. In arriving at any conclusions the following assumptions are made:

- the ratio of groundwater to RO water produced shall remain the same;
- the equivalent tourist population is based on a worst case scenario i.e. on the figures representing the maximum population equivalent load generated from tourist arrivals. This figure represents the maximum product of tourist arrivals and average length of stay for each year, which product yields the year 1999 as the one that has generated the largest population equivalent from incoming tourists;
- population forecasts based on the Demographic Survey 2002 are valid and take into account the variations in population characteristics that are expected to evolve over the period in question.

The Demographic Survey presents population forecasts that are different in timeline than those available for the water demand forecast. Thus, for example the population estimate for the year 2005 is given at 389,300, increasing to 394,600 by 2015 after which the population count is expected to decrease to 333,800 by 2050. Therefore, assuming that a worst case scenario prevails in the number of tourist days experienced by the Maltese Islands (year 1999 figures), the total population exerting a demand on water resources would be as summarized in Table 3. The amount of groundwater required to satisfy such a demand would depend on two factors namely:

- the groundwater to RO water ratio (for this analysis assumed as per Section 1 i.e. 47.5% to 52.5%);
- the per capita consumption, for which 2 scenarios will be tested namely:
  - 70 litres per head per day as quoted in the Environmental Statistics, National Statistics Office, 2002. This figure, albeit seemingly on the low side, is envisaged to represent the billed consumption which should provide a realistic indication of that amount of water that is actually consumed by the local population;
  - 100 litres per head per day as derived through an independent research exercise.

A word of caution needs to be placed on the second assumption for whilst domestic per capita consumption may be more accurately derived, that for the equivalent tourist population is usually higher and varies with the type of accommodation within which tourists opt to reside. Table 3 also captures the demand on groundwater that would result as from the projected demographic scenario on which the tourism demand is also superimposed. It is also important to note that *prima facie* the 70 litres per head per day quoted as the daily per capita consumption might contrast with figures quoted by other sources and which may be two times the order or magnitude. However, it is important to distinguish that actual demand is essentially equivalent to billed amounts and that such figures should not take into account demands exerted by industry. Although it is a known fact that a number of hotels supplement their potable water supply with water carried by tanker, it is impossible to quantify these amounts.

Table 3 – Projected Demand for Groundwater and RO Water to Satisfy Potable Demand (Population and per capita consumption based)

	2005	**2010**	**2015**	**2020**	**2025**	**2035**	**2050**
Population[1]	389300	392800	394600	398700	389000	369900	333800
Tourist load[2]	31603	31603	31603	31603	31603	31603	31603
Total Population	**420903**	**424403**	**426203**	**430303**	**420603**	**401503**	**365403**
Total potable water demand (million m^3) (based on 70lhd)[4]	10.75	10.84	10.89	10.99	10.75	10.26	9.34
Groundwater (million m^3)[3]	5.11	5.15	5.17	5.22	5.11	4.87	4.44
RO Water (million m^3)[3]	5.64	5.69	5.72	5.77	5.64	5.39	4.90
Total potable water demand (million m^3) (based on 100 lhd)[5]	15.36	15.49	15.56	15.71	15.35	14.65	13.34
Groundwater (million m^3)[3]	7.30	7.36	7.39	7.46	7.29	6.96	6.34
RO Water (million m^3)[3]	8.06	8.13	8.17	8.25	8.06	7.69	7.00

Notes

[1] Figures based on Demographic Survey 2001, National Statistics Office, Malta
[2] Worst case scenario assumed as per figures for the year 1999
[3] Assuming current production ratios between groundwater abstraction and RO water production remain unchanged
[4] Based on figures quoted in the Environmental Statistics, National statistics Office, 2002
[5] Based on research by Gatt (1993)

2.2 Conclusion

It is interesting to note that water demand figures from a production point of view seem to indicate that peak overall water demand has been reached and that, should current groundwater to RO water production ratios be maintained, the pressure on groundwater resources should decline slightly by about 8%. On the other hand, if projected demands on groundwater were to be analysed from a per capita consumption basis, and if two reliable scenarios of per capita consumption are taken as extremes within which the true consumption figure is likely to result, then this would imply, that the pressures on groundwater resources are likely to be maintained and possibly stabilize at slightly over 6 million cubic metres annually. It is obvious that the demand on groundwater resources will vary according to the prevailing circumstances and will rise or fall according to fluctuations in population, tourist arrivals and their average length of stay, groundwater quality and policies that determine the ratio of groundwater to RO water to be produced to satisfy total potable demand.

2.3 Groundwater Quality Constraints

The quality of water intended for human consumption is regulated by the provisions of Council Directive 98/83/EC wherein the term 'water intended for human consumption' is defined as:

- "all water either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes, regardless of its origin and whether it is supplied from a distribution network, from a tanker, or in bottles or containers";
- "all water used in any food-production undertaking for the manufacture, processing, preservation or marketing of products or substances intended for human consumption unless the competent national authorities are satisfied that the quality of the water cannot affect the wholesomeness of the foodstuffs in its finished form".

For the purposes of this report, the first definition is considered to be the most relevant and therefore groundwater may be considered to be water in an original state that is intended to be used for the purposes listed therein.

Article 5 of this Directive sets out the parameters that define the quality standards to which 'water intended for human consumption' is expected to satisfy. These parameters are subdivided into three main categories namely:

- microbiological parameters
- chemical parameters; and
- indicator parameters.

Published sources of information that may shed light on these parameters are the Water Services Corporation Annual Report 2001-02 and the Environment Statistics (2002). Unfortunately these two publications only mention specifically two parameters namely chloride (falling under Part C of Annex I – Indicator Parameters) and nitrate (falling under Part B of Annex I – Chemical Parameters). However, the Water Services Corporation Annual Report 2001-02 states that over the period under review (August 2001 – July 2002) chemical and bacteriological analysis were carried out at various sources of groundwater extraction points (boreholes, springs and reservoirs) with a total of:

- 664 samples from boreholes in Malta;
- 388 samples from boreholes in Gozo;
- 337 samples from springs in Malta;
- 199 samples from pumping stations in Malta; and
- 28 samples from pumping stations in Gozo.

