Chapter 7
Water demand

OVERVIEW OF CURRENT DEMAND

Table 8 presents the breakdown of estimated water demand by sector for 2003 along with the sources of water used to meet this demand.

Features of demand in 2003 include:

- when apparent losses are taken in account, domestic water use was the sector with the highest water demand;
- although an improvement on previous years, apparent and real water losses were still very high;
- agricultural water use for irrigation was the second largest user of "blue" water and the main user of groundwater;
- compared with the potential availability of TSE of about 14 hm^3 by 2008, use of TSE in 2003 was very low.

OVERVIEW OF THE CURRENT STATUS OF WATER RESOURCES

Figure 28 shows the current estimated balance between average inflow and outflow for the main groundwater bodies on the Maltese Islands. The areas in green and blue represent the Upper Coralline and the Lower Coralline Limestone aquifers respectively. However, because the perched aquifers overlie the sea-level aquifers, some deep boreholes in the areas marked as green will actually be abstracting water from the underlying sea-level aquifers, resulting in part of the estimated demand for that particular groundwater body being actually derived from the underlying sea-level aquifers and thereby increasing the existing imbalance in the sea-level aquifers.

Figure 28 helps to illustrate the following points:

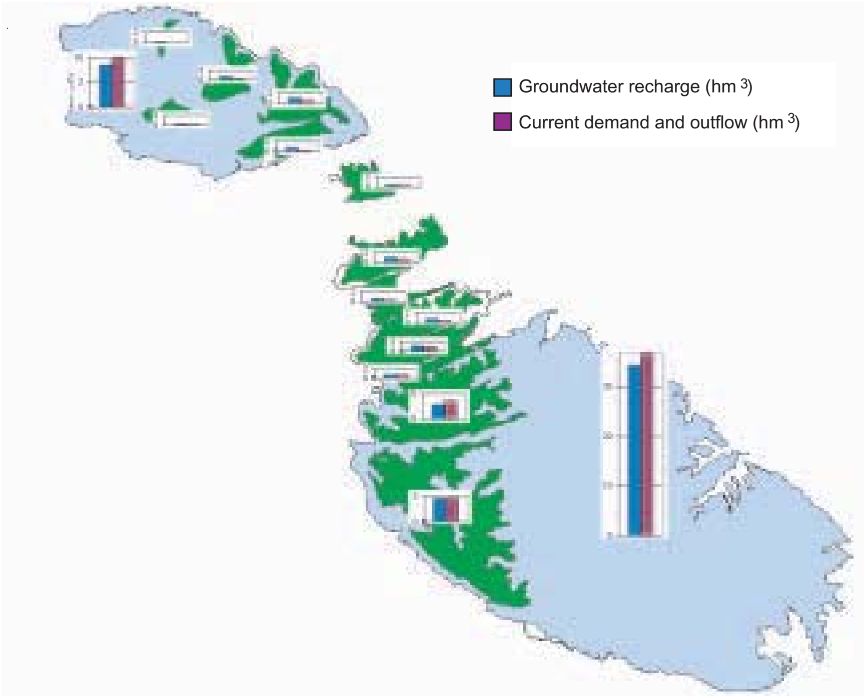
- Current levels of estimated abstraction from the sea-level aquifer systems exceed estimated aquifer recharge. Therefore, current levels of abstraction are not sustainable. Projected increases in demand by the agriculture sector will further exacerbate a deteriorating situation.

TABLE 8
General water accounting matrix, 2003

Malta: General Water Accounting Matrix Year: 2003 Production	WSC		Private				Total
Use	Billed (000 m^3)	Unbilled	Groundwater	RO	Treated effluent	Runoff harvesting	
Domestic	12 620	3 686	1 000			2 000	19 306
Tourism	1 134	331	500	1 000			2 965
Farms	1 336	390	500				2 226
Agriculture			14 500		1 500	2 000	18 000
Commercial	1 247	364					1 611
Industrial	941	275	1 000		500		2 716
Government	818	239					1 057
Others	869	254					1 123
Total consumption	18 965	5 540	17 500	1 000	2 000	4 000	49 005
Real losses		9 636					9 636
Total + losses	18 965	15 176	17 500	1 000	2 000	4 000	58 641
WSC:							
Total apparent losses	5 540	16%					
Total loss	15 176	44%					

Note: Unbilled consumption was estimated on the basis of the volumetric distribution of the billed consumption.

FIGURE 28
Map of the Maltese Islands showing the balance between estimated inflow and outflow for main aquifers, base year 2003



- Current levels of estimated abstraction from the main perched aquifers in Malta are also at a critical level.
- The abstraction potential of the perched aquifers in the north of Malta and in Gozo is limited mainly by the small size of these systems.

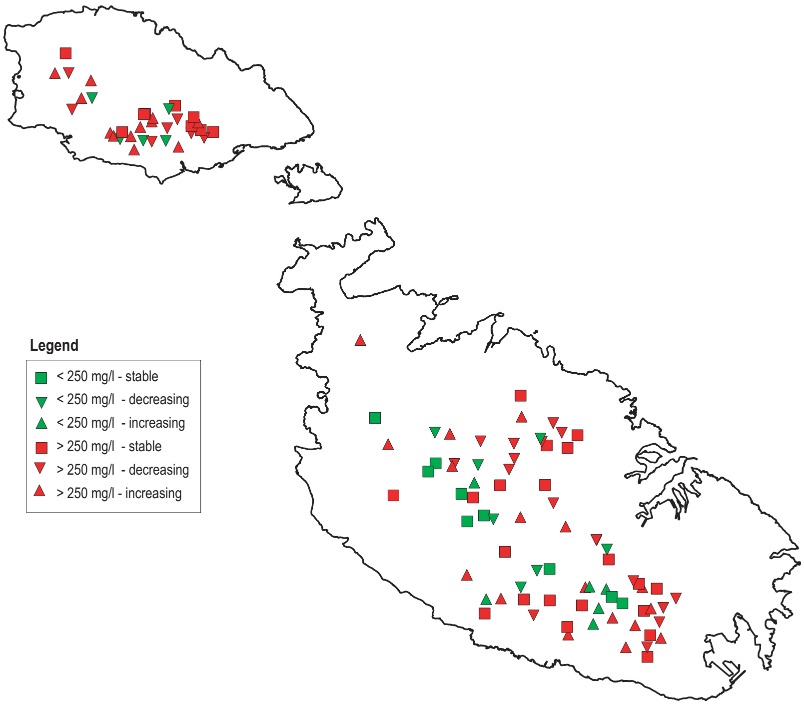
Figure 29 shows salinity levels and the salinity trends in groundwater production boreholes in the Maltese Islands. The threshold used in developing this figure assumes a limit of 350 mg/litre. New standards issued by the World Health Organization (WHO) recommend a limit of 250 mg/litre. Boreholes marked as green have a salinity level lower than the WHO permissible limit for drinking-water whereas boreholes marked as red exceed this limit. The WHO adopts a taste-based standard of 250 mg/litre for chloride content in potable water as "chloride concentrations in excess of 250 mg/litre can give rise to detectable taste in water". The directions of the arrows indicate whether salinity levels have been increasing or decreasing in the last five-year period. The boreholes marked with points have salinity levels that are relatively stable.

Figure 29 illustrates the following points:

- Salinity levels for many boreholes in the central part of the island exceed indicative limits. The situation in other parts of the island is more difficult to assess because observation boreholes do not exist. However, abstraction from boreholes in the south and north had to be discontinued because of the relatively high chloride content of the abstracted groundwater.
- Many of the boreholes that are within permissible limits are exhibiting a rising trend in salinity level. Hence, it is only a question of time before these boreholes exceed permissible limits.
- Many of the boreholes that are in excess of permissible limits are exhibiting a downward trend in salinity levels. This could be caused by the fact that pumping

FIGURE 29

Salinity levels and trends compared with previous five-year mean in WSC groundwater abstraction boreholes, 2003



rates from these boreholes have been reduced or abstraction from nearby boreholes has been discontinued, resulting in relaxation of the aquifer and leading to dilution of localized upconed saltwater.

However, past hydrogeological studies on the sea-level aquifers indicated a complex relationship between abstraction rates and chloride content. Thus, the situation described above cannot be considered as a conclusive indication of the situation in all abstraction sources.

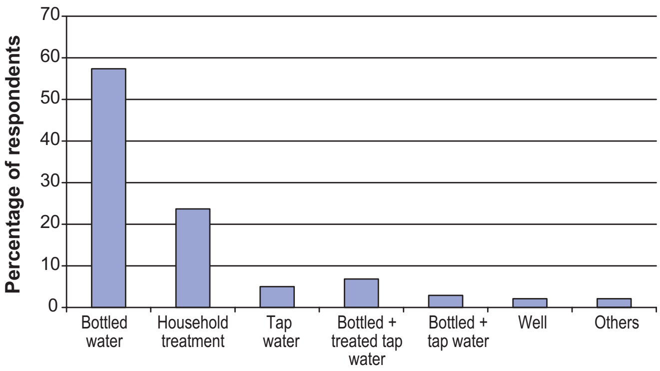
However, given the fundamental characteristics of the sea-level aquifer systems, changes in water quality are still a very good indicator of unsustainable localized abstraction of groundwater from the freshwater lenses. Additional evidence for unsustainable supply comes from research studies involving the profiling of the freshwater lens in deep boreholes, carried out jointly by the WSC and the MRA. These studies show a decline in the overall volume of Malta's sea-level aquifer along with the formation a much wider mixing boundary. The indications are that the lenses are reducing in both size and water quality.

The findings from research studies and monitoring by the WSC are supported by the observations of water users and the general public. These include:

- Farmers observing increasing problems of poor crop quality and yields as a result of deteriorating groundwater quality;
- Dwindling flows from springs.

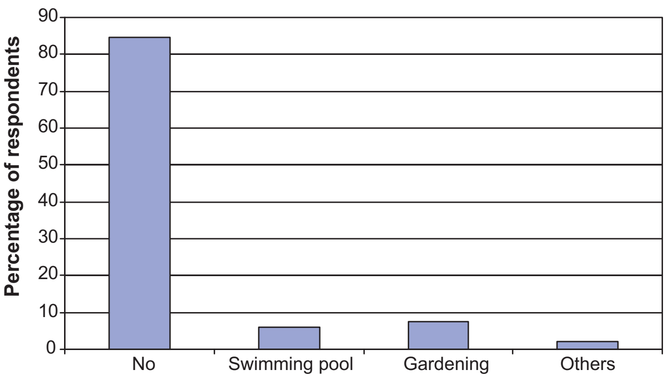
The overall conclusion is that demand is outstripping supply and that in many areas of the island a crisis has already been reached. If there is no reduction in groundwater demand from 2003 levels, the prognosis for the sea-level aquifers is extremely poor.

FIGURE 30
Preferred source of drinking-water



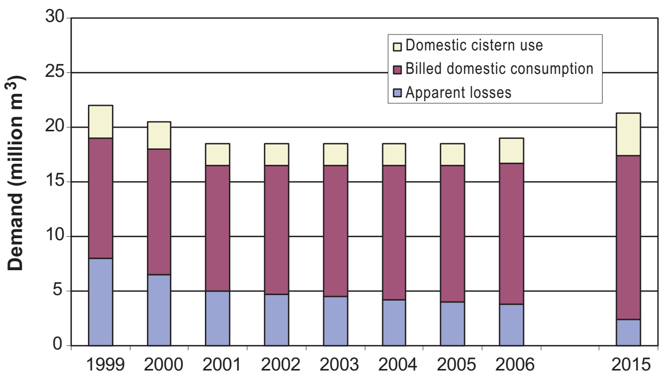
Source :MRA Water use survey 2005.

