Water demand management in the Mediterranean, progress and policies

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Monitoring progress and promotion of water demand management policies

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Monitoring progress and Promotion of Water Demand management policies

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Chapter 1

Introduction

The Maltese archipelago consists of three inhabited islands, Malta, Gozo and Comino, and a number of uninhabited islets scattered around the shoreline of the major islands. It is located about 96km south of Sicily (Italy) and around 290km north of Tunisia. The total surface area of the islands amounts to around 316km^2.

The islands have a population of about 400,000 increasing at a rate of about 2,400 inhabitants/year. Official statistics show that the Maltese population is expected to continue growing for the next 15-year period reaching a total of 425,000 inhabitants. This increase will impose further pressures on the socio-economic and socio-cultural structures of the country, with significant added strains on the water resources. With a population density of 1,250 inhabitants/km^2, Malta is among the most densely populated countries in the world. Consequently, the country is urbanized over more than 23% of its territory.

The Maltese economy is becoming increasingly service oriented. In 2002, the manufacturing sector contributed to around 35% of gross domestic product (GDP), while the market/services sector accounted for slightly more than 48% of GDP. Tourism plays an important role in the country's development, where through the multiplier effect, it contributes towards an employment complement of around 40,000. About 1.1 million tourists visit the islands annually, with arrivals peaking in July and August.

Malta has no national water law per se. While the Civil Code includes a clause dealing with entitlements to water from springs, it is the Malta Resources Authority (MRA) Act that sets out the regulatory arrangements for water resources. The MRA is mandated under Article 2 of its founding legislation to "*secure and regulate the acquisition, production, storage, distribution or other disposal of water for domestic, commercial, industrial or other purposes*". In as much the MRA has the duty to ensure the proper and sustainable use of all water resources in the Maltese Islands, while respecting hydro-environmental and socio-economic constraints.

Renewable water resources are limited in Malta, since the island has no surface waters which can be economically exploited, either for drinking purposes or for agriculture. Moreover the climate is typically Mediterranean and hence rather arid. Thus the aquifers provide the only natural sources of freshwater, albeit under the constant threat of the rapid economic development registered over the last decades, more so since accession into the European Union.

The demand for freshwater has been steadily increasing over the past years with agriculture being one of the major consumers. Irrigation water demand has increased remarkably during the last fifty years, almost doubling to reach an estimated annual demand of 18hm^3. The domestic sector has also registered an increase in consumption due to higher standards of living and heightened expectations by domestic consumers for better tap-water quality. Accession to the EU and the consequent alignment to the *aquis* meant a substantial investment to bring drinking water quality standards in line with the requirements of the Drinking Water Directive. The industrial, touristic and commercial sectors also register significant water demands.

This report will therefore examine in detail the various pressures on water resources arising from these different economic sectors, and will analyse the effects of these pressures both on the quantitative and qualitative status of the local water resources. It will draw on existing information to benchmark the local specificities against recognised international indicators, with a view of presenting the national strategies meant to increase water efficiency by improving on demand-management.

Chapter 2

Major Changes in the Water Situation in the Country

The Maltese Islands are densely populated but poorly endowed with freshwater resources. Since the 1980's, the drinking-water supply has been heavily dependent on saltwater desalination. The population and the tourist sector are served with good-quality drinking water, but certain trends give rise to concern: groundwater depletion in terms of both quantity and quality; and a growing dependence on oil imports for water desalination. These and other associated trends have raised concerns about Malta's long-term sustainability and security.

2.1 Resources, their mobilization and unconventional water production

2.1.1 Natural Resources

The climate of the Maltese Islands, is typically semi-arid Mediterranean, characterized by hot, dry summers and mild, wet winters. The mean annual rainfall was about 550mm for the period 1900-2000, but with high seasonal and inter-annual variability, with some years being excessively wet and other years being extremely dry. The highest precipitation rates generally occur between October and February. Rainfall is characterized by storms of high intensity but of relatively short duration.

Groundwater is by far the major source of natural freshwater in Malta, since the hydro-geological structure of the island does not support the existence of any economically exploitable surface-water resources. Replenishment of the aquifers is principally derived from infiltrating rainwater supplemented to a minor degree by leaks from the public water distribution systems. Available groundwater is equal to the mean annual recharge (based on a long term average) less the natural outflow (subsurface discharge which is generally estimated at around 50% of the total inflow reaching the sea level aquifers) to the sea. The mean annual groundwater available for abstraction is estimated at around 33 hm^3.

Runoff of rainwater to the sea is comparatively small because of the island's morphology, good water absorption by the soil and infiltration into the rock; and runoff interception by numerous dams, walls and terraces built over the centuries. Runoff intercepted by dams and surface reservoirs present another source of freshwater on the island, in particular for the agricultural sector. These storage facilities are small in size, but large in number; and they are estimated to be able to harvest around 4 million m^3 of freshwater annually.

Indicators:

Average renewable natural resources: 0.033 km^3/year

Renewable natural resources per capita: 72m^3/hab/year

The particular structure of the sea level aquifers presents a situation where the volume of water in-storage is considerably larger than the annual recharge. Moreover, isotopic investigations have determined that the average age of groundwater abstracted from these aquifers is of the order of 40 years. The annual yield from these aquifer systems therefore does not show an immediate response to annual variations in precipitation, but is more dependent on long-term climatological trends. In the case of the minor (perched) aquifers, however, groundwater flow is directly dependent on the annual precipitation. These groundwater systems are however of a relatively minor importance and are almost exclusively utilised by the agricultural sector.

The major effects in the central Mediterranean region arising from climate change phenomena are most likely to be a rising sea-level, a reduction in precipitation and an increase in temperatures in the summer months which will give rise to more pronounced evapotranspiration. In the case of the mean sea-level aquifer, a reduction in precipitation coupled with a sea-level rise would not only cause a diminution of the volume of freshwater available, but would also be expected to reduce the groundwater storage capability of the aquifer. Reductions in precipitation are however expected to have drastic effects on the other smaller aquifers in the island – since in these, the annual recharge forms a large percentage of the aquifer storage.

2.1.2 Mobilisation of natural resources

The annual potential surface runoff flow in Malta was estimated at 24 million m^3 during a review of water resources conducted by the FAO during 2004. This calculation was based on a variable catchment-area runoff coefficient and excluded coastal built-up areas. Coastal areas were excluded since these do not present any physical possibilities for runoff harvesting.

The volume of surface water regularized by various runoff harvesting facilities (dams in major valleys, public surface reservoirs and private reservoirs and wells) was estimated to reach an annual figure of around 4 million m^3.

Indicators:

Regulation index of water, WAT_C01: 17%[1]

A master plan for the management of storm water is currently being prepared by the Water Services Corporation (WSC). Amongst other purposes, this plan aims to increase the volume available for the storage of rainwater runoff through the upgrading of existing storm-water retaining facilities and the construction of large underground storage facilities – which should serve the function of both flood relief and the storage of water for secondary purposes.

2.1.3 Production of unconventional water

The two main sources of urban water supply are groundwater and desalinated sea-water. In 2003/04, desalination contributed about 55% of the water supplied to the public distribution systems. This was equivalent to an annual production of around $19hm^3$. Excess capacity currently exists for the production of desalinated sea-water; however, there is insufficient working capacity should all urban water supplies have to be sourced from RO plants. Currently the WSC operates three seawater RO plants at Lapsi, Cirkewwa and Pembroke. Malta has one of the longest and best track records of RO plant operation in the Mediterranean region with high output levels and reliability.

Currently, around 10% of the total sewage generated in the Maltese islands is being treated and made available for subsequent reuse by the agricultural and industrial sectors. This amounts to a total annual volume of around $1.5hm^3$. The situation is expected to change considerably by 2008, when the planned construction of three new sewage treatment plants will result in the production of about $14hm^3$ of treated effluent each year.

Use of in-house produced desalinated water in the hotel industry is also on the increase. 50% of five star ranked hotels and 20% of four star establishments consume in-house RO produced water. This translates into approximately 24% of the total hotel bedstock on the islands relying on

[1] Refer to Appendices for workings

own produced desalinated water; a figure which is expected to increase in the future due to more 4 and 5 star hotels installing their own RO plants. Reuse of treated sewage effluent in hotels is insignificant since only 2 hotels to date have taken up this initiative.