This author is, at the time of writing, unaware of the extent of tests that are conducted on these samples and whether all of the parameters specified in Annex I of Directive 98/83 are being conducted. What is clear is that the suite of parameters specified in Annex I of Directive 98/83 are being checked from water sources at randomly chosen consumer points.

2.3.1 Chloride

Published data for chloride, for various sources of groundwater abstraction, for the period 1995 - 2000 is summarized hereunder in Table 4.

Table 4 – Average of Chloride (mg/ltr)
Source: Environment Statistics, National Statistics Office, 2002
Malta Resources Authority

Aquifer	1995	1996	1997	1998	1999	2000	Average
Bingemma perched	194.00	232.35	457.69	173.64	183.33	183.64	237.44
Gozo MSL	485.94	495.23	480.00	567.71	475.00	448.33	485.47
Main MSL	1476.50	1018.69	1177.12	816.11	1030.06	899.91	1069.73
Mizieb	356.00	310.00	267.00	251.00	252.00	261.00	282.83

It is evident that, for the year 2000, apart from the Bingemma and Mellieha perched aquifers, the quality of water in the other aquifers fails to meet the indicator parameter values for chloride (250 mg/ltr). This is significant because most of groundwater abstracted that is 'intended for human consumption' is derived from the main mean sea level aquifer, which chloride values significantly exceed those that are established by Directive 98/83. In fact the quality of water in the Malta MSL, from a chloride perspective, are around 3.6 times prescribed values while those for the Gozo MSL are around 1.8 times prescribed values. The quality of the Mizieb aquifer has improved considerably over the past four years and whilst achieving quasi conformity levels during 1998 and 1999, the values obtained for the year 2000 have edged up slightly.

The high chloride level in groundwater results from the level of abstraction of groundwater that occurs in the Maltese Islands. In fact, in order to counterbalance these high chloride levels, water derived from groundwater sources has to be blended with water produced by reverse osmosis technology in order to produce potable water that is of a more acceptable quality. Even despite such efforts, statistics published in the Water Services Corporation Annual Report 2001-02 demonstrate that 90% of the samples taken exceeded the parametric value of 250 mg/ltr.

These figures amply demonstrate the gap that currently exists between current and mandatory chloride levels and judging on this parameter alone does not bode well for a sustained use of groundwater resources at current levels.

2.3.2 Nitrate

Published data for nitrate, for various sources of groundwater abstraction, for the period 1995 - 2000 is summarized hereunder in Table 5.

Table 5 – Average of Nitrate (mg/ltr)
Source: Environment Statistics, National Statistics Office, 2002

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
Main 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

There is a clear distinction between nitrate levels in the perched and mean sea level aquifers. The perched aquifers demonstrate a high nitrate level that significantly exceeds the recommended values established in Directive 98/83. This is possibly due to the high agricultural activity in the area and reflect the leaching of nitrates that occurs from such activities. It is likely that during the rainy season such levels will be higher than the averages quoted due to increased leaching as rainfall percolates into the soil to reached the perched aquifer. The Malta MSL aquifer also demonstrates an exceedance in respect of prescribed values (66.94 mg/ltr against the prescribed 50 mg/ltr). On the other hand, groundwater from the Gozo MSL aquifer is well within prescribed values. The same may be said of the Mizieb aquifer, which has demonstrated a water quality that is the clsoest to the prescribed parameters.

High nitrate levels are attributed to one or more of the following:

- intense agricultural activity and high use of fertilizer;
- leakages from the sewerage system;
- animal husbandry.

The Water Services Corporation's strategy towards ensuring that the consumers' water fulfills the obligations of Directive 98/83 is anticipated to be achieved through blending with water produced by reverse osmosis technology. In fact, samples from consumer sources have indicated that water arriving at the consumer conforms to the provisions of the Drinking Water Directive.

2.4 Conclusions

The conclusions that may be drawn are those that result from the data that is available in published statistics and in this case is based on that for chloride and nitrate parameters. It is evident that, with respect to chloride, groundwater quality is rather poor and that groundwater resources are under stress from the demands that they are being subject to. This may be the result of any of the following reasons:

- an over abstraction of groundwater in order to satisfy potable water demand with a view towards keeping production costs to the minimum possible in view of the increased expenditure that would result for producing water by reverse osmosis technology;
- over abstraction of groundwater as a result of illegal boreholes that may exist on the Maltese Islands and which, in total, cause a detrimental effect on the quality of groundwater;
- insufficient or poor infrastructure to enhance recharge of the mean sea level aquifer;
- insufficient rainfall to ensure sufficient recharge.

On the other hand it is thought that high nitrate levels may be minimized through proper agricultural practices. In fact it is hoped that through the formulation of a Code for Good Agricultural Practice, farmers would be in a better position to have the necessary information on how to make the best use of available resources in order to retain their produce at current levels whilst at the same time safeguarding groundwater resources.

2.5 Irrigation Demand

The demand for irrigation water is rather hard to quantify, particularly when this demand is satisfied through groundwater resources. A very rough estimate of the demand for water from the agricultural sector may be compiled through an analysis of the area of agricultural land that is available in the Maltese Islands. Table 6 aims to summarise the area of agricultural land available within the Maltese Islands by category (irrigated, dry and waste).

Table 6 – Agricultural Land (hectares) by type as in 2001

	Irrigated	Dry	Waste
Southern Harbour District	120.524	360.315	42.934
South Eastern District	139.514	1579.94	241.454
Northern Harbour District	79.092	241.588	29.061
Western District	303.830	2731.060	493.825
Northern District	417.342	1826.74	357.454
Gozo and Comino	87.109	1473.31	188.575
Total	**1147.411**	**8212.952**	**1353.303**

Source: Environment Statistics (NSO, 2002)

An analysis of total available agricultural land between the years 1955 and 2001 suggests that the total available irrigated land declined significantly between 1955 and 1983, but has recovered and since then doubled once again. Dry agricultural land has also experienced a similar decline between the years 1955 and 2001 with the exception of the period 1972-1976 when a marked increase in this type of land was registered. Similarly waste agricultural land has also been on the decline with the exception of a slight increase between 1991 and 2001.