FIGURE 31
Usage of water for recreational purposes



Source :MRA Water use survey 2004.

FIGURE 32
Domestic water demand



DOMESTIC WATER DEMAND

The domestic sector has registered an increase in consumption caused by higher living standards. WSC figures indicate that the consumption of water exclusively for domestic purposes was 142 litres/person/day in 2000/01. This figure falls to 76 litres/person/day when losses and unaccounted-for water are taken into account. Modern housing and a heightened demand for better-quality drinking-water have indirectly created a market for new sources of water supply (Figure 30). 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. However, “swimming pool” demand is determined by the total physical volume of pools. MRA databases indicate a total number of about 3 500 registered pools in the Maltese Islands, with a total combined volume of about 250 000 m^3.

A number of in-house water sources have been “illegally” drilled recently and are being used exclusively for recreational purposes. A recent survey on water use found that about 14 percent of respondents “were using large quantities of water other than for domestic and hygienic purposes”, which were indicated as being swimming pools and gardening (Figure 31).

Figure 32 shows the current and projected demand for water supplied to domestic users by the WSC. These figures do not include real losses (e.g. water lost as leaks, illegal connections, etc.) but take into account a proportional volume of apparent losses.

Figure 32 takes account of discussions on domestic demand that involved staff from the WSC. The figure illustrates the following points:

- In recent years, domestic demand has been relatively stable at about 17 hm^3 per year.

- Although tariff increases may dampen overall demand temporarily, demand is expected to increase steadily in the next ten years.
- The proportion of domestic demand that is met from water harvesting into cisterns is expected to increase. The rate of increase will be influenced by tariff increases and availability of incentives.
- Apparent losses have been falling and, with the introduction of new billing arrangements, further decline is anticipated.

Given the deterioration in groundwater quality, it seems likely that an increasing proportion of domestic water demand will be met from RO plants or further treatment (desalination) of abstracted groundwater. The limit of this process of substitution will depend on the rate of deterioration of the sea-level aquifers and whether or not a policy of regulating groundwater demand is introduced (Figure 33).

FIGURE 33
The Malta Environment and Planning Authority – policy and design guidance 2004

Rainwater runoff should be collected and recycled (for those uses which do not require potable water). This applies both to residential and non-residential development, where the collected runoff may be a useful resource. Collection also reduces the amount which needs to be dealt with by the storm water drainage system and so may have wider benefits. Plans submitted with application should show the proposed location of the water cistern.

All new development shall be provided with a water cistern to store rainwater runoff from the built up area. The volume of the cistern (in cubic metres) shall be calculated by multiplying the total roof area (m^2) by:

(a) dwellings – × 0.3;
(b) villas – × 0.45;
(c) industrial and commercial buildings – × 0.45;
(d) hotels – × 0.6.

The design of non-built development which paves or hard surfaces large areas should also take into consideration the provision of water catchment for surface water runoff.

For larger scale development, the authority may require the submission of details on how the water collected is to be used.

There is considerable scope for increased use of household cisterns in the Maltese Islands. However, an increase is only likely if tariffs are set at a level that encourages users to switch to alternative sources. Introduction of fiscal incentives would also encourage uptake among users with existing properties (as opposed to properties under construction, which are obliged to construct cisterns). The increased use of cisterns makes service delivery more complicated as demand for WSC water can be expected to increase substantially in low rainfall periods, when the potential for harvesting water is much reduced.

In terms of reducing pressure on aquifers and allowing a strategic reserve to be established, the WSC is in the position of being able to substitute pumped groundwater with RO water. Thus, unlike agricultural users, the WSC has an alternative source of supply (or “safety net”). However, strategies that involve reduced groundwater abstraction and increased RO production involve additional costs, which will be passed on to users in the form of increased water tariffs or taxes. The question, which requires political debate, is whether or not some fiscal pain before the aquifers deteriorate further is better than the much higher fiscal pain that can be anticipated if the aquifers do deteriorate further.

AGRICULTURAL WATER DEMAND

Agriculture’s share of the GDP for Malta is about 2.5 percent. 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 cost of land, scarcity of water resources, and high labour costs.

The total number of registered tenants of agricultural land was 11 444 in 2000. Of these, 974 were full-time farmers and 10 426 were part-time farmers. An analysis of agricultural land shows that the total area of agricultural land (inclusive of dry, irrigated and garigue land) decreased from 20 500 ha in 1955 to about 11 600 ha in 2000 (Figure 34). 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

FIGURE 34
Land cover distribution in the Maltese Islands, 2000

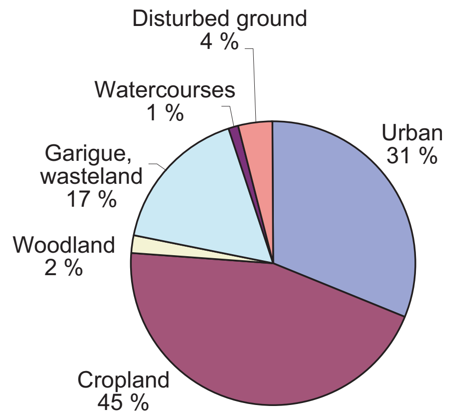
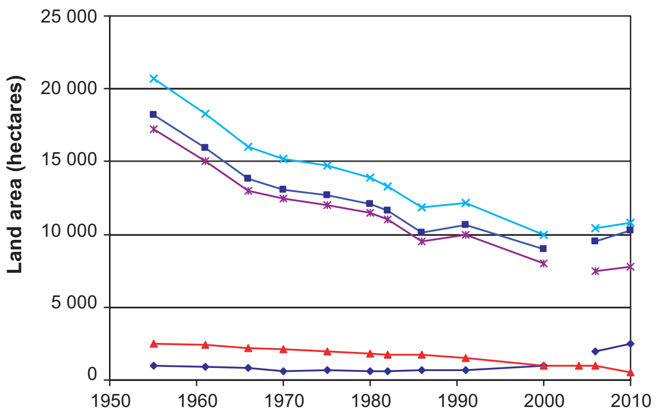


FIGURE 35
Agricultural land-use development in the Maltese Islands



spring, is served by second-class water or water supplied by other sources) from the 816 ha registered in 1955 to the 1 508 ha 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 Farm Structure Survey, carried out by the National Statistics Office (NSO) in 2003, showed an increase in agricultural land area for the first time since 1955. This increase was almost entirely at the expense of the garigue/ wasteland. In fact, while the total for agricultural land increased marginally to 11 680 ha, utilized agricultural land showed increased from 10 150 ha to 10 350 ha while the garigue/wasteland decreased by about 150 ha (Figures 35 and 36). This change was probably brought about by the land-based subsidies on agricultural investment from the EU that became available in 2003.

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 agriculture sector. The main points of interest from these negotiations are:

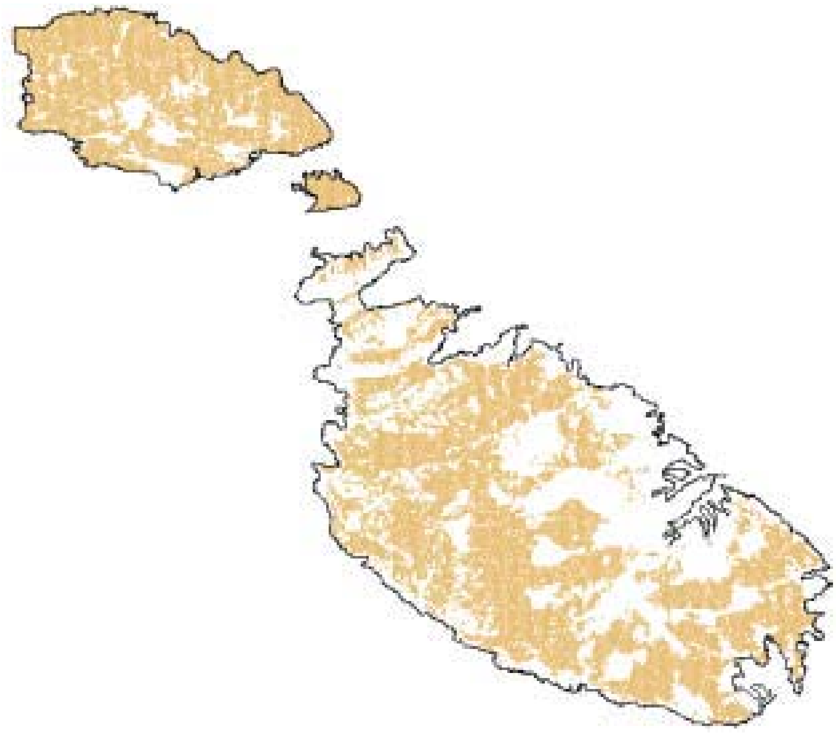
- The EU agreed that the base area applicable to Malta for arable crops would be set at 4 565 ha.
- The EU accepted that Malta should be granted new planting rights for the production of quality wines up to a total planted wine area of 1 000 ha.
- The national guaranteed quantity of olive oil for Malta was set provisionally at 150 tonnes (requiring between 50 and 75 ha of olive plantations).
- An area of 1 800 ha was indicated for the cultivation of potatoes.

Assuming that the utilized agricultural land area remains constant, attaining these thresholds will result in net irrigated land increasing to about 2 250 ha. 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.

Figure 37 shows historical, current and projected irrigated water use on the Maltese Islands. The main concern is that the proposed expansion in agricultural demand will not be achievable without further deterioration of water quality in the sea-level aquifers. As presented in Table 9, the strong likelihood is that irrigated agriculture is going through the "boom and bust" cycle seen in many parts of the world where irrigated expansion has been based on unsustainable groundwater abstraction. The major questions are whether immediate improvements in water-resource planning can

FIGURE 36

Distribution of agricultural land in the Maltese Islands

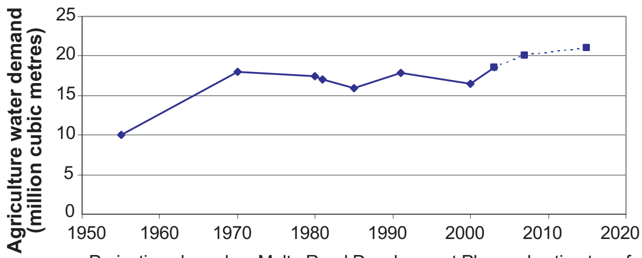


prevent the "bust" occurring at all and whether the most severe impacts of a "bust" can be mitigated. The important factors are:

- the extent to which unconventional water sources can substitute for the demand for groundwater;
- whether or not the cost of unconventional water sources will enable irrigated agriculture to remain profitable;
- the extent to which an improved water policy can have a very rapid impact on water use by individual agricultural users and the sector as a whole.

FIGURE 37

Historical, current and project irrigated water use on the Maltese Islands



Projections based on Malta Rural Development Plan and estimates of irrigation increases driven in part by Malta's accession to the EU. Details of methodology and assumptions are described in Hoogeveen (2004).