2.2 Water demand and pressure on resources

2.2.1 Withdrawals and demands: Total withdrawals in renewable natural resources

The total water demand for the Maltese islands has been estimated to reach an annual figure of 58hm^3. As stated above, however, a significant part of this demand is satisfied through the utilisation of unconventional water sources namely desalinated water and treated sewage effluent, in order of priority. The total dependence on groundwater resources amounts to around 32hm^3.

The domestic sector is by far the largest consumer of water on the islands, followed by the agricultural and the industrial sectors. Consumption in these sectors amount to 53%, 41% and 6% respectively. It should be noted that for the purpose of this exercise the domestic sector is taken to include also the touristic, commercial, municipal and other consumers.

Around 56% of the demand is satisfied through the abstraction of groundwater from the aquifers. The hydro-geomorphological characteristics of the islands do not sustain significant surface water bodies. In as much, surface water is only available during the rainy seasons as water stored behind dams or in reservoirs. The total volume of water available through these storage systems is estimated to reach around 4 million m^3.

Indicators:

Total water demand, WAT_P02: 0.058km^3

Relative shares:
Agriculture: 41%
Industrial: 6%
Domestic: 53%

No data is currently available to determine the water requirements for the sustainment of eco-systems. However, owing to the lack of significant surface water bodies on the islands, this is expected to be a relatively minor quantity.

2.2.2 Pressure exerted on the resources

The groundwater resources in the Maltese islands are heavily exploited, as is reflected by their relatively high exploitation index. The global exploitation index shows that abstraction is, as a long term average, fairly close to the supply potential of the aquifers.

However, a more in depth investigation, wherein the water balances of the single groundwater bodies are determined, shows that in the major groundwater bodies in the islands the mean annual abstraction exceeds the net water inflow to the aquifer system.

Indicators:

Exploitation index of renewable natural resources, WAT_P03: 97%
Non-sustainable water production index, WAT_C03: Not-applicable
Emissions of organic water pollutants, WAT_C09: No data available

2.3 Degradation and threats affecting water resources, facilities, ecosystems and populations

2.3.1 Overexploitation of aquifers, especially coastal ones

The largest and by far the most important groundwater bodies in Malta and Gozo are in vertical and lateral contact with seawater. These water bodies assume the shape of freshwater lens that floats over seawater by virtue of density contrast. As there are no impermeable barriers such as clay or marl that physically separate the two fluids, freshwater and seawater may be considered to occur in a hydrostatic balance when naturally found in undisturbed conditions. Hence in the absence of a sharp, well defined barrier, a movement of salts between seawater and freshwater is to be expected as a result of molecular diffusion.

As in most small islands the degree of saltwater intrusion is closely related to the positioning/type of wells and the associated rate of abstraction. Where groundwater is being regularly pumped, the freshwater lens in Malta and in Gozo shows signs of depletion, with the piezometric level being relatively drawn down and conversely the interface becoming up-coned to shallower depths at the same point. Both processes are related and strongly dependent on abstraction rates and the position of the well or gallery in relation to the depth of the interface, besides other hydrogeological factors.

The two major sea level aquifers are heavily exploited with the main abstraction sources being located in the central regions of the aquifers. This regional over-abstraction, over the years, has resulted in lowering the piezometric levels at the central regions of the islands to levels well below those under natural conditions. Consequently, abstraction sources located in this central region are quite susceptible to saline intrusion, due to the reduced distances between the well-bottom and the freshwater interface.

2.3.2 Alteration in the quality of the water and the eco-systems

The high population density of the islands is reflected in a relatively high pressure on the bodies of groundwater resulting from anthropogenic activities located in the respective catchment areas. Industrial activities are mainly located in near coastal areas and thus the main threats arise from agricultural and urban related activities. In as much, pollution by nutrients (nitrates) has been identified as the main threat to Malta's groundwater.

Nitrate content in groundwater is relatively high, with a significant number of monitoring stations exhibiting nitrate levels in excess of the 50mg/l limit value established under EU legislation. This is particularly true for the minor 'perched' aquifers where natural protection by the unsaturated zone is rather limited owing to the rather low depth to groundwater and the degree of geological fracturing...

Other potential contaminants associated with this type of land-use include pesticides and their degradation products, heavy metals such as copper and lead and hydrocarbons. However, until now, no high levels of these substances have been encountered in the groundwater monitoring stations.

The other main threat to the quality of groundwater in Malta is due to saline intrusion in sea-level and coastal groundwater bodies. Apart from localized upconing in response to abstraction, variations in the piezometric levels result in widening the width of the interface resulting in a diffuse zone of transition between saltwater and freshwater; thus effectively reducing the freshwater storage capability of the groundwater system.

A number of freshwater ecosystems which are dependent on groundwater have been identified as part of the characterisation process under the implementation process of the Water Framework Directive. Further investigations are however required in order to determine the qualitative status required to ensure the sustainability of these fragile ecosystems.

Indicators:

Water general quality index, WAT_C08: No data available

Wetlands area, WAT_C06: 0.243km2

2.3.3 Silting up of dam reserves

Throughout the years, a number of dams have been constructed along the major valley lines in the islands. The aim of these structures was twofold: the provision of a source of water for the agricultural sector and to increase the recharge to the sea level aquifers. Other benefits relate to flood relief.

However, in real terms, the storage volumes created by these structures has a limited economic importance, and the total design volume does not exceed 125,000m^3. Still silting is a very important issue and periodic maintenance is undertaken by the government on these structures.

Indicators:

Silting up of dam reserves, WAT_C02: No data available

2.3.4 Degradation cost (separating repercussion costs and repair costs) and of the rise in vulnerability to these risks

Degradation in the quality of a number of groundwater bodies has led to the progressive increase of desalinated water in the production of potable water. In fact, abstraction for potable purposes from a number of perched groundwater bodies had to be discontinued due to their high nitrate content; whilst increasing chloride levels in a number of abstraction sources in the sea-level aquifers has led to the progressive abandonment of a number of wells in these aquifer systems.

Further degradation could however have more far reaching consequences. The reduction in groundwater abstraction for domestic purposes was replaced by the production of desalinated water. However, if lower quality levels, which make the water unsuitable for irrigation, are reached; it is highly improbable that the agricultural sector can fall back on desalinated water without seriously affecting its economic viability.

Indicators:

Degradation cost of water resources as a % of GDP: No data available

Throughout the years, significant urban development has occurred in a number of valley systems in the islands. This is particularly evident in the Qormi and Msida catchments in Malta and in the Xlendi and Marsalforn catchments in Gozo. These catchment areas suffer periodically from flooding whenever high intensity storm events occur. Significant investment has been made in the last years to decrease flooding risks in these catchment areas.

Indicators:

Human and economic impacts of the floods, WAT_C06: Lm 4,211,791 (0.25% of GDP)[2]

Portion of constructions built in floodable areas in the last 30/40 years: No data available

2.4 Access to drinking water and to sanitation and collection and treatment of waste water

The Water Services Corporation (WSC) is a public utility responsible for the supply, production and distribution of water in the Maltese islands. The Corporation operates a groundwater abstraction network which is scattered over the whole island and three Reverse Osmosis desalination plants with a total nominal capacity of 100,000m^3/day. Desalinated water is blended with groundwater of higher salinity, in order to produce a blend of salinity within permissible drinking-water limits.

Private supply of drinking water is essentially limited to hotels which are equipped with small desalination units and a number of small operators supplying other private enterprises. The quality of the water supplied is regulated by the Department of Public Health.

The WSC also manages the municipal water-distribution network. This network consists of about 2,000km of pipework of varying materials and sizes and a further 1,700km of service pipework connecting more than 200,000 premises to the network. Extensive effort and investment have been devoted to leakage control, improved management practices and water conservation programmes.

Since 2003, the WSC has also been responsible for the collection and proper disposal of wastewater. The sewerage system in Malta collects domestic and industrial wastewaters as well as a certain unquantified amount of stormwater runoff. Basically, it comprises two main networks, commonly called the Marsa Land and the Marsa Sea, and three subsidiary networks.

There are currently two main outfalls in Malta (Wied Ghammieq and Cumnija) and one in Gozo (Ras il-Hobz). Other minor outfalls are present but their discharge rates are much less. The Wied Ghammieq outfall is located at the southeast coast of Malta and discharges raw sewage at an average rate of 33,000m^3/day. Wastewater from the northern region of Malta is conveyed to the outfall at ic-Cumnija, where average discharge rates amount to around 4,000m^3/day. The outfall at Gozo discharges around 3,600m^3/day.

It is planned that all the wastewater generated in the island will be treated prior to disposal by end-2008. This will entail the commissioning of three new wastewater treatment plants, located in the vicinity of the current outfalls. Options for the re-use of the treated effluent are also being investigated.