Overall agricultural land has declined as a result of urbanization as well as the trend to move out of agriculture and into less labour intensive operations. On the other hand one also has to take cognizance of the fact that efforts have been made to convert dry agricultural land to irrigated agricultural land thereby increasing the potential of the yield from that land. Historically this has been possible due to the availability of treated effluent from the Sant' Antnin Sewage Treatment Plant as well as from the availability of technology that has permitted the installation of boreholes that tap into the mean sea level and perched aquifers and which have thus enabled farmers to secure a constant and more reliable source of water.

Farmers mostly make use of the perched aquifer for their irrigation requirements and this is corroborated but the higher nitrate content in these waters. Notwithstanding, the demand for water used for irrigation has been augmented through the drilling of boreholes that tap into the mean sea level aquifer. Recent statistics however demonstrate that there are already 8490 private registered boreholes (Environment Statistics, 2002) in the Maltese Islands although there is the possibility that many more unregistered boreholes do in fact exist. This makes it very difficult to estimate the real demand that is being exerted on groundwater supplies.

Therefore, if one were to consider that the water demand for irrigation could hover around the 1000 m^3/hectare/month, there are two extreme scenarios, between which could possibly lie that figure which gives a good indication of the demand being exerted on groundwater resources.

Scenario 1 – Irrigated and Dry Land Consuming 1000 m^3/hectare/month

Area of irrigated land (ha)	1147.411
Area of dry land[2] (ha)	8212.952
Total land available for agriculture (ha)	9360.363
Amount of water required per ha (m^3)	12000.000
Total volume of water required per annum (million m^3)	112.32

Deductions

Rainfall falling over total land available for agriculture (mm)	540.00
Equivalent volume of water (million m^3)	46.80
Treated effluent supplied to agriculture (million m^3)[3]	1.43
Total volume available from other sources (million m^3)	48.23

Potential dependency on groundwater (million m^3/annum)	**64.09**

Clearly this hypothesis would be alarming as abstraction from groundwater sources has always fallen in the range 18-20 million cubic metres per annum. Of course, the great assumption being made here is that all dry land is in some way or another being irrigated. Although, it is thought, although there is no definite proof, that there may be a number of illegal boreholes tapping the aquifers, it is unlikely that this practice results in all dry agricultural land having sufficient water as irrigated land.

[2] In this case an extreme scenario is being assumed wherein land classified as "dry agricultural land" is being assumed to be in fact irrigated through water derived from groundwater resources. More conservative estimates of the percentage of this land which is really and truly dependent upon runoff for irrigation purposes may be assumed but would only serve as a guesstimate of the true value.

[3] Based on Figures for 1991 quoted in the Sewerage Master Plan for Malta and Gozo. Since the preparation of the Master Plan the Sant' Antnin Sewage Treatment Plant has been upgraded to treat up to 17000 m^3 of sewage per day.

Scenario 2 – Irrigated Land Consuming 1000 m^3/hectare/month

Dry Land relying on natural water resources

Area of irrigated land (ha)	1147.411
Amount of water required per ha (m^3)	12000.000
Total volume of water required per annum (million m^3)	13.77

Deductions

Rainfall falling over total land available for agriculture (mm)	540.00
Equivalent volume of water (million m^3)	5.74
Treated effluent supplied to agriculture (million m^3)[4]	1.43
Total volume available from other sources (million m^3)	7.17
Potential dependency on groundwater (million m^3/annum)	**6.60**

This is a modest figure compared to the previous scenario but which in itself represent around one-third of the amount that is abstracted for supply purposes. However, one must bear in mind that this figure might be on the decline as new sewage treatment plants are constructed in Gozo, Malta North and Malta South and which together are expected to treat around 70,000 cubic metres of sewage per day.

On the whole it is expected that the true demand on groundwater resources on agriculture lies closer to the estimated value of Scenario 2 although, as reiterated previously, it is very difficult to come to any definitive conclusion on the exact demand for irrigation in Malta. Two previous study on this demand are those by Mitschoff and Mangion. Mitschoff's findings, as quoted by Mangion, demonstrate that the net weighted irrigation requirements (cubic metres/ha/month) amounts to 12319. The paper by Mangion basis estimated groundwater use for irrigations, based on Mitscoff's work, at 37,439 cubic metres per day. This means that the total annual demand would be equivalent to 13.67 million cubic metres per year. This is in line with the expectations identified earlier in this paragraph and which anticipated this value to lie somewhere close to the computations for the two extreme limits outlined hereabove with an expectancy for the true value to lie closer to the lower limit.

[4] Based on Figures for 1991 quoted in the Sewerage Master Plan for Malta and Gozo. Since the preparation of the Master Plan the Sant' Antnin Sewage Treatment Plant has been upgraded to treat up to 17000 m^3 of sewage per day.

2.5.1 Forecasting Irrigation Demand

Over the past 10 years Malta has witnessed a very slight increase (0.58% increase) in the amount of agricultural land that is being availed of. The pressures of urbanization as well as changes in social patterns have confined the potential growth of the agricultural industry beyond what is available today. This is not to say that we might not witness slight fluctuations in the amount of agricultural land available, but, at the time of writing, it is not considered to be a determining factor that should impact demand for water. What may in fact affect the demand for water is the attempts to convert as much dry agricultural land into irrigated land. During the last ten years the amount of irrigated land has increased by nearly 60%. It is however anticipated that any further conversions of 'dry irrigated land' to 'irrigated land' will result from the availability of additional second class water resulting from the new sewage treatment plants.

2.5.2 Identification of Sources of Irrigation Water

There are three main sources of water that may be harnessed to satisfy the demand exerted by agricultural practices. These are the:

- use of treated effluent;
- harnessing of stormwater runoff; and
- tapping of groundwater resources.