Table 9 is a rather simplified description of the four stages of Malta's groundwater development. As described, Stage 4 is an optimistic description of the future if an effective water policy is implemented.

Figure 38 shows estimated average monthly irrigation requirements. Demand is highest during the summer months. The uneven nature of monthly irrigation demand complicates the challenge of increasing the use of TSE for irrigation. As TSE production is continuous throughout the year, it may be necessary to create surface storage for TSE or use TSE as a source of water for artificial recharge when irrigation water requirements are low.

TABLE 9
Simplified view of stages in groundwater development in Malta

	Stage 1 (Hundreds of years up to the early 1980s)	Stage 2 (Early 1980s to mid-2000s)	Stage 3 (Mid-2000s to late 2000s)	Stage 4 (Late 2000s onwards)
Stages	Low-level of irrigation meeting local demand for vegetables, olives, grapes, wine, etc.	Agrarian boom prompted initially by availability of drilling technology and subsequently sustained by EU-accession land-based subsidies. Large increase in area under olives and vineyards.	Symptoms of groundwater overexploitation increasingly apparent and starting to affect yields and crop quality.	Decline in overall groundwater use. Increased use of unconventional sources for irrigation.
Characteristics	Total irrigated area less than 500 ha. Use of spring water for irrigation and gradual development of the perched aquifer using shallow wells.	Total irrigated area increased to more than 2 500 ha. Large increase in use of supplemental irrigation. Deep boreholes used to exploit sea-level aquifers.	Peak reached in irrigated area and agricultural water use as a result of declining groundwater quality and introduction of regulations and tariffs.	Low-value crops no longer profitable. Area under irrigation declines. Agri-environment planning becomes the norm.
Impacts and sustainability	High-level of sustainability. Some decline in water levels and spring flows from perched aquifer. Onset of a nitrate pollution problem.	Unsustainable use of groundwater and high levels of pollution as a result of intensive livestock production and high levels of fertilizer use.	Impacts of groundwater regulation, awareness campaigns and improved planning starting to have an impact on sustainability.	A balance achieved between groundwater inflow and outflow. A strategic reserve created. Water quality improving steadily.
Interventions	Limited government support. No groundwater regulation.	Protected local market. No groundwater regulation. Financial support for activities that increased agricultural output and water demand.	Local market not protected. Groundwater regulation (including tariffs) and catchment planning introduced.	Adaptive management of groundwater becomes the norm. Good environmental awareness established at all levels.

Source: After IWMI (2005).

It is estimated that the agriculture sector is meeting about 80 percent of its demand from groundwater while non-conventional sources such as treated effluent and rainwater harvesting are only of marginal importance. In fact, from data collected during the 2001 agricultural census, it can be concluded that investments in rainwater harvesting have decreased substantially since 1997, possibly providing an indicator of the greater reliance of the sector on groundwater. The borehole drilling spree is normally associated with 1997.

The 2001 agricultural census registered about 9 000 agricultural reservoirs (Figure 39). A number of these reservoirs are currently being used to store abstracted groundwater. However, they can potentially be converted to store surface runoff and, thus, contribute to reducing the sectoral dependence on groundwater, particularly during the winter months. On a long-term basis, the total estimated storage capability of these reservoirs is about 2 hm³.

FIGURE 38
Estimated monthly irrigation demand

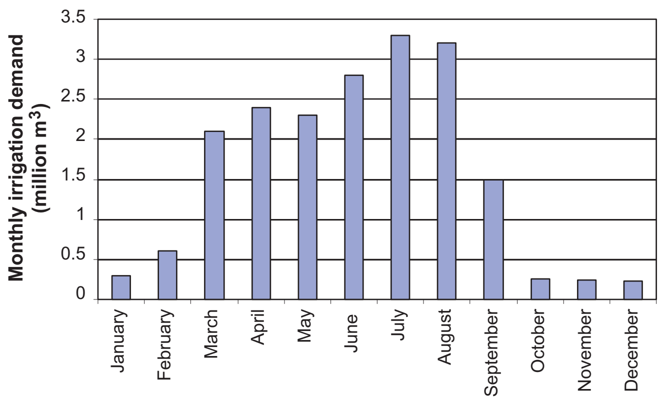
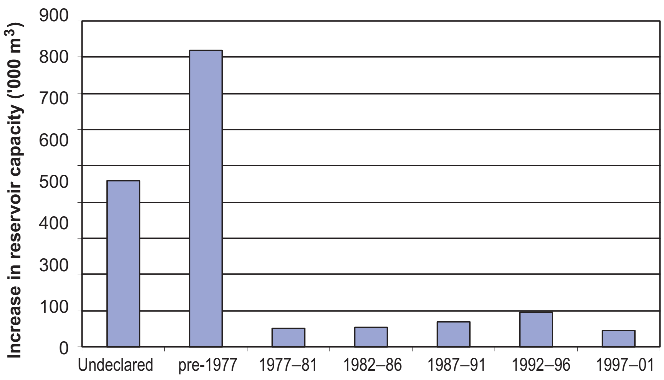


FIGURE 39
Increase in agricultural reservoir capacity



The demand of the sector (either the current 18 hm³ or the projected 21 hm³) cannot be met by groundwater alone. Other sources must be brought into play – treated effluent and rainwater harvesting in particular. More efficient methods of groundwater management, such as supply augmentation measures involving aquifer recharge with excess treated effluent and rainwater runoff, should also be considered. Thus, in the long term, unless the demand generated by the agriculture sector is met through the involvement of unconventional sources, the current levels of agricultural activity cannot be maintained.

Apart from groundwater, treated effluent is the only source of freshwater that is available all year round in significant quantities. Annual TSE production is estimated to reach about 14 hm³ by 2008. TSE will be available in almost constant monthly volumes. Thus, a significant volume produced during the winter months will not be utilizable, being in excess of the periodic demand. This water can either be stored (and the cost effectiveness of constructing large reservoirs is questionable), used for recharging the aquifers, or discharged into the sea. At current estimates, only about 6 hm³ of TSE can be potentially utilized owing to the disjuncture between availability and demand (Figure 40). Thus, the excess TSE is expected to be about 7 hm³, considering usage of about 0.5–1 hm³ by the industrial sector. If this excess TSE were used for recharging the aquifers, this would increase the abstractable proportion of groundwater in the long term, thus, ultimately increasing the sectoral quotas.

The 6 hm³ of potentially usable TSE requires substantial investments in distribution facilities in order for it to be available where and when needed. The utilization of TSE for different applications must be treated with caution and with full consideration

FIGURE 40
Correlation of irrigation demand with availability of unconventional water sources

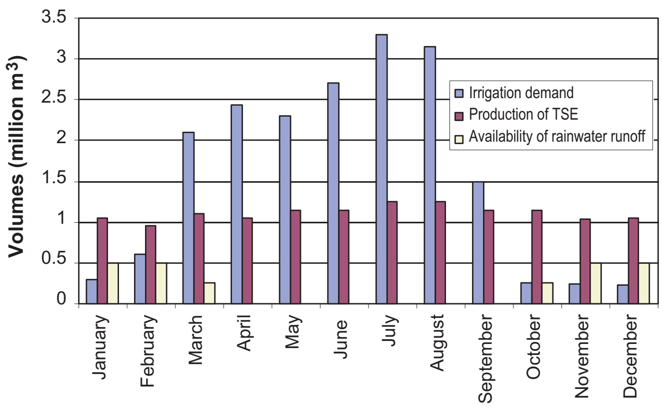
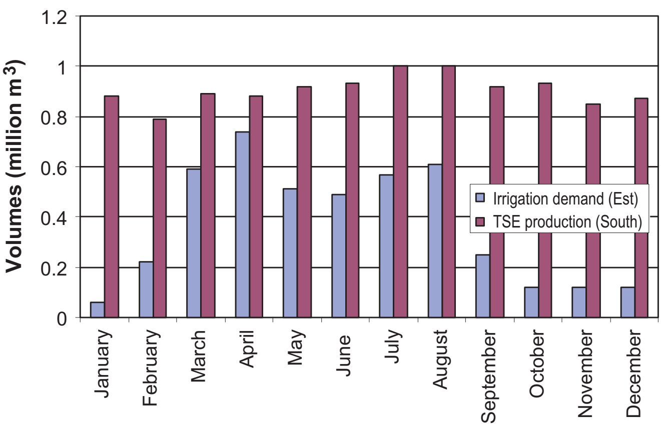


FIGURE 41
Correlation between irrigation demand in the southeast and the volume of TSE produced by the Malta South plant



of public health issues. Any type of application involving the infiltration of TSE into the ground, as in the case of irrigation, is thus constrained by hydrogeological conditions, the quality of the effluent, and the cost of treatment. Other constraints on TSE usage involve the cultivation of crops that "can be eaten raw" for which effluent use is not recommended.

TSE utilization is further constrained by the centralized location of the treatment plants. It is expected that the TSE produced during the summer months in the Malta North and Gozo plants will be utilized fully as the plants (particularly Malta North) are located in the middle of agricultural areas. However, production from the Malta South plant is expected to exceed the demand in the southern region.

Agricultural areas in the region of the Malta South plant have a current water demand of 2.7 hm^3, projected to increase to about 3.3 hm^3 by 2010. In fact, a correlation of TSE production in the Malta South plant with the irrigation demand in the region (Zabbar, M'Scala, Zejtun, Xghajra and Kalkara local council areas) shows that the supply is expected to exceed demand throughout the whole year (Figure 41).

Considering the long-term scenario, this would leave about 1.7 hm^3 of excess TSE production in the Malta South plant during the summer months. The usable TSE from the Malta North and Gozo plants (about 1 hm^3) faces the same "distribution" problems. However, the volumes in question are quite within reach of the carrying capacity of water hawkers in Malta – practically producing a "legal" market for their service.

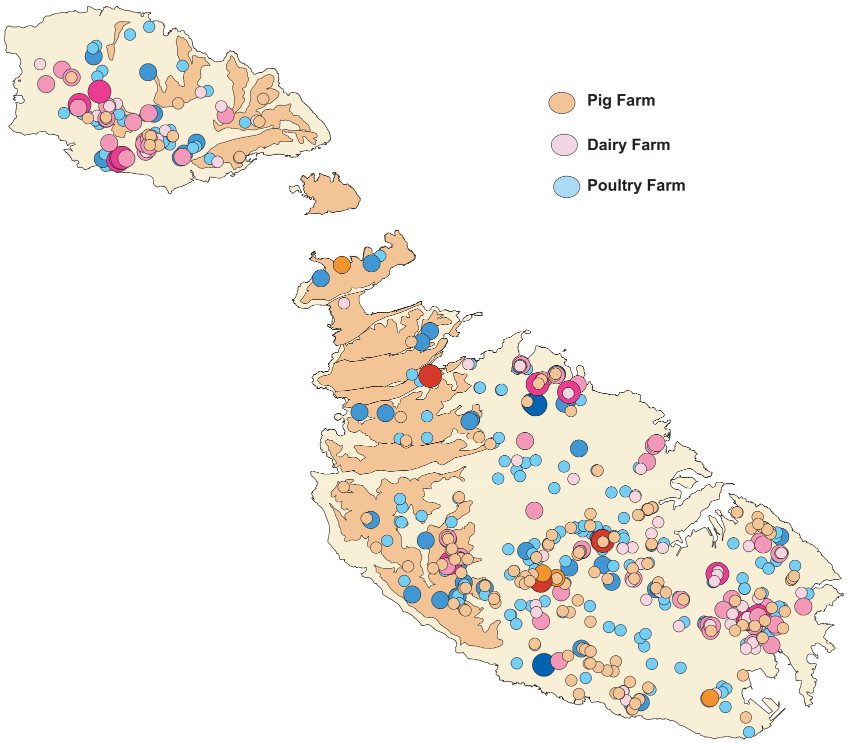
LIVESTOCK WATER DEMAND

According to NSO data, there are 260 dairy and beef cattle farm units in Malta and Gozo (Figure 42). Most of the farms (about 55 percent) are not specialized and are engaged in both milk and beef production. The cattle herd on the islands was established at about 18 000 head (Table 10). The breeding stock totalled 11 989 head, of which 9 306 were milk cows.