Indicators:

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[2] Sum is indicative of estimates taken from the Malta Insurance Agency, Storm Tempest Damage Results. Claims for compensation due to damages to crops have not been included.

Proportion of the population having a durable access to an improved water source, (MSSD-WAT_P04): 100%

Proportion of the population having an access to an improved sanitation system, (MSSD-WAT_P05): 100%

Share of collected and treated wastewater by the public sewerage system, (WAT_C10): 16%

Share of industrial wastewater treated on site, (WAT_C11): Not applicable

Chapter 3

Improve efficiency in the sectors of activity using the water demand management policies

3.1 Data and indicators

3.1.1 Water for agriculture

Agriculture's share of the GDP for Malta is about 2.5%. The development of agriculture in Malta is constrained by the natural and geographical characteristics of the islands. The major constraints facing agricultural activity are the opportunity costs of land, scarcity of water resources, and high labour costs.

An analysis of the agricultural land shows that the total area of agricultural land (inclusive of dry, irrigated and garigue land) decreased from 20,500ha in 1955 to about 11,600ha in 2000. The period also saw an increase in irrigated land (that is land which has a continuous supply of water all year round, irrespective of whether it has a natural spring, is served by second-class water or water supplied by other sources) from the 816ha registered in 1955 to the 1,508ha declared in the 2000 census. The main driver behind this increase in irrigated land area was revenue generation, backed by liberalization in water use, declining costs of borehole construction and improvements in irrigation technology.

The census of the agriculture sector conducted by the National Statistics Office (NSO) in 2001 showed that around 1320ha of the irrigated land was under localized irrigation. The remaining irrigated areas are assumed to be irrigated with other methods such as sprinklers. Furrow irrigation methods have decreased considerably although they are still used in certain non-irrigated areas, where however, crop-growing requires additional irrigation. No dedicated irrigation water distribution network has been developed in the islands and thus, the irrigation demand is met through auto-supply. Most of the water abstraction sources are located at the point of use, and this explains the relatively high value for the efficiency index of water use.

Groundwater is by far the major water source sustaining the agricultural sector. In fact it is estimated that as much of 80% of the total irrigation water is abstracted from the aquifers. Other sources such as treated sewage effluent and harvested rain water runoff play a relatively minor role and their contribution is estimated at 8% and 12% respectively.

The outcome of the negotiations preceding Malta's accession to the EU can be considered as a viable starting point for projecting possible changes in the agricultural sector. The main points of interest from these negotiations are:

1. The base area applicable to Malta for arable crops was set at 4,565ha;
2. New planting rights for the production of quality wines for a total of 1,000ha were granted;
3. The national guaranteed quantity of olive oil for Malta was set provisionally at 150 tonnes – requiring between 50 and 75ha of olive plantations; and
4. An area of 1,800ha was indicated for the cultivation of potatoes.

Assuming that the utilized agricultural land remains constant, attaining these thresholds will result in the net irrigated land increasing to around 2,250ha. Minimal increases are envisaged in the vegetable-cultivation sector as domestic demand is being met by the current levels of production and the possibilities of the sector being involved in large-scale exports are almost non-existent.

Indicators:

Water demand for irrigated agriculture, WAT_P02: 0.018km^3

Water demand for agriculture compared to the agricultural GDP (MSSD-WAT_P02): 8.4252 m^3/GDP or 0.0084km^3/GDP

Efficiency index of irrigation water use, WAT_P01: 0.78

Value added of the irrigated agricultural production compared to the water needed for irrigation: This indicator needs to be studied further.

Surface equipped with modern irrigation systems, WAT_C04: app. 100%

Price m^3 of marketable agricultural water and Marketable agricultural water cost recovery rate, WAT_C12:

Price m^3 of marketable agricultural water:
A block tariff structure exists charging the first 6810m^3 at Lm 0.165 and volumes exceeding this quota at Lm 0.18. An annual service charge of Lm 24 is also charged.

Marketable agricultural water cost-recovery rate, WAT_C12: 4.26%[3]

3.1.2 Domestic water (including tourism)

The domestic sector has registered an increase in consumption caused by higher living standards. WSC figures indicated that the consumption of water exclusively for domestic purposes was 142litres/person/day in 2000/01. This figure falls to 76litres/person/day when losses and unaccounted-for water are taken into account.

The net water demand of the sector has been relatively stable in recent years. This since effects due to the increasing consumption have been dampened with an intensive leakage reduction programme carried out by the WSC. It has been estimated that leakage has been reduced over the whole distribution system from 2,692m^3/hour in 1995 to about 900m^3/hour by July 2004. The unavoidable annual loss of the distribution system is estimated to be 300m^3/hour, and the WSC plans to reach this target by 2010. Other programmes initiated by the WSC, sought to tackle the issue of unaccounted for water – water which is consumed but not billed. These included the replacement of old and relatively inefficient water meters and a clampdown on water theft.

Modern housing and a heightened demand for better-quality drinking water have indirectly created a market for new sources of water supply. The consumption of bottled water has increased sharply in recent years, reaching an estimated annual volume of 50-60 million litres; while an increasing number of property owners source their recreational needs (swimming pools etc) from private 'bowser' suppliers who use groundwater as their main source of supply.

Data generated by the NSO show that the total annual guest nights in the period 1998-2000 varied between 10 and 11 million nights; or an average daily tourist load of 32,000 tourists. Tourist arrivals peak in the summer months of July and August and place additional strains on water resources.

[3] See workings for this indicator in appendices

The WSC estimates that tourism accounts for around 10% of the total consumption of municipal water. In fact, billed consumption for tourist establishments during 2000/02 stood at 1.74 million m^3. This would mean that each tourist used about 149litres/day of water. These official figures for consumption of water by the tourist industry are however quite low when compared to the situation in other Mediterranean countries, where the average daily demand of the sector ranges between 300 and 400 litres per capita.

However, the tourism sector does not depend exclusively on the municipal water distribution systems. There is a high degree of auto supply, with an increasing number of coastal hotels investing in private desalination facilities. Available evidence indicates that the sector could be acquiring up to 50% of its water from sources other than the potable water network. These sources include in-house RO facilities and private suppliers of groundwater.

Indicators:

Total domestic water demand and per capita and tourism water demand (total and by tourist), WAT_P02:
Total domestic water demand: 0.03km^3
Total domestic water demand per capita: 142 litres/day (exclusive for domestic purposes)
Total tourism water demand: 0.003km^3
Tourism water demand by tourist: estimated at 300 litres/day

Efficiency index of drinking water use, WAT_P01: 0.55

Price of m^3 of domestic water (and of water for tourism):
A block tariff structure exists charging the first 33m^3 at Lm 0.165 per person and volumes exceeding this quota at Lm 1.10. an annual service charge of Lm 12 is also charged.
For a domestic household on social assistance, the first 16.5m^3 per person are free of charge, the second 16.5m^3 consumed are charged at Lm 0.165, and any exceeding this amount is charged at Lm 1.10. No meter rent is charged.
A garage for private use is charged Lm0.85 for the first 30m^3 and Lm 1.10 when this amount is exceeded.
Consumption charges for the tourism sector (hotels) present a first block of 42m^3 per bed which is charged at Lm 0.90, with successive consumption being charged at Lm1.10. However, the tourism sector utilises various sources of water, not only from the public distribution network, including in-house RO facilities, which obviously present much lower production costs[4].

Domestic water cost recovery rate (and for tourism), WAT_C12: 39.55%[5]

3.1.3 Water for industry (including energy)

The industrial sector accounts for about 6% of the total water demand in the Maltese islands. Water efficiency and water recycling are being introduced slowly, particularly in the major industrial concerns as it is recognized that these measures reduce costs in the long term. However, cost-effective programmes are still a long-way off for medium-small industrial concerns.

The construction industry and the food and beverage industry are the concerns most dependent on groundwater in this sector. However, no appreciable expansion is envisaged. Thus, the sectoral demand on groundwater will most probably remain stable. Fiscal incentives should be promoted in order to reduce this dependence through runoff harvesting and recycling.

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[4] Source: WSC Tariffs, http://www.wsc.com.mt/wsc_tariffs.shtml

[5] Source: FAO Report, 'Malta Water Resources Review' p.47, table 8;
NSO consumption Report 02-05

With the possible availability of increased volumes of TSE, further use by the industrial sector of these sources is a possibility, also in view of the fact that the Ricasoli, Marsa and Bulebel industrial parks are all within range of the new Malta South Plant.