2.5.2.1 Treated effluent

The water available from the treatment of sewage is expected to increase dramatically by the year 2007. Currently there is only one sewage treatment plant in Malta, that at Sant' Antnin, which is capable of treating up to a maximum of 17,000 m^3/day of effluent per day. This treatment plant supplies both agriculture and industry. In respect of agriculture it must be pointed out that the existing distribution network can only serve around 240 hectares but deficiencies in the system permit only 120 hectares to be irrigated. The full potential of the plant may only be harnessed if it is operating at full capacity, at least during those months where the demand for water equals its production capacity, and if there is a suitable network to deliver the water to the end user.

Similarly, Malta has committed itself with the European Commission to treat all sewage prior to discharge by the year 2007 (Aggornat Special Edition No. 14, November 2002). This means that at the end of this period, the existing 17,000 m^3/day of effluent per day will be supplemented by a further 65,000 – 70,000 m^3/day of effluent per day should the provisions made in the Sewerage Master Plan be implemented according to the recommendations that had been put forward. There seem to be conflicting views upon the amount of sewage that will be available for treatment. Angelakis (2003) quotes the Sant' Antnin sewage treatment plant of currently being able to treat 10,800 m3/day with future expansion to 17,000 m3/day. Furthermore Angelakis (2003, Table 10.1) quotes differing figures for wastewater production at each of the three projected sewage treatment sites and the existing plants. These figures are reproduced hereunder.

Malta south	33000 m^3/d	12.05 $Mm^{3/}$/yr
Malta north	6000 m^3/d	2.19 $Mm^{3/}$/yr
Gozo	5500 m^3/d	2.01 $Mm^{3/}$/yr
Sant Antnin	6850 m^3/d	2.50 $Mm^{3/}$/yr
Others		0.25 $Mm^{3/}$/yr
Total		19.00 $Mm^{3/}$/yr

Water Service Corporation estimates for wastewater production for the year 2001/2002 are established at 18.71Mm^3/annum. In view of this apparent discrepancy it is important to establish the realistic production to be expected at these treatment plants and to validate the assumptions made in the sewerage master plan particularly in relation to per capita consumption. A revision of this figure to one that is quoted in local statistics would lower the expected production of wastewater to levels as established by the Water Services Corporation. One must also bear in mind that the sewerage system is also subject to a considerable inflow of stormwater which is discharged illegally into the sewerage system and which volumes need to be treated as they become part of the sewage effluent arriving at the treatment plants. However, for the purpose of this report, the figures being assumed are those quoted in the Sewerage Master Plan and would require revision if the volumes published in this latter document are revised in the future.

It is obvious that for this water to be utilized, appropriate distribution networks will need to be constructed in order to feed those areas where irrigation with this type of water is permitted. There is no doubt that the completion of this infrastructure will not only take time but will also come at a considerable expense and its execution will depend on the priorities that Government would have at that point in time. However, it is imperative that a feasibility assessment of the demand for this water be computed with a view towards assessing the cost of this water to consumers and whether such costs will guarantee any impact. The farming out of this business venture is strongly recommended.

2.5.2.2 Stormwater Runoff

Various figures for average annual rainfall have been quoted, but even if these figures are rounded to 500mm per annum, this amount of precipitation represents a significant volume of stormwater runoff that today is not being harnessed to make the best use of such a resource.

2.5.2.3 Groundwater Resources

This resource represents the business as usual scenario wherein demands from irrigation are satisfied through abstraction from the mean sea level aquifer or the perched aquifer. The demand on this resource has already been discussed and there is no further merit in discussing this resource in any further detail. However, it is important for policy makers to study a prioritisation policy for the abstraction of groundwater in a way that will allow withdrawals only for priority uses (potable supplies being the main priority) up to that point where the quality of groundwater becomes unsuitable for additional withdrawals. This will undoubtedly reduce the availability of water to the agricultural sector and therefore alternative initiatives need to be created in order to attempt to provide an equivalent amount or to induce the sector to indulge in more water efficient methods of irrigation. This could include the harnessing of stormwater for use in agriculture and the provision of treated effluent to greater areas that fall outside the groundwater protection zone.

2.6 Demand from Industry

Water consumption by the Industrial sector experienced a significant decline between 1997 and 1999 where total consumption was slightly over the 1.1 million m^3 mark. This represented a significant drop from the 1.70 – 1.78 million m^3 of water consumed during the period 1995 – 1996. During the year 2000 demand has picked up again and has nearly reached the 1.74 million m^3 mark. It remains to be seen whether consumption from this sector will stabilize in this region or whether it will show any significant departures. On average it may be assumed that this water is derived in the same proportion as that for the national supply although a deeper analysis might indicate that there is a predominance for use of groundwater in the light of specific heavy consumers and the industry in which they operate. However, irrespective of this latter statement, and based on the consumption figures for industry and assuming that 43.3% of all water produced is derived from groundwater, the industrial sector may be seen to exert a demand equivalent to 0.75 million m^3. Figures quoted in the Sewerage Master Plan for Malta and Gozo (COWI, 1992) indicate the following ten industries as those consuming most water.

Table 7 – 10 Most Water Consuming Industries (Sewerage Master Plan, 1992)

Industry	Consumption in 1000 m^3/year
Farsons Breweries, Mriehel	249
Malta Drydocks, Cospicua	236
ST Microelectronics (formerly SGS Thomson), Kirkop	219
Civil Abattoir, Marsa	188
Portanier Brothers (7-Up now taken over by Farsons)	105
Malta Dairy products	50
Marsovin, Marsa	41
Royal Products, Mriehel	35
Malta Shipbuilding, Marsa	34
China Dock, Corradino	28

Although, somewhat dated, this information clearly provides a snapshot of those industries which exert a significant demand on water consumption.

Bottling companies supplement their water supply through the local distribution network by boreholes. Most of the demand in this sector is essentially for industries that use water as one of their basic raw materials. However, it is worth assessing whether some of the heavier industries would be in a position to use second-class water, such as treated effluent, for that portion of their non-potable related operations.

In fact, whilst the predominant source of supply of water from industry is either through the local distribution network or through licensed boreholes, Malta is now looking at a scenario wherein it will have significantly high volumes of treated effluent which may be harnessed for re-use. It is therefore of utmost importance to look at the industrial sector at a micro level with a view towards determining the likely demand that may be generated for treated effluent by this sector. It is also important to ascertain whether this kind of demand is one that is concentrated around specific nuclei or whether the demand is so sporadic that it would not be economically feasible to satisfy such demand.