There are 174 pig farms in the Maltese Islands, of which 138 are production units, 18 are fatteners, 16 farms are engaged in both activities, and another 2 farms are involved in other activities. The pig stock amounted to about 73 000 animals.

In Malta there are about 1 100 breeders of sheep and goats with a total herd of about 15 000 sheep and 5 500 goats. Most of these are small farms concentrated in rural areas and operated as a small cottage industry. The number of poultry animals is estimated

FIGURE 42
Distribution of pig, cattle and poultry farms in Malta



Source: MRA.

TABLE 10
Annual water demand by animal category, 2003

Animal category	Number of animals	Daily water demand (litres/day)	Annual demand (m³)
Pigs	73 067	Summer: 20.25 Winter: 13.5	450 000
Cattle			
Calves 1 year	4 909	Summer: 139.5 Winter: 94.5	209 500
Cattle 1-2 years	4 983	Summer: 182.25 Winter: 137.25	290 500
Cattle 2 years	8 093	Summer: 195.75 Winter: 150.75	511 800
Total	17 985		1 011 800
Sheep	14 861	Summer: 18.0 Winter: 13.5	85 500
Goats	5 374	Summer: 18.0 Winter: 13.5	31 000
Rabbits	55 254	Summer: 3.0 Winter: 1.5	45 000
Poultry			
Layers (others)	756 288	Summer: 0.36 Winter: 0.32	94 000
Broilers	1 184 157	Summer: 0.22 Winter: 0.28	108 000
Total			202 000
Equine	853	Summer: 58.5 Winter: 49.5	16 800
Total			1 842 100

Note: The daily water demand per animal includes drinking and the corresponding amount for cleaning the shed.

FIGURE 43
Distribution of water demand for animal husbandry, 2003

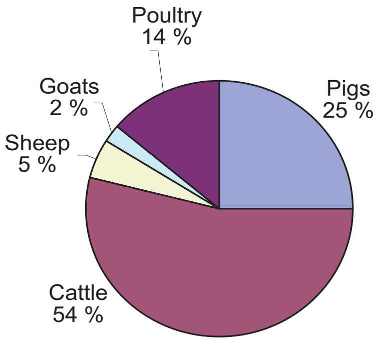


FIGURE 44
Decrease in water demand due to water recycling

- In Malta, large volumes of water are used during silicon wafer cutting. In the slicing process, silicon dust is too fine to be captured by traditional filters. The site installed a microfiltration unit to remove the fine particles and the water was then further purified by passage through ion-exchange resin columns. Water is then sufficiently clean to be recycled for operations requiring extremely high purity water. As a result, the use of city water was reduced by some 13 000 m^3 per year.
- The Malta site also recycles waste brine which is discharged by the plant's Electrodialysis Reverse (EDR) water purification system. EDR is a system in which a potential difference is applied to remove 80 percent of salts from the mains water. The concentrate waste is filtered and chlorinated and is suitable for non-potable use in toilet flushing, for instance. Through this means, city water consumption dropped by a further 6 500 m3.
- In 1998, the Malta site made a major effort to recycle waste water from its electroplating operations. A new design using ion exchange resins recovers metals from electroplating water. This is followed by a reverse osmosis system to further purify the water.
- Other water conservation strategies set up by Malta include the installation of a rainwater capture and recycling system. In 1999, the facility reduced its consumption from city mains from 183 000 m^3 for the year down to 48 000 m^3 – a remarkable reduction of 73 percent.

Source: ST-Malta Web site.

at 5 500 000, the number of rabbits at 2 400 000, and the number of horses at about 850.

The most important environmental implication of livestock farming is the generation of animal waste, and its disposal in a manner such as to prevent contamination of the freshwater aquifers, drinking-water supplies, bathing water, air and soil. If managed properly, animal waste can become an important nutrient resource of economic value.

Estimates for the billed potable water supplied through the public distribution system amount to a total of 1 822 premises classified as "farms" for the period 2003/04 amounted to about 7 percent of the total billed potable water consumption for this period (Figure 43). Annually this amounts to 1.3 Mm^3. Thus, comparing demand to billed supply indicates that the animal husbandry activities are acquiring about 75 percent of their water supply from the main distribution system, with the other water source most probably being groundwater.

INDUSTRIAL WATER DEMAND

The industrial sector accounts for about 8 percent of the total water demand in Malta. Water efficiency and water recycling (Figure 44) 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 (particularly batching plants) and the food and beverage industry (bottlers) are the concerns that are most dependent on groundwater in this sector. However, no appreciable expansion is envisaged. Thus, the sectoral demand for groundwater will most probably remain stable. Fiscal incentives should be promoted in order to reduce this dependence through runoff harvesting and recycling.

With the possible availability of increased volumes of TSE, further use by the industrial sector of this source is a possibility, also in view of the fact that the Ricasoli, Marsa and Bulebel industrial estates are all within range of the new Malta South plant. Currently, industry in the Bulebel region meets part of its water needs from the TSE produced at the Sant' Antnin sewage treatment plant. The annual volume of treated effluent supplied is relatively stable and in 2003/04 amounted to just more than 500 000 m^3.

In 2000/01, the WSC started an exercise in which consumers were classified in sectors according to categories used internationally. The classification was based on the Classification of Economic Activities in the European Community (NACE).

The resulting distribution is shown in Table 11.

The classification according to the NACE shows that the industry concerned in the manufacture of food products, beverages and tobacco is the major user of water in the industrial category, using about 58 percent of the total billed water consumption in this sector.

An analysis of these data shows that the mining and quarrying industry used about 0.2 percent of the total billed consumption (Figure 45), which works out to an annual figure of 36 000 m^3. Industrial statistics for Malta show the production of ready-mix concrete to be somewhere between 250 000 and 350 000 m^3/year. Assuming a water requirement of 0.25 m^3 for every cubic metre of concrete produced and a grossly inefficient process with 100-percent losses would result in an annual demand for this sector of 125 000–175 000 m^3. To this must be added the volumes of water used in the manufacturing of prefabricated concrete units, which, using similar assumptions, is estimated at about 40 000 m^3. This indicates that the mining and quarrying industry could be acquiring about 16–22 percent of its water requirement from the official distribution network, and with the remainder being obtained from groundwater.

TABLE 11
Water consumption according to the NACE (WSC interim results)

Category	Consumption (%)
Non-commercial	61.60
Agriculture, fishing, hunting and forestry	2.30
Mining and quarrying	0.10
Manufacture of food products, beverages and tobacco	9.30
Other manufacture	4.10
Electricity, gas and water supply	0.50
Construction	0.10
Wholesale and retail trade	0.70
Hotels and restaurants	10.40
Transport, storage and communication	1.10
Public administration and defence; compulsory social security	0.60
Education	0.70
Health and social work	3.60
Other community, social and personal service activities	1.60
Other (business activities, financial intermediation, etc.)	0.40
Consumption still unclassified	2.89
Total	100.00

FIGURE 45
Distribution of water use by industry

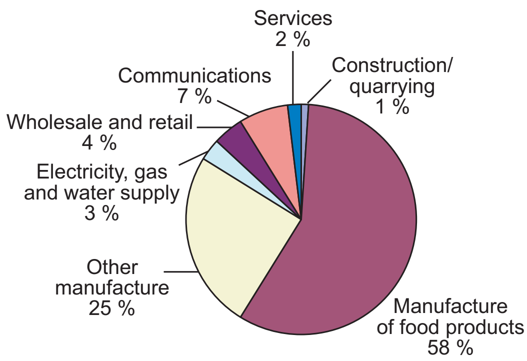
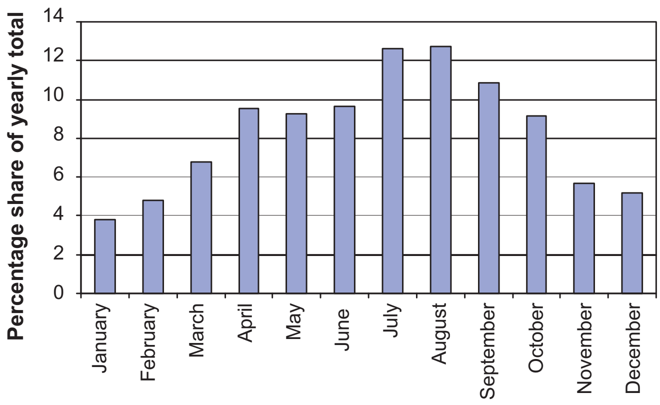


FIGURE 46
Percentage share of tourist arrivals by month in 2000



TOURISM WATER DEMAND

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. In the same period, tourist accommodation increased to 40 688 beds with a further 7 500 beds in holiday apartments. Tourist arrivals peak in the summer months of July and August and place additional strains on water resources (Figure 46).

The WSC estimates that tourism activity accounts for 10 percent of water consumed. Table 12 presents the demand for water by the tourism sector. The table presents estimated figures based on

TABLE 12
Water demand by tourism for the period 1997/98 – 1999/2000

	1997/98	1998/99	1999/2000
	(m^3)		
Total annual water production	40 772 926	37 963 808	36 604 128
Production to satisfy tourist demand	3 669 563	3 416 742	3 294 371
Per capita demand per day	0.324	0.293	0.321

Source: Azzopardi (2001)

FIGURE 47
Water demand management in hotels

The Radisson SAS By Point Resort produces over 45 000 gallons of water a day for its own use through an on site Reverse Osmosis Plant. The property is therefore self-sufficient and pulls practically no water at all off the national system. With the recurrent problems of water shortages on the Island the positive effect of such an investment is obvious.

In addition to this the property is also using a Dual Drainage System whereby water from the baths and wash hand basins within the guest bedrooms is filtered through a waste water treatment plant and pumped up for use in the toilet flushings. In this way the water is used twice. Any excess water produced is then stored and used for irrigating within the gardens of the Resort. Additionally, all rainwater catchment areas have been designed so as to achieve optimum levels of water collection

Source: Island Hotels Group Web site.

production levels. However, the billed consumption for tourist establishments for 2000/02 stood at 1.74 million m^3. This would mean that each tourist used about 149 litres/day of water.

These official figures for consumption of water by the tourist industry are low when compared with the situation in other Mediterranean countries. The corresponding official figure for Spain is 440 litres/day (with a maximum of 880 litres/day at tourist resorts) and that for Cyprus is 465 litres/day. These figures are inclusive of distribution network losses, and are reduced by about 300 litres/person/day when losses and unaccounted for water are eliminated.