Indicators:

Industrial water demand (including energy), WAT_P02: 0.0027km^3

Efficiency index of industrial water use, WAT_P01: estimated at 0.05

Price of m^3 of marketable industrial water (industries served):
Consumption charges for the industrial sector (excluding food & beverages, manufacturing processing of tomato sauce, soft drinks, bottled water, confectionaries) are at Lm 0.85 per cubic metre consumed. Added to that there is an annual service charge of Lm24. Also in this case, there is an unquantified amount of water supplied by water bowser.

When including the food and beverages, manufacturing processing of tomato sauce, soft drinks, bottled water, confectionaries, the service charge is Lm 0.60 per cubic metre consumed, with an annual meter rent of Lm24. Also in this case there is an unquantified amount of water supplied by water bowser.

Marketable industrial water cost recovery rate, WAT_C12: 59.88%

Cost of m3 of non marketable industrial water (industries not served): 1,775 000m^3

	(000 m^3)
Unbilled	275
Groundwater	1,000
Treated effluent	500
Total	1,775

3.2 Retrospective Analysis

The main efforts for managing water demand have been, in recent years, primarily concentrated on the municipal sector. In fact, municipal water productions have been progressively reduced from levels in excess of 50 million m^3 in 1995 to around 32 million m^3 in the last years. Leakage control (comprising active leakage localization, leakage repair, pressure control and smart infrastructure management) is considered to have been the major contributor towards this reduced national system demand. Public information campaigns on the need to use water more efficiently and periodic adjustments to water tariffs are also considered to have had limited temporary effects on the overall demand.

Compliance with the Urban Waste Water Directive has resulted in the development of three new wastewater treatment plants which are expected to be operational by end-2008. These plants will be producing an annual volume of 20hm^3 of treated effluent, which can be used in lieu of other water sources such as groundwater, in particular by the agricultural and the industrial sector. Significant investments in the distribution of this water are however required for it to be available where and when needed. Limited investments in water treatment and re-use have been made in the private sector with a limited number of hotels and industries investing in water recycling facilities.

There is also much scope for increased collection and use of rainwater runoff. In fact, a storm Water Master Plan is currently being developed which is expected to deliver a national plan for the increased use of this resource, tackling the issue on both a national and localized level.

Legislation requiring the construction of domestic cisterns with all new developments has recently been enacted, and guidelines have been issued by the Development Regulator on the sizing of such structures. Also, a campaign for the rehabilitation of water storing infrastructure in the major valley lines in the island has been initiated by government. The scope of this programme is to reduce problems related to flooding and making more water available for users and aquifer recharge.

3.3 Prospective Analysis

Efficient use of all available water resources is definitely a priority for all countries, and much more so for countries with arid and semi-arid climates such as Malta. Efficient water management measures should tackle issues related to water availability and use at both a local and national/regional level.

National Schemes
It is a known fact that measures for the augmentation of available water resources and increased management of demand are warranted. The success obtained so far in the leakage reduction programme by WSC must be followed up and the ambitious targets set by the Corporation met. National programmes and targets for increasing the harvesting potential of rainwater runoff should also be set. It is expected that this will be one of the results ensuing from the Storm Water Master-plan being currently developed.

Options for the eventual use of the treated effluent produced once the new treatment plants are commissioned should also be investigated. The agricultural and the industrial sector are considered as the main potential users of such waters. However, constraints such as the need for a dedicated distribution system and the eventual chemical and biological quality of the treated effluent need to be investigated and any ensuing problems addressed.

Being one of the major consumers of water in the islands, changes to current agricultural practices will have a profound effect on water use and demand. National agricultural and water policies should thus have a common aim: increasing the efficiency of water use. National technical studies on crop production and yield under deficit irrigation techniques and the effects on crop yield with varying water quality should be initiated, in order to pilot any ensuing agricultural policy. An economic survey of the sector, wherein the economic benefits obtained from each crop in relation to its water needs are analysed should also be carried out in order to ensure that the sector is obtaining the maximum possible economic benefits from its water use. These issues need to be included in the Development Programmes for the rural sector required under the Common Agricultural Policy (CAP). This is to ensure that Community subsidies encourage a better use and protection of the water resource.

Targeted information programmes on water demand management measures in the various consuming sectors should also be carried out. These information campaigns can also be backed up with fiscal incentives to ensure a better implementation of the proposed measures.

Local Schemes
Different focalised water demand and supply augmentation measures exist for the various water consuming sectors.

The domestic per-capita water demand in the Maltese islands is still relatively low, indicating that a water-saving culture already exists. However, there is still scope for improvements in this sector. One of the main targets of any water efficiency campaign in this sector is that to reduce wastages. Experience in Malta has shown that these issues are best tackled through a long-term public information campaign, The use of water efficient appliances in the home also contributes to a reduced water demand. Fiscal incentives should be introduced for this end; similar to those being currently applied for energy saving appliances. Current literature shows that these water saving appliances require less input water, and can reduce the demand by as much as 25% when compared to a non-efficient appliance.

Recently enacted legislation requires the construction of rainwater cisterns in each new urban development; a practice which although required by previous legislation was generally not enforced. However, standards and recommendations for the eventual use of this water need to be developed. Options for re-using this water for washing, flushing and gardening do exist; however subject to regulations from the public health authority.

Further margins of improvements in the domestic sector exist if options for re-using grey-waters for toilets are considered. Even here, technical standards regulating the installation of dual systems in houses need to be developed. Estimates, however, show that such measures can lead to a reduction in demand by as much as 30%. However, the current development trends for high rise buildings could present new challenges for such measures.

Localised measures aimed at managing water in the agricultural sector primarily consist of supply augmentation measures such as the construction of rainwater harvesting structures such as reservoirs and demand management measures such as the use of more efficient irrigation practices. Fiscal incentives for the introduction of such measures are important, however these need to be managed in the framework of the National Rural Development Strategy, as envisaged in the CAP.

In the industrial sector, the introduction of water treatment and re-use schemes, particularly for water used in the processing phases should be encouraged and incentivised. These measures can lead to high potential water savings particularly in water consuming industries such as those in the food and beverage and IT sectors. To cite a particular example, water treatment technologies introduced at the ST-Malta plant resulted in a reduction in the water demand of around 80%.

The implementation process of the Water Framework Directive envisages that by 2009, a River Basin Management Plan is established with the aim of achieving the environmental objectives of the Directive. This plan will include a programme of measures which will tackle issues related to the qualitative and quantitative status of water bodies in the country. This plan would be expected to propose a holistic set of measures, in which the measures proposed in this section, could be included.

Currently several basic and supplementary measures for the main economic sectors (agriculture, municipal, tourism and industry) have been identified and are being put forward to stakeholders for public consultation. Other than the Water Framework Directive, these measures involve the implementation of different Directives such as the Nitrates Directive and the Urban Waste Water Directive. A cost effective assessment and socio-economic assessment for each of the suggested measures is also being carried out.

Chapter 4

Towards integrated policies for water resource and demand management.

4.1 Taking into account of the Environmental Objectives in Water Policy

As one of the new Member States of the European Union, Malta is committed to align its environmental policies with the “acquis communitaire” by complying with EU environmental legislation, including that governing the development of water resources. The Water Framework Directive (WFD) comprises a framework legislation for the sustainable management of water resources and sets clear environmental objectives for both surface and groundwater bodies. By this legislation, Member States are required to achieve good quantitative and qualitative status by 2015. To fulfil the legal requirements set by the WFD, water policies were therefore revised and integrated with other national policies, land-use in particular. The new strategies are today being focused on environmental outcomes (ecological objectives, risk focus) and adopt a Basin Management approach as the delivery mechanism to achieve these aims.

MRA has launched for public consultation, policy proposals which recognise the importance of groundwater and surface waters in the specific insular context of Malta. The proposals aim to promote the sustainable management of water resources in the light of environmental factors that influence the status of the aquifers and the local socio-economic factors that impact directly on the well-being of the Maltese community. In this context, therefore, several strategic measures are proposed with the aim of:

- achieving ‘good’ quantitative and qualitative status of groundwater bodies by controlling abstractions and reducing the pollution threats arising from point or diffuse sources.
- improving water-efficiency.
- ensuring equitable allocation of the resource to different stakeholders.