2.7 The Impact of Leakages

The Water Services Corporation has, over the past years, embarked upon a significant programme aimed at reducing leakages to that value termed unavoidable ‘background’ leakage level, that is, that absolute minimum value of leakages which the system is bound to experience. In order to monitor leakage level performance the Water services Corporation has adopted an Infrastructure Leakage index (ILI) which calculates the ratio between Current Annual Real Losses (CARL) and the unavoidable background leakage level (UARL). The Corporation’s goal is to achieve an ILI of below 1.5 by the year 2006 a ratio that would imply that overall annual losses would amount to around 2.6 Mm^3.

It is, at this stage, opportune to attempt to quantify the leakage volume that is expected to be experienced over the forthcoming years with a view towards determining its impact on groundwater resources. This will be calculated on the basis that the volume of ‘leaked’ groundwater would be estimated as that percentage of production that is derived from groundwater resources multiplied by the total leakage volume. As outlined in Section 1.0 of this report the ratio of groundwater to reverse osmosis water ranges at around 47.5% to 52.5% and it will therefore be assumed that a good estimate of that portion of groundwater that is being ‘leaked’ will approximate 47.5% of the total leakage volume.

Table 8 – Projected ILI indices for the period 2003 – 2006 (Water Services Corporation Annual Report 2001 – 2002)

Year	2003	2004	2005	2006
ILI	3.06	2.47	1.96	1.49
CARL (m^3/hr)	820	663	524	398

On the basis of the data in Table 8 it is now possible to calculate that volume of water which, albeit derived from groundwater, is being ‘leaked’ from the system and which potentially is of no benefit to the community in general. This proviso is being made in the light of the possibility that part of this water eventually finds its way as recharge into the aquifer and that another portion is attributable to ‘theft’ which action, although damaging the Corporation financially still represents a demand that might be otherwise still exerted if that source had been metered. However, these two aspects cannot be quantified and it is important to focus on reducing the ILI to pre-established targets.

Table 9 – Volume of Groundwater being ‘Leaked’ from the System

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
Apportioned Leakage from Groundwater Sources (Mm^3/yr)	3.41	2.76	2.18	1.66

It is therefore vital for the Corporation to pursue its sterling work in this area in order to achieve the stated targets by 2006. This would represent a reduction of 51.3% on current losses and a saving of 1.75Mm^3 of groundwater. Therefore, Government should ensure that this programme is maintained and that sufficient funds are made available for its success to truly materialise.

3.0 Water Policy Scenarios

Safeguarding the quality of groundwater is of particular importance to the Maltese Islands as this source of freshwater is one on which the island is still heavily dependent upon in meeting its demand from the various sectors. In fact, groundwater resources still constitute around half of all the "accounted for" water that is produced for supply purposes.

In developing possible scenarios for adoption by Malta, it is important to be in a position to characterize the existing situation wherein issues are highlighted together with any critical decisions to be addressed. Subsequently, the proposed scenario must be set within the context of the boundaries that define that particular situation taking into account the major driving forces such as demography, economic outlook, technology, social aspects, governance and environmental factors. In this ways possible scenarios, which usually reflect the bias of the author but which are also supported by data, may be construed with a view to addressing a particular problem. The scenarios may be mutually exclusive or may complement each other, the latter option enabling the decision maker to combine, and adopt, one or more scenarios that make the addressing of the problem more effective.

3.1 Demand Side Management

The Maltese Islands are characterized by a domestic sector that exerts the major influence on water consumption, which after having declined between 1997 and 1998 is now manifesting a steady rise. Table 8 provides an analysis of the water consumption patterns by sector.

Table 10 – Water consumption per sector (m^3)

Year	Domestic	Industrial	Touristic	Government	Commercial	Farm	Other	Manual Industrial
1995	11,984,035	1,785,284	1,451,428	1,516,240	1,693,076	614,569		211,630
1996	13,079,326	1,702,071	1,487,885	695,185	1,691,104	968,911	41,403	207,410
1997	14,002,315	1,149,710	1,460,432	1,206,609	1,369,664	1,327,278	307,517	182,467
1998	10,730,902	1,129,146	1,502,635	1,313,044	1,130,555	1,066,801	274,800	96,319
1999	11,320,803	1,141,368	1,509,106	1,037,334	938,900	1,245,921	220,960	623
2000	11,594,197	1,736,303	1,543,738	1,646,960	1,048,799	938,421	222,441	766

Consequently, proper demand side management of this sector could lead to potential positive impacts on groundwater resources. The cost of water has always been characterized by heavy subsidies that do not reflect the true cost of its production and delivery to the end user. This has essentially fuelled a belief that water is a cheap, if not *quasi*-free commodity. This was very much reflected in 1998 when the said tariffs were altered in order to better reflect the true cost of water and the public outcry that ensued. Full cost recovery of public infrastructure and the costs associated with its operations and maintenance (and any decommissioning) is the ultimate goal and this should be achieved within realistic timeframes. This does not exclude the use of economic instruments to aid the end user if such person risks not having adequate income to support basic sanitation needs.

Rates for water consumption that reflect the true cost of water are one of the most effective means for ensuring a responsible use of groundwater. Coupled with strong educational campaigns, economic instruments have proved to be very successful in altering the behaviour of individuals towards consumption patterns. Statistics for water consumption in Malta seem to reinforce this theory.

Local legislation and planning regulations require every development to have a well to store the equivalent of one year's rainfall falling on its paved areas. Often enough this practice has not been respected consequently leading to a high wastage of good quality second-class water. Runoff from paved areas, particularly in domestic dwellings, could be the source of an ancillary system of water supply used for non-potable activities such as toilet flushing, cleaning of floors, car washing and irrigation of soft landscaping. These non-potable activities consume a considerable amount of water. It suffices to say that a normal toilet flush discharges around 9 litres of water. Although this scenario would require that households opt for a secondary second-class water system, this could lead to demand reduction of up to 30% of current consumption. This could potentially represent a "saving" from withdrawing such volumes from the mean sea level aquifer. This saving should be attractive to policy makers and may warrant the introduction of schemes that afford a subsidy to those opting to install a dual water system whilst at the same time providing the necessary level of enforcement to ensure that new developments comply with existing provisions. Furthermore, it could also be considered that a water management plan is requested to accompany each development thereby reinforcing further the appreciation for making the best possible use of water resources.