The fact that the official demand figures for Malta are artificially low can be confirmed from other sources. It is customary for hotels with a bed capacity of 350–400 to install a 125-m^3/day RO unit (Figure 47). Assuming this RO unit to be the sole water supply for such a hotel yields a water production figure of 312 litres/bed/day.

These facts indicate that the tourist industry in Malta could be acquiring up to 50 percent of its water from sources other than the potable water network. These sources include in-house RO plants and private suppliers of groundwater (bowser operators).

Tourism demand should not increase appreciably in the near future as it has become cheaper for hotels (which are mainly situated near the coast) to install private RO units rather than buy water from hawkers or the WSC. The price per cubic metre from a hawker varies between LM0.6 and LM0.8 while an RO unit would produce the same amount for LM0.30–0.35. Moreover, the RO unit is a more reliable form of supply of better-quality water.

Therefore, any increases in tourism demand are expected to be met by private RO production, with the dependence of the sector on private groundwater sources gradually decreasing.

ENVIRONMENTAL WATER DEMAND

Groundwater is also essential to sustain terrestrial surface-water ecosystems. 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 aquifers 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.

Chapter 8
Economics of water

FINANCING

In 2003, 36 percent of the total cost of production and distribution of water was financed directly by government. In addition, bank loans undertaken for investment projects by the WSC are backed by government guarantees. Such loans amounted to LM9.782 million in 2002. The exposure of the WSC with the banks in loans and overdrafts amounted to LM31.836 million in 2002.

Government also finances the cost of collection and purification of wastewater. Owners of new buildings pay a contribution that covers the cost of connecting the premises to the sewage network. The MEPA receives 10 percent of these receipts and the rest is paid to government and not to the operators, i.e. the WSC. The capital and infrastructural cost of constructing the Gozo recycling plant is being financed from funds made available by the Italian Protocol. EU funding is being sought to upgrade the RO plants and other projects.

COSTS

The cost of producing and distributing tap-water in 2003 amounted to LM17.923 million. Turnover of LM11.486 million covered 64 percent of the total cost of production. The WSC is planning to spend LM450 000 to renew and upgrade the transfer mains connecting the Ta' Qali reservoir and the Luqa reservoir. The upgrade is intended to reduce the level of nitrates. Leak repairs cost the WSC LM104 000 annually. In 2004, these repairs resulted in a saving of 1.185 million m^3 of water. If these are costed at LM0.55 per unit, then the total savings made by the WSC amount to LM1.2 million.

The WSC is also proposing to refurbish and upgrade the desalination plants while addressing issues of water quality, security of supply, and costs. This investment will cost about LM33.86 million (about US$11.3 million at the current exchange rate). Such investment will:

- upgrade plant capacity from the present 67 000 m^3/day to 95 000 m^3/day;
- improve the water quality by reducing chlorides from 360 mg/litre to 200 mg/litre;
- raise power efficiency from 5.57 kWh/m^3 to 4.74 kWh/m^3.

The total operating costs of public collection and purification of wastewater amounted to LM3.6 million between January and August 2004. This statistic is inclusive of a depreciation charge of LM2 265. The WSC is conducting an audit to establish the costs of fixed and working capital.

Further investment is needed to continue operating the Sant'Antnin recycling plant. Part of these costs may be offset by a fall of 50 percent in the running costs once the WSC starts managing the plant. At present, the cost recovery is nil.

The cost of setting up the sewage treatment plants at Gozo, Malta North and Malta South is estimated at LM36.016 million (about US$12 million).

The cost of private abstraction for agriculture and industrial purposes is unknown.

PRICING

Water pricing has always been a sensitive political and social issue. Successive governments have followed a policy of supporting water consumption by households and of maintaining such water tariffs stable for several years at a stretch. This policy measure meant that the actual consumption of water by households was not conditioned directly by changes in tariffs because prices were held constant for successive periods. Thus, in the period 1987–1999, prices were changed four times. There were no price changes between 1987 and 1990 or between 1994 and 1996. Tariffs were raised to 109.03 in 1997 and 154.17 in 1998 and 1999 (1995 = 100).

The demand for water is price inelastic. The price elasticity of demand was estimated at -0.28 in the short run and at -0.37 in the long run. The higher value in the long run implies that households respond to a price change when they are given time to adjust their consumption patterns. At -0.28, the short-run price elasticity of household demand for water falls within the range observed for other countries.

WATER TARIFFS

Malta operates a rising-block water-tariff system, where successive blocks of water are sold at a higher price. Before 1994, the first block of 27 m^3 was free of charge. A service charge is paid regardless of the amount of water consumed (it includes a sewage charge). More favourable tariffs are charged to vulnerable consumers, such as persons receiving social assistance and pensioners. Such measures are in line with the WFD. Article 12a of the WFD refers to "an affordable price" in order to guarantee a basic level of domestic water supply. Table 13 lists the different water tariffs and service charges paid by the various economic sectors.

TABLE 13
Water tariffs as at January 2005

Type of consumer	Service rent	Consumption charge	Tariff per cubic metre (LM)
Domestic	LM12	0 33 m^3/person	0.165
		> 33 m^3/person	1.100
Social assistance	Free	0–16.5 m^3/person	Free
		16.5–33 m^3/person	0.165
		> 33 m^3/person	1.100
Agriculture & agrofood	LM24	0–6810 m^3	0.165
		> 6810 m^3	0.350
Personal health use in field	LM24	0–15 m^3	0.225
		> 15 m^3	0.600
Industrial	LM18		0.850
Food & beverage	LM24		0.600
Tourist flats	LM24	0–252 m^3	0.750
		> 252 m^3	1.100
Hotels	LM24	0–42 m^3/bed	0.900
		> 42 m^3/bed	1.100
Laundry	LM24	0–6810 m^3	0.750
		> 6810 m^3	1.100
Sea craft	LM24		1.100
Government	LM24		1.100
Boat house, garden & garages	LM24		1.100
Non-commercial	LM12	0–171 m^3	Free
		> 171 m^3	0.350
Commercial & other	LM12	0–33m^3	0.165
		> 33m^3	1.100

WILLINGNESS TO PAY

A survey carried out in August 2004 among 468 households in Malta and Gozo, showed that 60 percent of the households were not prepared to pay more than the current price (Table 13). The term "current price" stands for bills paid by households in recent months. These bills reflect the existing water tariffs and already include subsidies on water consumed, reflecting the particular household participating in the survey. Table 14 presents the data on households' willingness to pay.

Three percent of respondents considered the tariffs to be high and would be willing to pay less than the current tariffs. Respondents in a survey of industrial units operating from the Bulebel Industrial Estate, and the beverages, services and tourism sectors also claimed that the present tariffs are high and some argued they could produce RO water more cheaply at LM0.25/m^3.

TABLE 14
Willingness to pay: water tariffs in Malta

Multiple of tariff	Number of respondents	Percent
Five times	8	1.7
Three times	9	1.9
Two Times	39	8.3
One and Half Times	96	20.5
Twenty percent more	18	3.9
Current Price	271	58.0
Less	13	2.8
No reply	14	2.9

Source: Water Surey (2004)

WILLINGNESS TO PAY FOR RECYCLED WATER

Some 46 percent of Maltese households will consider using and paying for recycled water provided that its quality is "guaranteed" safe for health purposes (including use for gardening and other domestic uses). Some respondents emphasized that they are not willing to pay for any additional infrastructure costs that the water suppliers may have to incur for distribution. Those households that already resort to water bowsers to obtain water indicate that they will be willing to consider buying recycled water provided that it is cheaper than the price they are currently paying.

REVENUE COLLECTION

In 2003, the WSC recovered 64 percent of the cost of producing and distributing tap-water. In 2004, the WSC undertook a massive campaign to collect arrears due to it. Customers who fail to pay for arrears due within a stipulated date will have their services discontinued. This campaign is having a positive effect on the cash flow of the WSC. In November 2004, the government announced its intention to introduce a surcharge of 17 percent on water and electricity bills. Discussions are underway at the Malta Council for Economic and Social Development on the implementation of this surcharge and its impact on household consumption and industrial production. In line with government policy, families in the social case category are exempted from payment of such surcharges.

VALUE OF WATER

Water as an intermediate input varies from one industrial sector to another. According to official input–output data that rely on billed consumption data, the demand for water is relatively low in relation to output. It falls in the 0.1–0.45-percent bracket for most industries, that is out of every LM100 worth of output, the outlay on water ranges between LM0.10 and LM0.45. For the electricity-generating sector, it is LM1.65 per LM100; for services and tourism, it is LM1.46. In agriculture, the share of water in output is LM2.40 per LM100. However, the exact value of water in use is not known. Industrial units in manufacturing and the leisure sector are known to utilize additional sources of water. For example, water is abstracted from boreholes or privately produced mechanically. Research is being carried out to establish the volume and value of such water.

ECONOMIC INCENTIVES AND PRICING PRINCIPLES

In the past, public authorities in Malta focused on the social implications of water-pricing policies and on ensuring a regular water supply for homes and industry. There was no systematic attempt to encourage water conservation, as such, via a pricing system that made it worthwhile for consumers to avoid unnecessary consumption. The government subsidized water use as a matter of policy. Moreover, in industry and agriculture, producers ensured their regular water supply through extraction, at times even illegally. It is only in recent months that there has been a greater awareness of the need to use water optimally and channel the consumption of this resource to its highest economic value. Indeed, the drive by the WSC to collect outstanding bills due is a sign of the determination to introduce accountability in water consumption. This is the first step towards generating an effective cost-recovery system and introducing widespread conservation attitudes and habits.

Chapter 9
Options and opportunities for improved water management

CONSTRAINTS ON IMPROVED WATER MANAGEMENT

Constraints that should be considered in the development of Malta's water policy and that limit the number of resource-focused options include:

- Climate: The climate of the Maltese Islands is semi-arid and, consequently, rainfall is extremely variable in time and space. Hence, groundwater recharge and runoff into cisterns is also extremely variable, as is the productivity of rainfed arable and non-arable lands. It is this variability that makes access to irrigation so important to the agriculture sector.
- Extreme events: Meteorological drought and floods are recurring natural phenomena. Estimates of sustainable annual aquifer yield must consider the probability of prolonged periods of drought. Similarly, rainwater-harvesting strategies need to consider potential damage to structures from flooding and the technical and economic viability of harvesting runoff resulting from large intense-rainfall events.
- Aquifer characteristics: The two main aquifer types in Malta, namely the perched and the sea-level aquifers, have distinctly different characteristics and levels of vulnerability.
- The "desalination" safety net: By decreasing the dependency of domestic users on groundwater, desalination plants have reduced the political imperative for long-term protection of the aquifers. Arguably, it is only the agriculture sector that has a high-level dependency on sustainable access to groundwater of adequate quality. To put it another way, farmers growing low-value crops do not have the safety net that is afforded to other water users who have the ability to pay high water tariffs.
- Awareness: Although there is increasing concern among some farmers that overextraction may be damaging the sea-level aquifers, there is generally poor awareness of the current poor condition of the sea-level aquifers and the consequences of their continued mismanagement.
- Water governance: There is scope for improvement in all aspects of water governance. Decision-making is fragmented and policies that affect water supply and demand are poorly aligned.
- Poor-quality information: Much water-related decision-making is based on data that are incorrect and/or out of date. There are also discrepancies between water-related information held and/or published by different organizations.
- EU water directives: While Malta's water policy should be tailored to the needs and the specific characteristics of the demands and the resources available, accession to the EU places some constraints and pressures on the Maltese authorities.
- Water-related myths: A number of water-related myths have become accepted wisdom at all levels in Malta (Box 1). Subscription to these myths can lead to poor decision-making, ineffective policies and a waste of financial and human resources. Without an effective awareness campaign, subscription to these myths is likely to undermine support for a water policy and affect its implementation.