The value of public health and the right to an equitable and sustainable access to water services are deemed to be the founding principles of the future policy strategies. Concurrently, economic development should not be constrained by lack of water service, whilst environmental systems including groundwater, and surface waters should be adequately protected. As water is considered to be both an economic and a social good emphasis is made to the polluter pays principle meaning that “users” must pay for the water they use whilst “polluters” pay for the damage they cause. Statutory and legal instruments are required to support the policy and empower the institutions with sufficient enforcement capability to ensure an effective application of management measures. Regulations have been drafted for this purpose and are being currently vetted by legal experts.

In Malta water is a scarce resource because of geographic and climatic conditions. The Maltese islands have no surface waters on which to rely, but depend instead on frail groundwater that is nowadays subject to intense pressures by different sectors of the community. Malta is among the first 10 top-ranking countries in global water scarcity with the highest competition index of 24,800 inh/hm^3.yr in 1995 (Margat and Vallee, 2000).

Until the early seventies, groundwater was the only source of potable water; today it accounts for only half as seawater desalination inevitably provides for the shortfall in drinking water demand, though at a relatively higher price. Other non-conventional sources, such as treated sewage effluent and rainwater harvesting contribute marginally and have not been yet exploited on a large scale.

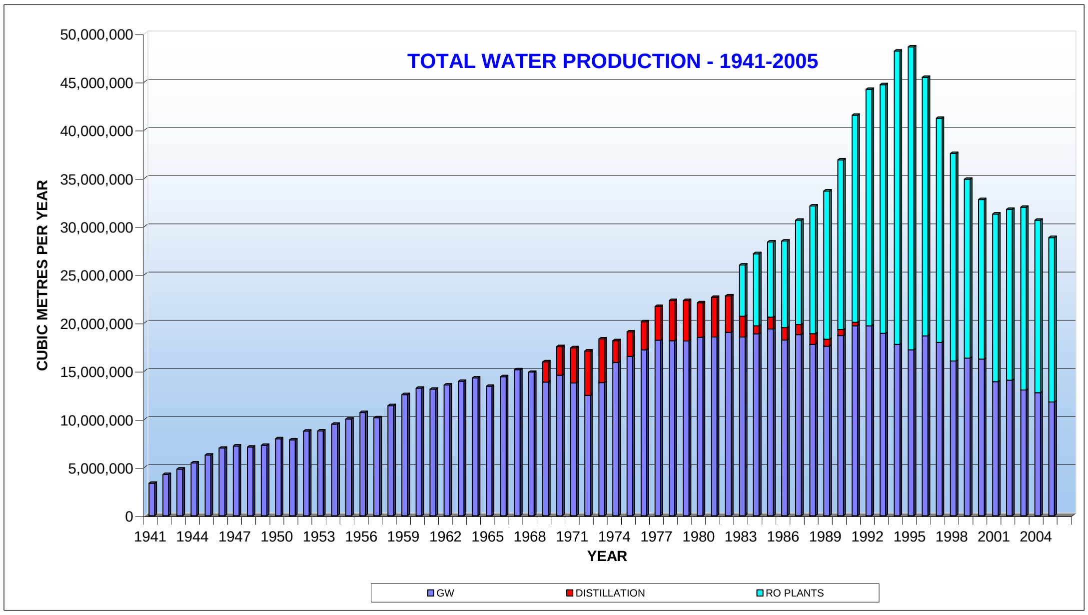

Figure 4.1: Bar chart showing development in water production.

Groundwater is also essential to sustain terrestrial eco-systems. These habitats depend on a year-round supply of freshwater. Thus, they are quite rare and of limited distribution. However, they support distinctive types of flora and fauna, some of which are endemic to the Maltese islands. A reduction in groundwater abstraction could be necessary in certain aquifer systems in order to sustain groundwater flow to these dependent ecosystems. A study is underway to determine the degree of dependence of these ecosystems on groundwater in order to better ensure their future protection and sustainability.

Indicators

Total Water demand (MSSD WAT_PO2):

Total Water demand (MSSD WAT_PO2):	**m3/GDP (Lm GDP prices)**	**m3/GDP (US$ GDP prices)**	**km3/GDP (Lm GDP prices)**	**km3/GDP (US$ GDP prices)**
Total Water demand compared to GDP	0.016	0.006	1.59885E-08	6.0468E-09
Water demand in Agriculture compared to GDP	0.551	0.208	5.51057E-07	2.08408E-07
Water demand in Industry compared to GDP	0.007	0.003	6.69104E-09	2.53053E-09
Water demand in Tourism compared to GDP	0.027	0.010	2.73264E-08	1.03348E-08
Water demand in Government compared to GDP	0.008	0.003	8.36784E-09	3.16469E-09

Water Requirements for the ecosystems (WAT_C07): data not available

Water cost recovery rate (WAT_C12):

Water Cost Recovery Rate					
	Production* (m3)	**Cost/m3 (LM)**	**Cost (LM)**	**Revenue****	**Cost Recovery Rate (%)**
Total Water Consumption	49,004,000				
Domestic & Tourism	22,271,000	1.10	24,498,100	7,731,840	31.56
Agricultural (irrigation + farms)	20,226,000	1.10	22,248,600	80,837	0.36
industry	2,716,000	1.10	2,987,600	800,957	26.81
*source: *FAO report* *source: ** WSC*					

Rate of public investments and expenditure allocated to water and Water Demand Management (WDM) (WAT _C13): data not available

4.2 Taking into account of water demand management (WDM) in the water policies.

The aforementioned approach to water resources management cannot be put into effect without a proper water-demand strategy, meant to promote water savings by actually changing “water behaviour” to eliminate wastage. For this to effectively take place, water resources management must shift from a traditional supply-oriented approach towards a demand-management strategy that aims at improving the efficiency of water use and at maximizing the cost-effectiveness of water resources.

Demand management efforts strategies have a long history in Malta. Over the past years the Water Services Corporation has embarked upon a significant program aimed at reducing leakages to acceptable levels aiming to achieve an Infrastructure Leakage index (ILI)[6] of 1.5 in 2007.

Originally the first efforts focused on reducing losses and levels of *unaccounted-for* water supplied through the distribution network. This approach obviated infrastructural investment at three different levels:

a) Replacement of old pipelines.

b) extensions of the distribution network to improve service efficiency

c) meter replacement to eliminate meter under-registration and loss of revenue

d) replacement of service connections with PVC pipework

An educational campaign was launched to change behaviour patterns of consumers. Special emphasis is given to education at schools by promoting water-saving measures in schools and other public places.

[6] Infrastructure Leakage index (ILI) is the ratio between Current Annual Real Losses (CARL) and the unavoidable background leakage level (UARL).

Demand management strategies helped in reducing wasteful practices. A reduction of water production for municipal purposes by 36% has been achieved during the last 10 years bringing the annual production for drinking water to 34hm^3 in 2005. Targets set by WSC for leakage reduction are ambitious and a further drop in system demand is expected during the next five years.

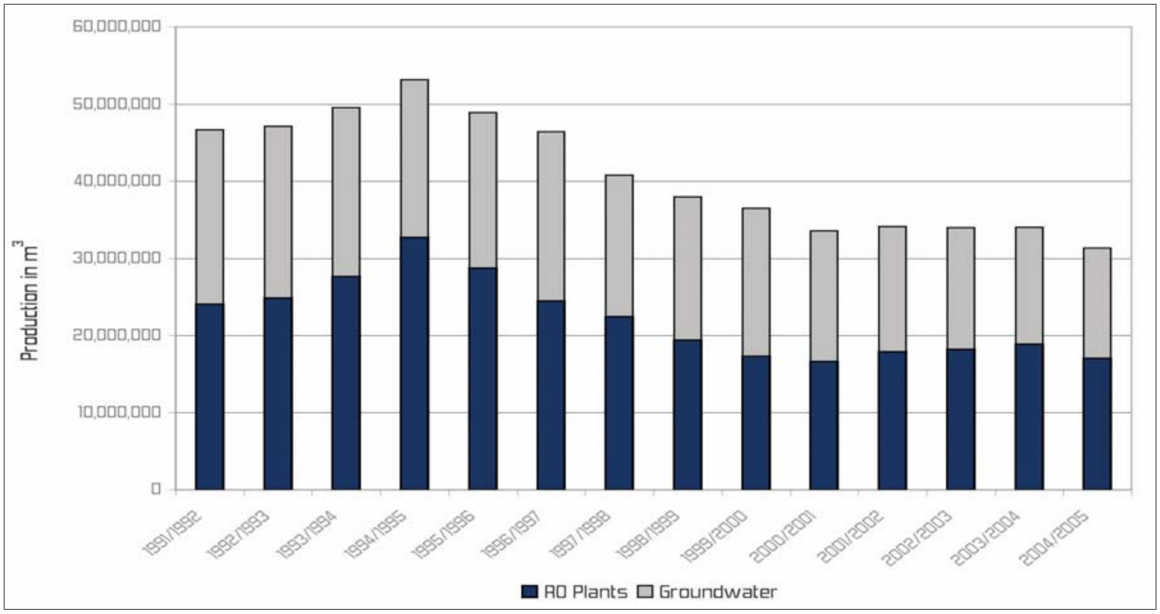

Figure 4.2: Chart showing changes in municipal water production.