Within other sectors, there is an additional scope for demand management of current consumption patterns. Industrial estates and large factories (Industry), hotels (Tourism), hospitals and schools (Government) could potentially be encouraged to treat the wastewater discharged on site and to use the treated effluent to fuel a second-class water supply system aimed at reducing the demand for potable supplies for non-potable activities.

In formulating this scenario, one has to be realistic and to assume that penetration may be slow initially and can be most effective if the installation of such systems may be incorporated as the "planning gain" developers need to contribute towards. The conversion of existing systems to introduce a second class water supply may also merit some form of assistance, be it in subsidizing part of the cost of installation or in making purchases for such systems eligible for a lower VAT rate or a one-time deduction from subsequent water bills. In essence, decision makers have to provide a ripe climate to ensure buy-in for in the long run, any savings on water derived from groundwater resources will ultimately contribute to an improved quality of groundwater.

3.2 Regulation of Boreholes

The advancement in technology has given rise to machinery that is both affordable and that can also deliver a faster result. As a consequence, pumping equipment has become more affordable and drilling costs have also become cheaper whilst at the same time permitting higher depths to be achieved. Consequently this may give rise to an increase in potential illegal use of the aquifer.

Licensed boreholes are generally unmetered and therefore there is no record of the amounts being drawn. Moreover, as abstraction is in no way linked to the amount one would pay, their use is indiscriminate and the current situation offers no incentive towards responsibility of use. Consequently, the authorities should consider undertaking an exercise with a view to metering such boreholes and establishing charges to cater for this type of water supply.

A few years back the Water Services Corporation had launched an initiative wherein it invited persons who had a borehole that was not registered to come forward and register it. It is natural that one might fear registering such sources but the result is one that may lead to a significant deterioration of groundwater quality and supply. The authorities should consider re-launching this initiative, this time backed by suitable subsidiary legislation that would allow the imposition of stiff fines to any illegal boreholes that are subsequently discovered after the established cutoff period. The authorities responsible for water resources, agriculture, industry and planning could jointly set up a task force to ensure that proper enforcement may be undertaken in order to locate and subsequently eliminate any residual illegal boreholes.

Drilling equipment should also be subject to a consent from the water authorities with a view to keeping track of potential contractors who are in a position to carry out such works. Holders of drilling equipment could also be asked to submit a declaration of all drilling carried out.

3.3 Maximising the Use of Treated Effluent

Currently Malta has only one sewage treatment plan, that at Sant' Antnin, with a capacity of 17,000 m^3/day. However, by 2007, it is expected that all sewage will be treated prior to disposal. This means that the availability of second-class water will increase significantly. It is of utmost importance to ensure that as much of this treated effluent is reused. Reuse will undoubtedly require a significant support infrastructure if the effluent is to be carried to the end user.

Within the agricultural sector, the current practice for irrigation with second-class water has been to restrict its use to those areas that fall outside the groundwater protection zone. This practice minimizes considerably the risk of any contamination of groundwater resources with excess percolating treated effluent. One can therefore envisage a scenario wherein those areas falling outside the groundwater protection zone could also be made areas where boreholes are not permitted and where existing ones would have to be closed down once infrastructure providing water to the area is established. Permits for boreholes would only be granted for any activity that cannot avail itself of the potable distribution network or where the quality of second-class water does not meet the standards it requires. However, this would be the exception rather than the norm and applicants would have to prove their case with the competent authorities. This course of action would limit seawater intrusion and hence potentially improve the quality of water in the protected zone.

At the same time it is important to consider whether specific aquifers that are not envisaged to further contribute towards the abstraction of potable water could be used as a storage basin in which treated effluent could be directed with a view towards creating a temporary storage that might enhance the livelihood of the agricultural community in the vicinity.

A detailed assessment of industry requirements in terms of second class water will also need to be undertaken with a view towards determining the possibility of using treated effluent to satisfy non-potable uses rather than through the use of traditional water resources.

Consideration must also be given to the feasibility of using treated effluent as a feedstock for further polishing and treatment with a view towards boosting potable water supplies. Without considering the psychological impact this might create, any moves in this direction should be treated with utmost caution and pilot studies should be carried out to ensure the safety and feasibility of such processes for the production of potable water.

It must also be pointed out that current treated effluent is characterised by high salinity levels that are seen to be derived from leakages into the sewerage system of seawater from low lying areas. It is of utmost importance for Government to commit itself to the necessary investment in the sewerage system with a view to eliminating seawater intrusion and therefore have a better quality of treated effluent which is less aggressive and which is more appealing both to the agricultural as well as the industrial sectors.

3.4 Revision of Tariffs and the Principle of Cost Recovery

Although there are other manners in which to change behaviour, the use of economic instruments has proven to be one of the most effective. Therefore the authorities might wish to consider whether current tariffs are in effect a true reflection of the actual cost of production and delivery of potable water. Taking this argument one step forward, it is not uncommon for water authorities to be considered as profit making entities and therefore the financial regulator may also allow charges, beyond full cost recovery.

As alternative sources of water enter the global water budget it may also be appropriate to introduce a charging regime for all water that is consumed by the end user. "Free water" is a non starter and would contribute not only to a further deterioration of existing supplies but also to any initiatives to induce a responsible use of this precious resource.

At the same time the introduction of incentives that facilitate the transition from current practices to more socially responsible ones could be put in place. Therefore the local infrastructure required for:

- the installation of domestic second-class water supplies;
- the closure of existing "legal" boreholes and the transition to alternative second class water sources;

could initially qualify for one-off subsidies.