BOX 1
Water-related myths

Water-related myths that are widely held in the Maltese Islands include:
- Salt is filtered from seawater as it passes through the limestone geologies that underlie the islands. The logic is that saline intrusion does not occur when groundwater depletion takes place and, hence, the quality of water in aquifers will not deteriorate as a result of overextraction.
- Aquifers under Malta are replenished by groundwater systems that are linked to the Nile River and/or Continental Europe. This myth is also linked to the concept that the aquifers can provide an unlimited source of freshwater.
- Water quality improves with depth of borehole. This myth is still held by many despite increasing failure of deeper boreholes as a result of deteriorating water quality.
- Crops grown with TSE are of inferior quality. In particular, there is a belief that these crops have a shorter shelf-life than those grown with untreated water. However, more justifiable concerns on the use of TSE also exist.

RISKS TO THE SUCCESSFUL INTRODUCTION OF IMPROVED WATER MANAGEMENT PRACTICES

Risks and assumptions that are inherent in the proposed water policy include:
- Reversibility of aquifer degradation: It is assumed that a reduction in groundwater extraction will lead to an improvement in water quality to acceptable levels. The risk is that in some areas this may take longer than anticipated.
- Climate change: While there is no compelling statistical evidence of climate change affecting the water resources of the Maltese Islands, there is a risk that climate change will become a serious issue in the future.
- Equity: Implementation of the water policy will almost certainly lead to changes in patterns of water availability and use that may result in distinct winners and losers and reduced equity. If there is a risk of this happening, conflicts should be managed by ensuring that losers are compensated.
- Impact on livelihoods: In order to be effective, the water policy must have an impact on the water demand of the water-using sectors and individual water users. While there is scope for many users to make more efficient and productive use of water, and thereby to reduce their overall demand, there is a risk that there will be negative impacts on some commercial operations and the livelihoods of some users. Attempts should be made to minimize impacts on poorer social groups.
- Non-compliance: There is a history of poor compliance with water-related regulations. Even a perfect water policy will fail if the resources and political will do not exist to enforce it.

OPTIONS AND OPPORTUNITIES

Table 15 lists 20 options and opportunities for improving water management.

TABLE 15
Options and opportunities for improving water management

Options/opportunities	Main components	Potential nature & scale of impact
Improved awareness of the characteristics and vulnerability of Malta's water resources and the potential consequences of different courses of action	Carefully targeted and structured awareness campaign for decision-makers at all levels Educational campaign in schools	Islandwide long-term impact on decision-making at all levels Higher levels of collective responsibility for the management of water resources
Improved access of all stakeholders to quality-controlled water-related information	Establishment and management of a common water-related information base including consensus building among stakeholders on the status of water resources	Islandwide long-term impact on decision-making all levels Improved stakeholder dialogue as using the same information as a basis for discussion
Improved policy-level water governance	Alignment of policies that have the potential to affect the supply of or demand for water resources Apolitical approach to long-term water resource planning Regulatory systems that have more independence from government	Islandwide impact at the policy level Policies that no longer promote groundwater use in excess of sustainable levels Emphasis on long-term planning
Improved strategic water governance	Alignment of planning processes that have the potential to affect the supply of or demand for water resources	Groundwater extraction will be reduced to and maintained at sustainable levels Introduction of EU WFD catchment-planning procedures
Establish water governance arrangements that facilitate greater involvement of stakeholders in water resources planning and management	Establish a stakeholder platform that includes representatives from all the main sectors and that holds regular meetings and consultations	Better involvement of stakeholders in decision-making processes Better ownership of plans, regulations, etc.
Immediate regulation of users of groundwater who are damaging the integrity of the sea-level aquifers	Identification of deep boreholes and/or boreholes from which there is a high rate of abstraction; fitting of meters and issuing of licences	Reduction in localized upconing of seawater into the sea-level aquifers Potential for slow recovery in the water quality of sea-level aquifers
Staged regulation of all groundwater users	Registration of all boreholes, issuing of licences, introduction of tariffs and other relevant demand-management instruments Costs of implementing the regulatory system are recovered	Reduction in groundwater use to sustainable levels Allocation of water to uses that have the highest social, environmental and economic value Promotion of efficient and beneficial use
Improved regulation of all activities that have the potential to pollute surface and groundwater resources	Identification of polluters and polluting activities Enforcement of polluter pays principle	Improvement in surface-water and groundwater quality
Establishment of a groundwater strategic reserve	Relaxing groundwater extraction for a period of time sufficient to allow a strategic groundwater reserve of acceptable quality to be established	This will reduce the risk of major disruption to the Maltese economy that might result from problems with RO production resulting from, say, a major pollution incident and shortage of energy for RO production
Pricing of TSE at an acceptable level, investment in infrastructure for better distribution of TSE and protection of aquifers from low-levels of pollution from TSE	Fixing the price of TSE at a level that will enable profitable production of high-value crops and profitable commercial use Construction of an appropriate reticulation system Use of precautionary principle when deciding on areas/aquifers to be supplied with TSE	Relaxation of the pressure on groundwater by providing groundwater users with a substitute TSE source Users of groundwater currently faced with deteriorating groundwater quality have the potential to stay in business
Increased water harvesting in urban areas. Also increased water harvesting in rural areas wherever there will not be negative downstream impacts	Increasing use of well-designed and well-constructed local solutions (including cisterns) for making better use of runoff particularly during years with good rainfall Provision of fiscal incentives where appropriate	Reduced pressure on groundwater Cost savings to users that substitute harvested rainwater for water supplied by the WSC

TABLE 15
Options and opportunities for improving water management (Continued)

Options/opportunities	Main components	Potential nature & scale of impact
Strict regulation of activities likely to increase the salinity levels of drainage water	Banning of hotel use of seawater in dual plumbing systems	This will improved the quality of sewage effluent and reduce treatment costs
	Banning of the dumping of brine from small RO plants in drainage systems	Leaks of sewage into aquifers will have a lower pollution risk
Regulating the sale of groundwater	Licensing and imposing a charge for tankers selling water	Reduced pressure on groundwater
		This will reduce the use of tankers as a means of avoiding regulation based on block tariffs
Long-term protection of aquatic ecosystems and rare habitats	Planning procedures that give a high priority to maintaining rare and important ecosystems	In addition to being the right policy, this will help Malta meet obligations under the EU WFD
Improvement in conveyance efficiency (i.e. leak reduction)	Continued efforts by WSC to reduce water lost in the form of leaks, illegal connections, etc.	Reduced pressure on groundwater
		Reduced risk of pollution
		Better and more economic service delivery
Improved water-use efficiency by agricultural users	Improved irrigation and cropping practices leading to a reduction in demand by individual farmers and the agriculture sector as a whole	Reduced pressure on groundwater
Increased recycling of water	Tariffs and incentives are used to encourage relevant industries to install the necessary equipment to recycle water	Reduction in pressure on groundwater and reduced risk of pollutants leaving the relevant industries
	Tariffs and incentives are used also to encourage household-level reuse of water	Reduced costs for users
Use of agro-environment funds aimed at protecting aquifers	Range of practices include funding set-aside strategies or a more permanent switch from irrigated agriculture to rainfed land uses	Reduced pressure on groundwater
		Improvements in biodiversity and in scenic and touristic value of islands
Hotels are encouraged to install RO plants to meet the demands of any increase in tourism	Tariffs and incentives are provided to hotels to install RO plants	Reduced pressure on groundwater and the supply infrastructure during the summer months
Sufficient resources allocated to enable water law to be implemented	Staff and equipment are in place so that a regulatory system can be operated effectively and efficiently	This is a precondition for the successful implementation of a regulatory system
	Confidence is built among stakeholders that an equitable and just approach is being taken to implementing the regulatory system	

Chapter 10
Water demand scenarios and possible water supply strategies

THE WATER MANAGEMENT VISION

Most national water policies would state that the primary goals of the policy are:

- safe and secure drinking-water supply for the population;
- reliable water supplies to support a sustainable economy;
- protection of the water-dependent environment.

This would certainly hold true for Malta, but Malta cannot afford a generic approach to water policy. If the country is to be serious about reversing trends and restoring the integrity of its natural resource systems to the point where the primary goals are likely to be met, it needs a much sharper, more focused vision of what is possible in the short to medium term. The first priority is to restore public water-supply aquifers and remove volatility in groundwater supply. The second is to maintain a strategic reserve and minimize social and economic risks to Malta's economy that are inherent in a water-supply policy based on imported energy. The third is to achieve "good" status linked to commitments to the EU.

In order to be effective in reversing current trends, that vision would have to set targets achievable by 2015 that at the very minimum comprise:

- levels of groundwater and surface-water use regulated according to sustainable abstraction levels;
- sea-level and perched aquifers restored to a status that represents a strategic reserve (a figure of the equivalent to 18 months of demand has been proposed);
- water quality of all aquifers restored to within permissible limits;
- widespread use of local and decentralized solutions (e.g. rainwater cisterns, grey-water recycling, and pollution control);
- high levels of collective responsibility at all levels for managing and protecting Malta's water resources.

Achieving this vision will call for a mix of economic and regulatory measures to be applied, some as a matter of urgency. This chapter discusses a set of water supply and demand scenarios that are based firmly on the analysis of current trends. At the same time, different strategies are considered for each scenario that have the potential to achieve the vision described above.

WATER DEMAND SCENARIOS

It is assumed that a combination of the options and opportunities listed in Chapter 9 will form the backbone of a new water policy. In this section, attention is given specifically to "demand" scenarios and the possible water supply strategies for each scenario.

Four "demand" scenarios have been selected on the basis of information presented in this report and discussions with key stakeholders. Table 16 presents the "demand" scenarios along with various "supply" strategies for each scenario. The logic is that each strategy will be analysed in full view of its potential to achieve the overall vision identified above. Table 16 also summarizes the potential socio-economic implications of each demand scenario and supply strategy.