Such a drop in demand has lead to a decrease in groundwater abstraction for municipal purposes while RO production has slightly increased to supplement groundwater and enable compliance to EU drinking-water standards.

The current abstraction of groundwater for public and private purposes is around 32.5hm^3. In a recent water resources assessment it has been reported (Sapiano 2004) that the sea-level aquifers are being exploited above their sustainable limit by around 5hm^3/annum.

By far the most demanding sector on water resources is agriculture. Irrigation water demand has increased remarkably during the last fifty years; from an estimated 8.5 hm^3 in 1940 to around 18 hm^3 in 2003 (FAO Water Resources Review).

Accession negotiations prior to Malta's membership to the European Union gave new planting rights for the production of quality vines, olive oil and potato cultivations that would increase the footprint of land under irrigation to around 2250 hectares during the coming years.

Moreover, extending the current trends of land conversion brought about by CAP land-based subsidies, a further 5% increase in land under irrigation is projected bringing the total irrigated land to 2600ha by 2010. The resulting irrigation demand as a result of this sprawl of irrigated land is projected to exceed 21 hm^3. This is judged to be the maximum threshold as a further extension of irrigated land is constrained by land availability.

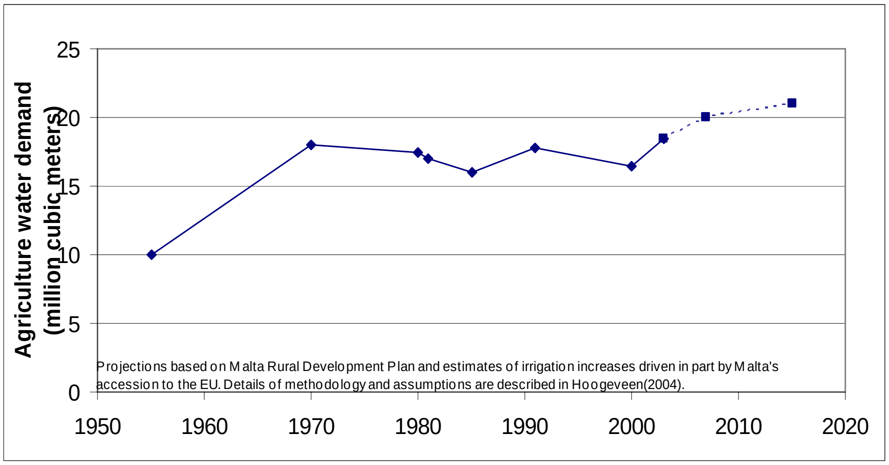

Figure 4.3: Plot showing estimated trends for irrigation demand

The domestic sector has also registered an increase in consumption due to higher standards of living. Modern housing and a heightened demand for better quality drinking water has indirectly created a market for new sources of water supply. Consumption of bottled water shot up in recent years while an increasing number of property owners source their recreational needs (swimming pools etc) from private water-sellers. Hence the overall demand of the domestic sector is today estimated to be higher by at least 2 hm^3 or 17% than the consumption billed by WSC. (Sapiano 2004), recognising also the growing domestic use of groundwater from old hand-dug wells and of rainwater collected in cisterns – two alternative sources which are slowly being re-discovered.

Industrial and commercial establishments account for 8% of the total demand or 4.2hm^3 per annum. While the food and beverage industry consumes more than half of the water supply billed to industry, there is growing concern over the increasing demand created by the mining and quarrying industry that is estimated to be obtaining 33% of its water requirement mostly for concrete batching through un-metered wells.

Tourism is another sector that weighs on water resources. Although tourism accounts for 10% of consumption billed by the utility, there is enough evidence to assume higher consumption levels, more so when comparing with other figures for water consumption by tourists in other Mediterranean countries. Many hotels are regularly obtaining their water requirements from own desalination plants or private suppliers thus being excluded from official metered consumption. Assuming a daily consumption of 300l/cap/day by tourists (consumption estimated on self-sufficiency levels required for hotels), it works out that tourism is consuming around 3hm^3 or 5% of the overall demand.

Indicator

Water efficiency index (total and by sector) MSSD1 WAT_PO1:

(1) Sectoral efficiencies

- (a) Drinking Water Efficiency: 0.55
- (b) Irrigation Water Efficiency: 0.78
- (c) Industrial Water Efficiency: 0.05

(2) Total efficiency: 60%

Chapter 5

Taking into account of water demand management in the cooperation and development aid policies.

Indicators
Public development assistance devoted to water and proportion of this aid dedicated to programs of WDM (WAT_C14) – At the time of writing of this report not enough data was available for the computation of this indicator.
.
The sustainable management of water resources basically involves a three–pronged approach aiming at efficiency, fairness and environmental sustainability. Water demand management is thus considered a process conducive towards the achievement of one of these objectives namely that of attaining higher levels of efficiency.

Municipal water demand has dropped by 36% in the last 10 years (Fig 4.2) as a result of a successful leakage-reduction campaign. However there are other areas which can benefit through improved demand management in particular by recycling on a decentralized scale and by using treated wastewater for non-potable use. Re-use of treated sewage effluent is an important consideration in Malta's overall strategy for sustainable water use. Reclaimed water is a reliable resource, even during the dry season and can thus substitute other sources of water supply. Agriculture and industry are two sectors which can recycle and make good use of treated wastewater whilst gaining through financial savings.

Only 11% of the total sewage generated in the Maltese islands is currently being treated and made available for subsequent reuse by the agricultural and industrial sectors.

Nonetheless there appears to be a growing demand for non-potable water for a variety of purposes; commercial, industrial, and agricultural, primarily driven by cost considerations.

The availability of treated wastewater following the commissioning of three new treatment plants in Malta and Gozo, offers scope for improving the present water supply situation by making more water available to meet this emerging demand. Projections show that the new facilities will provide around $23hm^3$ /yr of treated effluent.

Following accession to the EU, Malta saw an institutional reform in the water sector where regulatory roles became detached from the responsibilities of the public water-utility and transferred to the Malta Resources Authority (MRA), the regulator for water energy and minerals.

As the institution responsible for the regulation of water resources, the MRA has always promoted efficiency in the use of resources and in the recycling of treated sewage for non-domestic purposes, provided that this is carried out diligently and in a cost-effective manner while respecting public health and environmental sustainability. The authority is currently seeking to promote Pilot Actions for decentralised treatment of grey waters in urban areas, which would eliminate the need for investment in distribution systems as with large scale plants located in relatively remote areas.

In promoting this strategy the Authority seeks to create synergies by setting the right enabling environment which encourages dialogue between stakeholders, in an effort to overcome the constraints and apprehensions over the use of this resource.

As regulator the Authority is also fully committed towards its obligation as required by law, to develop appropriate mechanisms that will motivate consumers to use water resources efficiently and wisely. MRA regulates the economic and financial efficiency of the water industry, the utilities and their subsidiary industries through a framework of licences and within this remit it sets efficiency targets for water and wastewater operators while monitoring the progress achieved through a licensing framework.

MRA is now developing the programme of measures required by the Water Framework Directive to achieve the environmental objectives set by the Directive. The programme will be integrated in the river basin management plan and will identify cost-effective measures to address demand management, and efficiency improvement. Amongst these measures, wastewater re-use and recycling will be given due priority as a means of improving water efficiency and of controlling demand

Chapter 6

Overview and conclusions

The priority and complementary indicators assessed and presented throughout this report give a clear indication of the present and future challenges that need to be targeted in order to fully achieve or implement a sustainable development strategy. It is evident that the Maltese Islands have successfully achieved their Millennium Development Goal targets when it comes to securing durable access to a clean water source and improved sanitation system for all the population. Now, in the face of climatic change uncertainty, a limited natural water resource base and ever increasing water demand, the necessity of integrating demand management with the augmentation of supply has become the major objective for water managers on the islands.