Another set of tariffs that should be considered are those related to the abstraction of groundwater from authorized boreholes. The abstraction of water in this manner is in itself a demand that is exerted on groundwater resources and, unless metered, will never be fully appreciated. It is therefore worth considering issuing regulations that are properly embraced within a legal framework so as to set the obligation for all licensed boreholes to have installed devices that would enable metering and with the powers that would render any borehole that does not have such installations to be deemed illegal and hence liable for immediate closure.

The principle of cost recovery presumes that tariffs for the use of a particular commodity or service (in this case the provision of water) should be at levels that reflect the capital investment as ammortised over the life of the infrastructure as well as recurrent expenditure incurred by the producer in order to produce and deliver that water. The aforementioned rise in tariffs should therefore be justified on this internationally acceptable principle and may be introduced in a gradual or immediate manner and reflecting fixed or variable and fixed costs. The options available would therefore be:

- immediate full cost recovery (fixed);
- immediate full cost recovery (fixed plus variable);
- progressive full cost recovery (fixed); and
- progressive full cost recovery (fixed plus variable).

3.5 Harnessing Stormwater Runoff

The Maltese Islands have always suffered during intense storms due to a limited infrastructure that results from the climatological characteristics of our islands. In fact, any stormwater infrastructure is usually dormant for most of the year and has to be designed for a high intensity short duration type of rainfall that mirrors the typical runoff volumes that are generated.

Consequently high volumes of water are lost to the sea with little recovery. Over the years a number of initiatives have been taken with a view to enhancing the retention of stormwater and the recharge potential of the aquifers. These interventions have essentially been limited to valley areas that have been dammed at certain places for this purpose. However, other attempts at stormwater management have had, primarily, a flood relief drift rather than the harnessing of these waters for reuse.

Thus, whilst it is important for Government to properly plan for stormwater management and to commit the necessary funds for such a system, it is also important to ensure that innovative ways of promoting recharge of the aquifers is achieved. The introduction of soakaways and the construction of reservoirs at strategic points, such as high level areas where the quality of stormwater is still acceptable for recharge purposes, could improve the availability of water and its reuse potential thereby reducing the need for abstraction whilst at the same time providing an additional input. Perhaps the high level areas to the North and West of the Maltese Islands (Rabat and Mellieha areas) could offer scope for undertaking a pilot project to this effect.

3.6 Improving the Agricultural Dimension

In line with the Nitrates Directive, a Code of Good Agricultural Practice is to be prepared. This document is deemed to be of utmost importance on two main counts where groundwater resources are concerned, namely:

- farmers would have better guidance on the quantity of water that is required for a successful crop dispensing with any ill notion of "the more water is supplied, the better the crop"; and

- farmers would be made aware on the use of fertilizers with a view to reducing the amount of chemicals the leach into the groundwater aquifer and which contribute to its deterioration – as amply evidence in our analysis of the impact of agriculture on the local aquifers.

Therefore, the Code of Good Agricultural Practice will be a very important document that should help both regulate and educate the agricultural community ensuring that its impacts on water resources are minimized to the absolute minimum. At the same time, for this Code to be successful full stakeholder participation and support is required. It is important that work on the preparation of this document will be commissioned at the earliest possible date such that this task may also be launched.

3.7 Benchmarking

Benchmarking is a tool that enables an organization to compare its results or processes with that of a similar organization with a view towards identifying weaknesses that may be rectified in order to enhance overall performance. Perhaps this concept may still be somewhat new to the water sector. However, it should be considered as a tool that would give an indication as to how the Maltese Islands fare with respect to similarly sized countries or areas that exhibit similar characteristics.

It is very difficult to find scenarios that are very close to that experienced in Malta, however the analysis of practices and comparison of result may lead to important pointers that, if implemented, could lead to a more sustainable use of our groundwater resources.

3.8 "Unaccounted for water" Control

The Water Services Corporation has over the past years embarked upon an intensive programme aimed at controlling leakages from the water network. This has yielded notable success. However, if one were to compare figures for consumption with that of production it becomes immediately obvious that the "unaccounted for water" component seems to have remained at a rather high level. Unaccounted for water may be the result of either errors in meter registering, theft or leakages.

This loss in itself represents a loss to groundwater resources. This is because in an ideal situation, where no water is being lost, any abstraction going to production would represent the true amount required. Leakages, although potentially returning part of that loss to groundwater might in fact result in a "drain" on groundwater resources.

It is therefore not unreasonable to suggest that this initiative be pursued with a view towards limiting all components that form part of the unaccounted for water volume.

In conclusion, it is to be pointed out that the above 8 scenarios represent a number of potential policies that may be undertaken separately, or in parallel with each other with a view towards ensuring the sustainable use of groundwater resources whilst at the same time improving the overall quality thereof.

One notable observation is the lack of published information that makes research into these matters rather difficult. We are now witnessing an era where Environment Statistics, containing information of water production and consumption, are being produced on a regular basis. Moreover, the technological era also permits the hosting of significant volumes of data on the websites of water companies or water regulators. It is in this way that an interest in this subject is raised and through it comes the possibility of enhancing the awareness of the local population to the problems facing the water industry and our natural resources. An informed society is more likely to digest the need for tough measures to be implemented than had it been unaware of the context in which those measures were required.

3.9 Data Availability

One concern that needs to be voiced concerns the lack of availability of sufficient data related to water resources within the public domain. This lack of readily available data is in itself a barrier to researchers and/or policy makers and/or NGOs who may wish to avail themselves of such data in order to further their studies or conduct appraisals. This is not to say that the entities who posses these data manifest a reluctance to share such data but, data readily available in the public domain is in itself a readily available source for such activities. Consequently policy makers and regulators should insist that data related to water resources be made available on host web sites into which authorised users may log on - a form of extranet - that allows some degree of user control. However, access should not be restrictive for in the coming months, upon accession to the European Union, Malta will have to adhere to the Directive that allows access to environmental information. Consequently, rather than using the provision of law to extract information the law should be an enabling instrument that acts as a catalyst towards the posting of data within the public domain.

One other concern is the reliability of certain published data. It has been observed that certain sources, albeit quoting information for the same period of time, fail to produce the same numerical values thereby potentially leading to inaccuracies in research if a set of figures is quote in lieu of another. Moreover, statistics should be as comprehensive as possible and should be updated to reflect the latest developments in the sector.