TABLE 16
Demand scenarios and supply strategies

Water demand scenarios	Potential demand scenarios based on current trends	Water supply strategies	Strategies for meeting current and future demands (i.e. 2015)	Economic/social implications
I	Municipal demand* remains fairly constant at current values or increases at about 1–2%/year while agricultural demand increases reaching a maximum not exceeding 21 hm^3 as projected**.	I	Agriculture is given priority over the use of groundwater and, consequently, the urban supply is increasingly sourced from RO plants.	The WSC has to source its supply increasingly from RO plants, with resulting price increases on the urban sectors. The quality of the domestic supply will increase. However, the country will be fully dependent on RO plants for the production of potable water – leaving the country vulnerable to fluctuations in the energy sector, oil spills, etc. Significant price increases in the industrial and tourism sectors would be expected to reduce their economic competitivity.
		II	No action is taken and groundwater abstraction remains unregulated.	Overabstraction will result in an increase in the salinity of groundwater abstracted from the sea-level aquifers and in the drying-up of perched aquifers in the summer period. Degeneration in quality will make groundwater unsuitable for direct utilization, and extra treatment costs will be incurred by all sectors in the long-term as groundwater becomes progressively unusable for all sectors.
		III	A reduction in groundwater abstraction is implemented in order to achieve a sustainable abstraction strategy allowing the setting up of a strategic groundwater reserve. The available abstractable groundwater quota is then allocated on a 50/50 basis between the WSC and all other users. Options involving artificial recharge of groundwater and improved rainwater harvesting will also have to be implemented in order to augment groundwater availability. Agri-environment schemes and smart irrigation techniques are used to encourage low-water-using farming systems.	The WSC will have to reduce the proportion of abstracted groundwater; while agriculture and industry will have to substantially increase the amount of recycled water used. Tariffs for the domestic/ commercial sectors will be utilized to manage the sectoral demand. Agriculture will have to absorb a proportion of the cost of treating sewage effluent - possibly additional costs of desalination on the effluent treated to tertiary level. Groundwater will be viewed as a national strategic resource and a strategic reserve will be established in the long-term. Although there will be a potential negative impact on the livelihood of some agricultural users, these will be outweighed by the potential benefits to the economy as a whole. In the long term, better groundwater quality will result in decreasing treatment costs for all sectors.
II	Municipal demand remains fairly stable at current values or increases at about 1–2%/year while the agricultural demand decreases to pre-EU Accession levels (of 15 hm^3/year) driven mainly by market forces.	I	Agriculture is given priority over the use of groundwater with the potable supply being increasingly sourced from RO plants. Effluent from wastewater treatment plants viewed primarily as an option to supplement water supply to the agriculture/industrial sectors, thus, further reducing the pressures on groundwater.	The cost of the WSC supply will increase, in proportion to the increased dependence on RO water which will be required in order to maintain potable quality standards.

* Municipal demand refers to the domestic, industrial, commercial and tourism sector demand.
** The projected increase of 1 percent in urban demand is expected to be countered by a similar decrease in system demand (i.e. leakages) at least in the medium term. Therefore, for the period under consideration, the total WSC demand (inclusive of leakages) is projected to remain stable at 34 hm^3.

TABLE 16
Demand scenarios and supply strategies (Continued)

Water demand scenarios	Potential demand scenarios based on current trends	Water supply strategies	Strategies for meeting current and future demands (i.e. 2015)	Economic/social implications
III	Municipal demand decreases to about 27 hm^3 because of significant investment in local water conservation and reuse; while agricultural demand increases, reaching 21 hm^3 as projected.	I	Agriculture is given priority over the use of groundwater and, consequently, the urban supply is increasingly sourced from RO plants. Treated effluent is used in agriculture to address possible regional overexploitation of groundwater.	The WSC has to source its supply from RO plants with resulting unit price increases on the urban and economic sectors. Although the increased unit price of the supply will not be fully reflected in water bills owing to the smaller volumes consumed. The chemical quality of the domestic supply will also improve significantly. However, the country will be fully dependent on RO plants for the production of potable water. This strategy is the least dependent on groundwater.
		II	A cut-back in groundwater abstraction is implemented in order to achieve a sustainable abstraction strategy allowing the setting up of a strategic groundwater reserve. Available groundwater is then allocated between the WSC and all other users. Because of the projected decrease in treated effluent availability, the proportion of groundwater allotted to agriculture should exceed that allotted to the WSC. Options involving artificial recharge of groundwater and improved rainwater harvesting will also have to be implemented in order to augment groundwater availability.	Significant long-term savings will be made by the domestic/commercial sectors, while agriculture will have to absorb a proportion of the effluent treatment cost. A national strategic groundwater reserve is established.
IV	Municipal demand decreases because of significant investments in local water reuse, while agricultural demand decreases to pre-EU accession levels (of 15 hm^3), driven mainly by market forces.	I	A cut-back in groundwater abstraction is implemented in order to achieve a sustainable abstraction strategy allowing the setting up of a strategic groundwater reserve. Available groundwater is then allocated between the WSC and all other users.	The WSC will be in a position to decrease the amount of water produced from RO plants. Agriculture will have to absorb a proportion of the effluent treatment cost. Reduced abstraction of groundwater and eventual higher quality of domestic supply will reduce the salinity in the sewage, leading to lower effluent treatment costs in the long term.

[*] Municipal demand refers to the domestic, industrial, commercial and tourism sector demand.

[**] The projected increase of 1 percent in urban demand is expected to be countered by a similar decrease in system demand (i.e. leakages) at least in the medium term. Therefore, for the period under consideration, the total WSC demand (inclusive of leakages) is projected to remain stable at 34 hm^3.

Groundwater abstraction is currently about 32 hm^3. Water-balance data indicate that the sea-level aquifers are being overabstracted by about 5 hm^3 and the perched aquifers by 2 hm^3. Thus, the potentially abstractable groundwater from all the groundwater bodies in the Maltese Islands is about 25 hm^3. Any abstraction above this figure will lead to overabstraction with the consequential degrading in the quantitative and qualitative status of the groundwater bodies. Apart from harming the aquifer systems and limiting future uses of groundwater in Malta, this situation would also lead the country to be in violation of agreed EU environmental obligations. The re-establishment of the sea-level aquifers is estimated to require a further 10-percent cut-back in groundwater abstraction from these aquifers, thereby reducing the annual recommended abstraction volume to 23 hm^3.

The situation described above is an oversimplification of the way the aquifer systems in Malta function. Further in-depth management actions must be taken in order to distribute the abstractable volumes among the different aquifers, where the different geological and storage characteristics lead to a very diverse spectrum of groundwater availability. Furthermore, the calculations do not take into account any reduction in both natural recharge (arising from increased urbanization) and artificial recharge (resulting from the municipal supply leakage-reduction programmes). Thus, periodic adjustments to these calculations to reflect changing recharge patterns will have to be implemented.

The following sections present a detailed analysis of the demand scenarios presented in Table 16 and discuss the possible supply strategies required in order to meet the projected demand. The technical feasibility of each strategy is then analysed from a socio-environmental perspective in order to assess the possible implications of each strategy.

SCENARIO I

Scenario I considers a stable or slightly increasing urban/commercial demand accompanied by a significant increase in agricultural demand, which will be assumed to attain but not exceed the projected 21 hm^3 by 2010. It is expected that projected increasing urban demand will be dampened by the planned/expected reductions in the distribution system demand (leakages), thus contributing to an overall stable WSC production requirement of 34 hm^3.

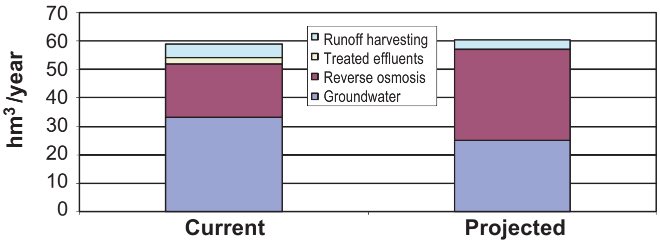
The first strategy considered (Figure 48) assumes that the agriculture/economic sectors will be given priority over the use of groundwater, subject to the provision that the global abstracted volume does not exceed recharge. The WSC will then be obliged to source its supply increasingly from RO plants as it reduces its abstraction quota in response to increases in agricultural demand. The quality of the potable water supplied by the WSC will increase as the RO product will not be blended with groundwater.

However, urban demand is expected to be quite close to the WSC's nominal RO production capacity (about 35 hm^3/year). This may require additional investment in RO facilities in order for the WSC to be in a position to operate effectively. Further constraints relate to the water supply situation on the island of Gozo, which currently depends almost exclusively on groundwater. As this strategy would almost certainly lead to an increase in the WSC's production costs, the unit price of water is likely to rise and be highly sensitive to fluctuations in the price of energy.

The demand of the agriculture and commercial sectors would in this case be catered for from the aquifers without the need for overabstraction. However, the demand is quite close to the calculated sustainable yield of the aquifer systems in the Maltese Islands. Agricultural demand would be managed primarily by introducing a licensing system, by water pricing, and by the use of macroeconomic instruments.

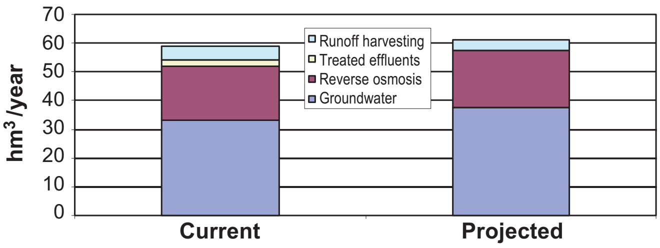
No further investments would be required in the management of sewage, which would be treated to secondary level and discharged to the sea. However, with the municipal supply increasingly dependent on RO water, the chloride levels in sewage would be expected to decrease considerably, thus reducing any treatment costs constraining reuse. Options relating to the reuse of treated effluent could also be considered in order to reduce the pressure on groundwater and possibly opening up the possibility of fulfilling the strategic obligation of augmenting groundwater storage through this option. The use of TSE is an option that gives greater flexibility to the strategy.

FIGURE 48
Redistribution of supply under Strategy 1 for Scenario I



This strategy can be seen to result in consumers having to meet increasing water bills in order to sustain the agriculture sector. Apart from that, given that energy costs constitute about two-thirds of the cost of producing desalinated water, this strategy would expose water users, taxpayers and the Maltese economy to potential further increases in energy costs. The country's water supply would also be more vulnerable to disasters such as oil spills or political crises that might interrupt energy supplies.

FIGURE 49
Redistribution of supply under Strategy 2 for Scenario I



The second strategy (Figure 49) assumes that no regulatory action is taken by the MRA to control groundwater abstraction. Under this strategy, no quotas/allotments will be set for any sector.

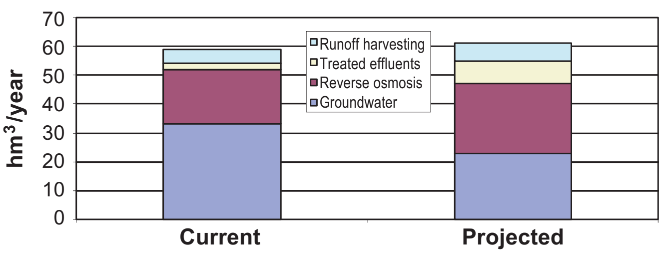
It is assumed that the WSC will keep its current groundwater abstraction levels at 15 hm³/year, possibly reducing or further treating this volume as the quality deteriorates. The agriculture sector will also derive most of its demand from groundwater while no significant further investment would be made in the new sewage treatment plants in order to treat the effluent above the secondary level prescribed in EU legislation, making the effluent practically unusable for agriculture.

This supply strategy is heavily dependent on groundwater and would ultimately lead to the gradual deterioration in quality of the sea-level aquifers from overabstraction, making groundwater practically unusable for direct utilization by all sectors. The relatively smaller perched aquifers would be significantly threatened from a quantitative point of view, possibly even effectively drying up in the summer months.

In the long term, this strategy would lead to increased treatment costs to ensure the usability of groundwater, thereby resulting in higher costs for urban consumers and significant added costs to the agriculture and economic sectors, which would seriously threaten their competitivity. It would move away from harmonization with the environmental *acquis* of the EU.