The main challenge lies in the securing of water supplies through alternative and non-conventional water sources whilst simultaneously managing demand in all economic sectors. This challenge dictates the need for a full integration of measures within the existing intricate web of social, economic, political and legislative environments. The successful integration of these measures hinges on public acceptance, which in turn evolves around an enabling political environment through political will; cost-effectiveness of measures; effective regulation, enforcement and monitoring. Moreover it has been recognized that there is a need for further consultation and collaboration between stakeholders.

Several constraints already pose as potential obstacles to the successful implementation of these measures. Apart from the inherent problems of limited space, urbanization and contested land ownership, which can be unravelled with careful planning, rigorous enforcement and education; other problems are sector specific. Demand measures in the domestic, touristic, industrial and agricultural sectors require government incentives to encourage their uptake, together with enhanced public awareness campaigns that target specific sectors. The Water Services Corporation has already strived to manage demand through its intensive leakage reduction programme which has reduced leakages over the whole distribution system by 2/3 since 1995 (2,692m^3/hour – 900m^3/hour), and is still striving to cut down on leaks as much as possible by 2010, to reach a 300m^3 target.

Though water irrigation efficiency is high, there is an urgent need to curtail groundwater abstraction and concurrently encourage water saving in agricultural fields and in livestock holdings. This requires expert advice that is not always available and thus there is an acknowledged need for extension services so that farmers have easy access to information. Supply augmentation can be restricted due to infrastructural requirements that are presently unavailable, or, in some cases exist but are not well maintained. The proper rehabilitation of reservoirs and dams located in valleys translates into a potential of storing up to 4 million m^3 of water per year. The current on-going process to develop a Storm Water Master-plan would ensure that the full potential of storm water and rainwater harvesting at both the national and local scale is exploited.

In the case of the reuse of treated sewage effluent, only 12% of sewage generated is being treated at present. This figure is set to read 100% by the beginning of 2009, once all three waste water treatment plants are in full operation. Even so the reuse of treated effluent can only be assured once an effective conveyance system from point of treatment to point of use is achieved. The guarantee of an easily accessible, good quality water source provided by treated wastewater and harvested stormwater is likely to compete with groundwater abstraction which should be subject to better regulation if it is meant to be developed sustainably. Even at a local scale, water treatment and re-use schemes, especially in industries and hotels, should be encouraged and incentivised since local case studies in both hotels and industries have proven that such measures could lead to high water savings. Successful implementation at the local scale should therefore be used to promote these measures even further.

A binding prerequisite that would enable effective regulation and enforcement of demand management and supply augmentation schemes is definitely the formulation of a central database whereby information can be readily uploaded, managed and shared between different stakeholders, according to clearly defined memorandums of understanding between different authorities and end-users. Transparency in data exchange between stakeholders would enable the right choices and decisions to be made regarding the application of demand and supply augmentation measures that need to be addressed in order to achieve good water quantity and quality status by 2015.

Hence the overarching Water Framework Directive is definitely an effective legislative tool that has encouraged communication and data sharing between authorities and end-users, and has enabled the setting up of a programme of measures, which will eventually lead to a Water Catchment Plan by the end of 2008 and in doing so seek to achieve integrated water resource management.

APPENDICES

Appendices

Workings on Indicators

Priority Indicators

WAT_PO1 Index of water efficiency

This indicator measures progress in water savings through demand management by reducing losses and waste during transport. It covers total and sectoral efficiency (drinking water, agriculture and industry).

(i) Sectoral Efficiencies

a) Drinking Water Efficiency

This is the share of drinking water produced, distributed and paid by consumers.

$E_{pot} = V_1/V_2$; where

V_1; the drinking water volume invoiced and paid by consumers = 16.34hm^3
V_2; the total drinking water volume produced and distributed = 31.03hm^3
(during 2005)

$\mathbf{E_{pot} = 16.34/31.03}$
$\mathbf{E_{pot} = 0.53}$

b) Irrigation Water Efficiency

The physical efficiency of irrigation water is the product of "network for irrigation water transport and distribution" efficiency by plot efficiency.

$E_{irr} = E_1 x E_2$

E_1 is the efficiency of irrigation water transport and distribution networks, upstream from agricultural plots, measured as the ratio between water volumes actually distributed to plots and the total volume of water for irrigation, upstream of networks, including losses in networks.

As an initial estimate, this parameter is expected to be relatively high owing to the fact that water is abstracted at source. It is therefore being assumed at 90%

E_2 is the plot irrigation efficiency, defined as the sum of efficiencies (per plot) of all irrigation methods (surface irrigation, sprinkler irrigation, micro irrigation, others), weighted by the respective proportions of all local methods and estimated as the ratio between water volumes actually consumed by plants and volumes delivered to plots.

Method efficiency	
Surface irrigation	40%
Sprinkler irrigation	70%
Localized irrigation	90%

Irrigation methods
If irrigated lands are considered (1500ha in 2000 census); app. 1320ha are under localized irrigation (drip or clotches). If the rest are assumed to be under sprinkler irrigation; then

$E_2 = (1320*0.9/1500) + (180*0.7/1500)$
$E_2 = 0.87$

$\mathbf{E_{irr} = 0.9x0.87}$
$\mathbf{E_{irr}=0.78}$

c) Industrial Water Efficiency

The volume of recycled industrial water (recycling index)

$E_{ind} = V_1/V_2$

V_1 = recycled water volumes
V_2 = gross volume consumed for industrial processes which is equal to the volume incoming for the first-time to the industrial plant + recycled volume.

Minimal water recycling is undertaken by industrial process in Malta. The exception is ST Microelectronics, where the volume of recycled water amounts to around 150,000m^3 annually.

The average industrial demand is assumed at around 3.2million m^3.

$\mathbf{E_{ind} = 0.15/3.2}$
$\mathbf{E_{ind} = 0.05}$

2) Total Efficiency

Total physical efficiency of water consumption is defined as the sum of water quantity ratios per sector (demand-losses) over sector demand, weighted by the share of sectoral requirements (drinking water, irrigation and industry)

$E = (E_{pot}xD_{pot} + E_{irr}xD_{irr} + E_{ind}xD_{ind}) / D$

E = (0.53x27.4 + 0.78x18 + 0.05x3.2) / 58.6

E = 0.49

NOTE:
Water demand is defined as the sum of water volumes dedicated to satisfying the needs (excluding green and virtual waters), including volumes lost in production, transport and consumption. This corresponds to the sum of water volumes abstracted, non-traditional water production and water re-use minus export volumes.

WAT_ PO2 Water Demand (total and by sector), and compared to the GDP (total and by sector)

INDICATOR: Total water demand (MSSD 2-WAT_P02)

INDICATOR:

	m3/GDP (Lm GDP prices)	m3/GDP (US$ GDP prices)	km3/GDP (Lm GDP prices)	km3/GDP (US$ GDP prices)
Total Water demand compared to GDP	0.016	0.006	1.59885E-08	6.0468E-09
Water demand in Agriculture compared to GDP	0.551	0.208	5.51057E-07	2.08408E-07
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Water demand in Government compared to GDP	0.0084	0.0032	8.36784E-09	3.16469E-09

DATA & WORKINGS:

Total Demand*

		(volumes in 000m3)	Total (in 000m3)	(volumes in km3)	Total (in km3)
Total water consumption		49,004		0.049	
Total water demand (*includes losses in WSC distribution system)		58,640		0.059	

Sectoral (billed + unbilled)

Domestic					
	Domestic	19,306		0.019	
	Tourism	2,965		0.003	
	Commercial	1,611		0.002	
	Government	1,057		0.001	
	Others	1,123	26,062	0.001	0.026
Agriculture					
	Irrigation	18,000		0.018	
	Farms	2,226	20,226	0.002	0.020
Industrial					
	Industry	2,716	2,716	0.0027	0.002716

GDP Figures**

Gross Domestic Product	1,630,044.00	4,310,046.47
Agricultural GDP	36,704.00	97,050.11

Industry GDP	405,916.00	1,073,294.23
Tourism	108,503.00	286,895.92
Government	126,317.00	333,998.43

Annual Average Opening Middle Rate of Exchange US$/1Lm for 2003***	2.644

** source: FAO report, 'Malta Water Resources Review', p.47, table 8*

*** source: NSO, News Release 277_2006, p.5,6,7,10*

**** source: Central Bank of Malta, http://www.centralbankmalta.com/site/exchange.html*

WAT_P03 Exploitation index of Renewable Resources

This indicator measures the relative pressure of annual abstraction (A) over traditional renewable natural drinking water resources (R).