3.10 Stakeholder Involvement

There are many stakeholders that are involved in some way or another with water resources. From consumers, who need to be aware of economic water usage, to farmers, who need to be educated on the importance of proper farming in order to avoid groundwater contamination and the use of alternative sources of water, to industry representatives who might raise concerns on higher water prices or increased regulation, there are a number of players who need to be roped into the decision making process within the water sector. Ownership of the decision making process by stakeholders is a key success factor towards ensuring that these stakeholders observe the decisions made. Increased regulation may be one avenue of ensuring conformity to prescribed standards whilst self regulation is another avenue. These two ends of the spectrum reflect an undisciplined stakeholder population whilst the latter reflects a willingness on the part of stakeholders to actively participate and contribute towards the common good. The true scenario may lie somewhere in between, and it is only through active discussions with stakeholders and subsequent monitoring of progress registered that the extent to which regulation is applied may be truly determined. Notwithstanding, no entity is an island and the success of those entrusted to guard and protect the country's local resources may be enhanced through stakeholder collaboration and involvement. Therefore leading parties should come together and work towards the development of a strategy to fulfil this principle. Initially it is envisaged that the Malta Resources Authority, as the lead party, would seek the collaboration of the Water services Corporation and the Malta Environment and Planning Authority in order to chart out a road map to bring stakeholders closer to their mission, vision and strategic objectives.

3.11 Raising Awareness

An informed society is an educated society and therefore it is of utmost importance for the authorities concerned to expose all sectors and levels of the population to the most important issues concerning water resources. It is important for the lead players within the water sector, namely the Malta Resources Authority and the Water Services Corporation to forge successful partnerships with professionals within the educational sector in order to appraise to what extent the population is being furnished with educational resources to ensure that they are aware of the issues that currently prevail as well as to set the foundations for a better educated population on matters that relate to water resources.

It is therefore thought important to carry out a situation audit of what is currently available in terms of awareness and educational campaigns. It is anticipated that the prevailing information lies within the primary, secondary and tertiary education domains and that there are numerous gaps within the working population and the sectors in which they work. This would enable the competent authorities to assess what vehicles are required to bridge the identified gaps. Such a task might also be eligible for funding through international institutions.

Within the formal education curriculum it is important to secure that water resources are placed within the specific agenda of what is thought in the classroom. At a primary level the focus could be on raising initial awareness whilst at a secondary level this could be entrenched into the environmental studies and integrated science programmes. MCAST is already offering a specific programme entitled "Water and the Environment" and these programmes should be encouraged and fostered throughout the student's learning experience. Within the academic scenario, the University of Malta offers specific credits that in some way or another expose students to issues related to water resources. However, an effort should be made to include at least one aspect related to water resources in as many courses as possible. This would ensure that the awareness within students is enhanced and the future working population, independent of its chosen walk of life, is well versed with issues related to water resources, their use and protection.

3.12 Capacity Building

It is useless to set and publish Regulations if there is not the capacity to enforce such legislative instruments. On the contrary, the publication and subsequent lack of enforcement of Regulations is tantamount to inducing the users to lack any sort of respect for such

Regulations even when a genuine effort is subsequently made to enforce them. Lack of enforcement is a regressive measure towards the successful implementation and enforcement of such measures.

A suitable human resource complement is required to take samples of groundwater from specific locations in order to determine whether there are any activities that are contributing towards the deterioration of this resource and should this be the case to take the necessary steps to identify these sources and to take the necessary action to halt such practices. Another requirement for additional human resources is the need to control existing legal and illegal boreholes. Whilst the former need to be monitored for compliance with prevailing permits, the latter need to be located and closed down according to prescribed standards. The situation that prevails in groundwater with respect to chlorides and nitrates is sufficient to warrant the necessary efforts to be directed towards the abatement of pollution.

The Malta Resources Authority Act provides the legal backing to the Authority to delegate this task to other entities. This could be the opportune legal vehicle to bring the Malta Resources Authority and the Water Services Corporation together with a view to partitioning this enforcement role such as to maximise the human resource potential of the two entities. Consequently, it is important for these entities to identify the work component involved, the human resources available and to subsequently conduct an operations review of these activities with a view to scientifically identify the additional component that is required.

3.13 Allocation Policy

Water supply in Malta has, over the past years, been characterised by a quasi equal contribution of groundwater and reverse osmosis derived water to the overall supply. Notwithstanding the excellent quality of reverse osmosis water, and the blending of this water with that derived from groundwater sources, certain quality parameters still remain high when compared to international guidelines. If groundwater quality characteristics prevail at current levels, or deteriorate even further, the Maltese Islands will have to experience an increase in that portion of water generated from desalination methods which in turn will inflate costs to the producer, and hence ultimately to the end-user. It is therefore anticipated that water allocation policy should be directed from the affordable withdrawal volumes of groundwater that would still permit the overall blended water quality to respect international guidelines.

3.14 Introducing Appropriate Fiscal Initiatives

Previous sections of this report have already highlighted the need for the introduction and/or amendment of certain fiscal instruments. However, whilst the previous section dealt with fiscal policies that raise costs to end users there are also a number of fiscal measures that are intended to help out investments that aim to make better use of certain water resources.

The installation of sewage treatment plants in establishments that may reuse this water instead of discharging it to the main sewer and consequently reducing demands on current water demand could perhaps qualify for a reduction in the applicable VAT rate on these installations. This would provide an additional incentive for persons to opt for this kind of technology.

The building of reservoirs to harness stormwater could also benefit from either a subsidy or to a rebate on the amount of VAT paid in respect of installing such terminal structures.

State owned offices and plants should themselves qualify for the necessary investment required in order to set the example into how efficient water usage may be achieved. Particularly in areas where there are a number of State owned premises a shared infrastructure could prove an example for other entities to put their efforts together with a view towards achieving economies of scale in rendering their operations more water efficient.

These fiscal initiatives are but a few that may be considered for introduction with a view towards promoting the conservation and better use of water resources in the Maltese Islands.

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