(A / R) x 100

A: Amount of annual traditional renewable natural water volumes consumed for all other purposes, including volume lost during transport;

R: Annual traditional renewable natural water flow volume. (Country resources are individually defined by surface runoff and underground flows, either formed or entering the territory. Volumes are measured on the basis of hydrological data, in reference to average values over sufficiently long periods to ensure stability, and to avoid double accounting of surface and underground water)

Total mean annual abstraction amounts to $32hm^3$

Total potentially abstractable groundwater amounts to $33hm^3$

(32 / 33) x 100
97%

Complementary Indicators

WAT_C01 Regulation index (average flow of water resources controlled compared to natural irregular flow)

This indicator measures the efforts made for the control of the irregular water resources, by the construction of dams, i.e. the annual security of supply. It is calculated as the proportion of the irregular natural theoretical flow actually and regularly available for annual use.

$100 \times Qr / Qt$

Qr: sum of the irregular flows regularized by reserves (annual average)
Qt: annual average irregular flow (internal and external)

The annual potential surface runoff flow in Malta was estimated at 24 million m^3 during the FAO review. This calculation was based on a variable catchment area runoff coefficient and excluded coastal built up areas. Coastal areas were excluded since these do not present physical possibilities for runoff harvesting.

The volume of surface runoff water regularized by various runoff water harvesting facilities (dams in major valleys, public surface reservoirs and private reservoirs and wells) was estimated to reach an annual figure of around 4 million m^3.

100 x 4/24
17%

WAT_CO6: Human and Economic Impacts of floods

INDICATOR:				
Human and economic impact of floods	=	Lm 4,211,791 / Lm 1,684,300,000	=	0.25 %

DATA & WORKINGS:

Damages caused by September 2003 storm*

Fisheries Conservation and Control Division	**Lm 2,039,393**

Agriculture (N.B. Claims for compensation due to damages to crops has not been included)

Farm Access Roads	
Rubble Walls	140,672
Loss of Soil	344,096
Greenhouses and Plastic Tunnels	287,178
Farm Machinery and Irrigation Equipment	5700
Others	20,500
	15,000
	Lm 813,146

Resources and Infrastructure

	Value of Completed Works	**Value of work in hand 2004**	**Estimate to be included for 2005**
Construction and Maintenance			
Cleansing Services	67,723		
Marine and Water Course Unit	65,790	140,227	
Drainage	12,400	304,400	513,000
Manufacturing and Services	140,430	22,220	
	4,830	300	80,000
	Lm 291,173	**Lm 467,147**	**Lm 593,000**
Grand Total			**Lm 1,351,320**

Private Sector (N.B. The data collected is net of excess i.e insurer's cost)

Home Policies	332,271
Yacht & Pleasure Craft	58,192
Motor Policies	460,546

Commercial Policies	1,196,315
	Lm 2,047,325

Total damages caused by September 2003 storm

Agriculture	813,146
Resources and Infrastructure	1,351,320
Private Sector	2,047,325
	Lm 4,211,791

GDP for 2003 was Lm 1,684,300,000

** source: Malta Insurance Agency, Storm Tempest Damage Results*

WAT_C12: Water Cost recovery rate (total and by sector)

(i) Agriculture

Price of m^3 of marketable agricultural water and marketable agricultural water cost recovery rate

A block tariff structure exists charging the first 6810m^3 at Lm 0.165 and volumes exceeding this quota at Lm 0.18. An annual service charge of Lm24 is also charged.*

DATA & WORKINGS:

Water Tariffs

Type of Consumer	**Meter Rent**	**Consumption Charge**	**2005**
Agriculture & Agro Food Industry	Lm24	6810m^3	16c5
		> 6810m^3	18c

** source: WSC Tariffs, http://www.wsc.com.mt/wsc_tariffs.shtml*

Marketable agricultural water cost recovery rate

	Quantity* (m3)	**Price/m3 (LM)**	**Cost (LM)**	**Revenue****	**Cost Recovery Rate (%)**
	(1)	*(2)*	*(1)*(2)*	*(3)*	*[3/(1)*(2)]*100*
Agricultural Sector (Farms)	1,726,000	1.10	1,898,600	80,837	4.26

** source: FAO report, 'Malta Water Resources Review', p.47, table 8*

*** source: NSO Consumption Report 02 - 05*

(ii) Domestic sector and Tourism
Price in m^3 of domestic water (and of water for tourism)

A block tariff structure exists charging the first 11m^3 at Lm 0.165 per person and volumes exceeding this quota at Lm 1.10. An annual service charge of Lm12 is also charged

For a domestic household on social assistance, the first 16.5m^3 per person are free of charge, the second 16.5m^3 consumed are charged at Lm0.165, and any exceeding this amount is charged at Lm1.10. No meter rent is charged.

A garage for private use is charged Lm0.85 for the first 30m^3 and Lm1.10 when this amount is exceeded.
Consumption charges for the tourism sector (hotels) present a first block of 42m^3 per bed which is charged at Lm 0.90, with successive consumption being charged at Lm1.10. However, the tourism sector utilises various sources of water, not only from the public distribution network, including in-house RO facilities, which obviously present much lower production costs.

DATA & WORKINGS:

Water Tariffs

Type of Consumer	Meter Rent	Consumption Charge	2005
Domestic	Lm12	0 - 11m^3 / person	16c5 / m^3
		> 11m^3 / person	110c / m^3
		rebate / person >4	Lm1.40
Social Assistance	Nil	0 - 5.5m^3	nil
		5.5m^3 < x > 11m^3 / person	16c5 / m^3
		> 11m^3	110c
Garage (for private use)	Lm12	0 - 10m^3 / year	85c / m^3
		> 10m^3 / year	110c / m^3
Tourism		0 - 14m^3 / bed	90c / m^3
		> 14m^3	110c / m^3
		RO Facilities	

** source: MRA http://www.mra.org.mt/Downloads/Tariffs/tariffs_water1.pdf*

Domestic water cost recovery rate (and for tourism)

	Quantity* (m3)	Price/m3 (LM)	Cost (LM)	Revenue**	Cost Recovery Rate (%)
	(1)	*(2)*	*(1)*(2)*	*(3)*	*[3/(1)*(2)]*100*
Domestic & Tourism	17,771,000	1.10	19,548,100	7,731,840	39.55

** source: FAO report, 'Malta Water Resources Review', p.47, table 8*

*** source: NSO Consumption Report 02 - 05*

(iii) Industry

Price m3 of marketable industrial water (industries served)

Consumption charges for the industrial sector (excluding food & beverages, manufacturing processing of tomato sauce, soft drinks, bottled water, confectioneries) are at Lm 0.85 per m^3. Added to that there is an annual service charge of Lm24. An unquantified amount of water is supplied by water bowser

When including the food & beverages, manufacturing processing of tomato sauce, soft drinks, bottled water, confectioneries, the service charge is Lm0.60 per m^3, with an annual meter rent of Lm24. Also in this case, there is an unquantified amount of water supplied by water bowser

<u>DATA & WORKINGS:</u>

<u>Water Tariffs</u>

Type of Consumer	Meter Rent	Consumption Charge	2005
Industrial Sector	Lm18	n/a	85c / m^3

** source: MRA http://www.mra.org.mt/Downloads/Tariffs/tariffs_water1.pdf*

Marketable Industrial Water Cost Recovery Rate

<u>INDICATOR:</u>

	Quantity* (m3)^	Price/m3 (LM)	Cost (LM)	Revenue**	Cost Recovery Rate (%)
	(1)	*(2)*	*(1)*(2)*	*(3)*	*[3/(1)*(2)]*100*
Industral Sector	1,216,000	1.10	1,337,600	800,957	59.88

^ This amount is exclusive of any water purchased for industrial use from water bowsers

** source: FAO report, 'Malta Water Resources Review', p.47, table 8*

*** source: NSO Consumption Report 02 - 05*

WAT_C12: WATER COST RECOVERY RATE

	Quantity* (m3)	Price/m3 (LM)	Cost (LM)	Revenue**	Cost Recovery Rate (%)
	(1)	*(2)*	*(1)*(2)*	*(3)*	*[3/(1)*(2)]*100*
Total Water Supply by WSC	58,640,000	1.10	64,504,000	44,577,972	69.11

** source: FAO report, 'Malta Water Resources Review', p.47, table 8*
*** source: NSO Consumption Report 02 - 05*