The third strategy (Figure 50) considers a further cut-back of 10 percent in groundwater abstraction from the sea-level aquifers over and

FIGURE 50
Redistribution of supply under Strategy 3 for Scenario I



above WFD requirements as necessary in order to reduce seawater intrusion, restore the system, and establish a national groundwater reserve. Detailed monitoring would be needed to assess whether this cut-back is sufficient or excessive.

Information currently available indicates that a total reduction in groundwater abstraction of about 9 hm^3 from current values would be necessary for a "sustainable" situation to be reached. Thus, under this strategy, groundwater abstraction must not exceed 23 hm^3/year.

Therefore, the immediate question relates to the eventual distribution of these 23 hm^3 among the different demand sectors. The strategy here assumes a quasi-50/50 division of this potentially abstractable groundwater between the WSC and the private sector (including agriculture).

This would see the WSC being allotted an annual groundwater abstraction quota of about 11 hm^3. Then, all the other sectors would be left with an annual abstraction quota of about 12 hm^3, where these other sectors comprise agriculture (irrigation and animal husbandry), industry, tourism, commercial entities and private domestic usage. Currently, the water demand of these sectors from sources other than the public distribution network is estimated at 24 hm^3. Mainly owing to increases in the agriculture sector, this demand is estimated to reach as much as 27 hm^3 by 2010.

In order to replace groundwater abstraction, it is envisaged that increased investment would be required to harness alternative water sources such as the harvesting of rainwater runoff and the treatment of sewage effluent. This would introduce added costs on the sectors utilizing this water as it is expected that some form of cost recovery would be required for any treatment over and above the secondary treatment required by legislation. This measure would affect mostly the agriculture sector as it is the sector most dependent on groundwater and one that is not giving enough consideration to the cost of water in its production costs. Moreover, for this strategy to be feasible, the treated effluent produced would have to be made available to the agriculture/industrial sectors at the point of use.

SCENARIO II

Scenario II considers a stable or slightly increasing urban/commercial demand accompanied by a significant decrease in agricultural demand, which will be assumed to revert to pre-EU accession demand levels of about 15 hm^3, a change driven mainly by market forces.

The first supply strategy analysed (Figure 51) proposes that agriculture should be given priority over the use of groundwater with the urban supply being increasingly sourced from RO plants. However, in this case, the decreased agricultural demand would enable the WSC to maintain a significant abstraction quota of groundwater. The price of water for urban consumers would thus be expected to rise reflecting the proportion of RO-produced water in the supply blend.

Therefore, this strategy would require the full exploitation of the estimated abstractable annual groundwater yield (25 hm^3) in order to keep RO production low and, consequently, keep prices for urban consumers down as RO water costs more than groundwater to produce. There should be no added costs for the agriculture sector as the demand would be met from the groundwater supply. This strategy sees no use for treated effluent, and it considers groundwater

FIGURE 51
Redistribution of supply under Strategy 1 for Scenario II

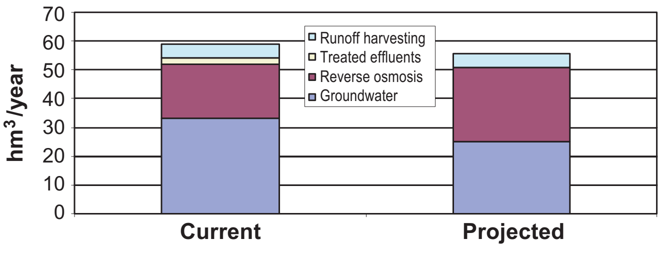
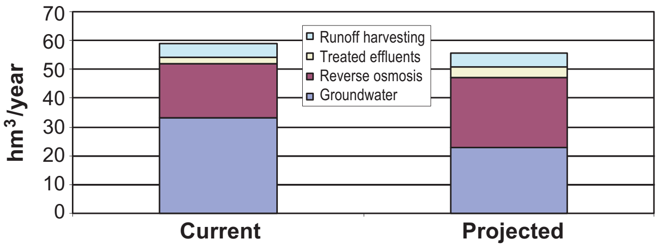


FIGURE 52
Redistribution of supply under Strategy 2 for Scenario II



as a more reliable and higher quality supply for the agriculture sector. Consequently, sewage would be treated only to secondary level and discharged to the sea. Treating sewage effluent could be considered as an option to tackle possible increases in agricultural demand or utilized in order to reduce the pressure on groundwater

The second supply strategy (Figure 52) is based on a further cut-back in the abstraction from the sea-level aquifers over and above WFD requirements in order to establish a national groundwater strategic reserve. In fact, a cut-back of 10 percent of the current abstraction from these aquifers is implemented in the calculations underlying this strategy. This cut-back was recommended by BRGM in 1990 as a measure for improving the status of the aquifers. The remaining abstractable groundwater resources (23 hm^3) would then be allotted almost equally between the WSC (the urban water service provider) and agriculture together with the other commercial sectors.

In this strategy, the WSC would have a fixed abstraction quota of 11 hm^3, with the remaining 12 hm^3 being reserved for the other sectors. Thus, the WSC would have to fill the gap between the demand and the abstraction quota from RO sources. As the agriculture sector has now a fixed quota of groundwater, the volume of which is smaller than its demand, increasing use would have to be made of alternative sources such as treated effluent and rainwater harvesting. In fact, the strategy envisages that sewage will be treated up to irrigable quality and supplied to farmers at the point of use.

Therefore, this strategy foresees the need for significant investments in effluent treatment, part of which would have to be borne by the sectors utilizing this water. However, by establishing a national groundwater reserve, the strategy aims at improving both the qualitative and the quantitative status of the aquifers. In the long term, this would result in reduced costs in treatment from which all users would be expected to benefit.

SCENARIO III

Scenario III considers a decrease in the urban/commercial demand fuelled by significant investments in local water conservation and reuse against a backdrop of increasing demand from the agriculture sector, which would reach the 21 hm^3 as projected in previous chapters.

This scenario suggests that local/household systems are introduced for the local recycling of grey-waters (water from baths, showers, washing machines, dishwashers, etc.) and its eventual reuse in lavatories and for the irrigation of gardens. Such a system has been adopted in Cyprus, where it is reported that more than 33 percent of household water was saved by such recycling initiatives. However, for the purpose of this study, a more conservative reduction of about 15 percent in WSC demand will be assumed to result from the introduction of such initiatives. This assumption takes into consideration that such initiatives will also be introduced in commercial concerns. Fiscal measures could also be considered in order to make these changes more cost-effective for the user. Another issue concerns urban/commercial rainwater harvesting. Here, the scenario assumes that the storage potential will be doubled, mainly because of increased eco-environmental awareness as well as through the enforcement of existing planning guidance and legislation. This would lead to a total reduction of 7 hm^3 from the WSC demand; which would thus decrease to about 27 hm^3.

FIGURE 53
Redistribution of supply under Strategy 1 for Scenario III

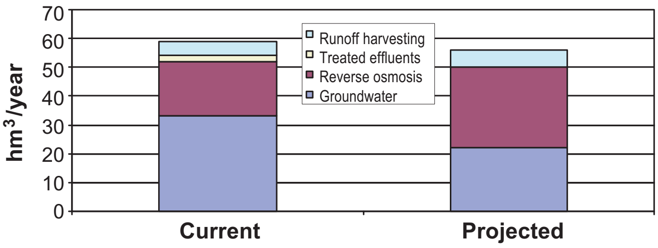
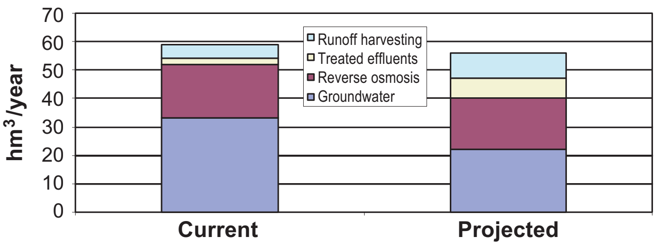


FIGURE 54
Redistribution of supply under Strategy 2 for Scenario III



The first supply strategy (Figure 53) for this scenario envisages that groundwater is written off as a source of potable water, with the agriculture and other economic sectors being given exclusive rights for its exploitation. The reduction in WSC demand would enable the corporation to meet all the urban/commercial demand from RO production (the WSC has a nominal RO production capacity of about 35 hm^3). This situation would also enable the WSC to reduce its operating costs significantly.

The total demand for groundwater with this strategy amounts to 22 hm^3, which is less than the estimated abstractable potential of groundwater in Malta. Thus, it fulfils the requirements for the establishment of a national reserve and the subsequent restoration of the aquifers. This strategy can be seen as taxing the urban consumers. These would have to construct water-treatment devices (which could be aided through the introduction of fiscal incentives) and at the same time meet higher water supply bills owing to the fact that the supply would be sourced exclusively from RO plants. However, the quality of the potable supply would increase considerably and the increase in the water supply bills would be dampened by the reduced consumption.

The second option (Figure 54) envisages strategically pre-fixing the abstractable quantity of groundwater at 23 hm^3 in order to restore the status of the aquifers and establish a national groundwater reserve. This quota is then subdivided almost equally between the WSC and the agriculture/economic sectors.

According to the estimates backing this strategy, the WSC would thus continue to blend RO and groundwater in the provision of the potable supply, the quality of which would be expected to increase in the long term as the groundwater status is restored. However, the quota allotted to the agriculture sector does not satisfy the projected sectoral demand. This would be achieved only through significant investment in sewage effluent treatment (the availability of which would be expected to decrease in response to the reduced urban consumption) and in rainwater-harvesting facilities. Investments in distribution facilities for the treated effluent produced would also be needed for this strategy to be implemented effectively.

SCENARIO IV

The fourth scenario maintains the decrease projections for the urban sectors and envisages a corresponding decrease in the demand of the agriculture sector to about 14 hm^3.

The strategy for this scenario (Figure 55) envisages that the abstractable groundwater quota is pre-set to 23 hm^3 in order to allow for the relaxing of the aquifers and the attainment of good status. This quota is then subdivided between the WSC and the agriculture/economic sectors. The WSC will supplement the abstracted groundwater (11 hm^3) with RO production (16 hm^3) in order to meet the urban demand (27 hm^3). No major changes in supply patterns are envisaged for sectors such as tourism and industry.

On the other hand, the agriculture sector would have to meet its demand by supplementing the abstracted groundwater (of which the sector would have a quota of 9 hm^3) with other sources of water such as harvested rainwater runoff and treated effluent. Various options could be considered in order to meet this demand, which would involve striking a realistic cost-effective balance between the supply of treated effluent and the storage of runoff. As with similar strategies, it is envisaged that distribution facilities will be constructed so that the TSE produced will be supplied to farmers at the point of use.

Figure 56 provides an overview of the results for each of the three scenarios and their respective strategies, and compares them with the current situation.

FIGURE 55
Redistribution of supply under Strategy 1 for Scenario IV

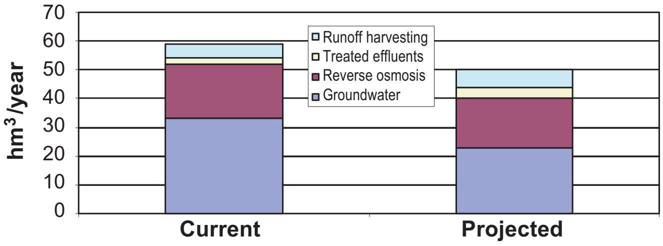
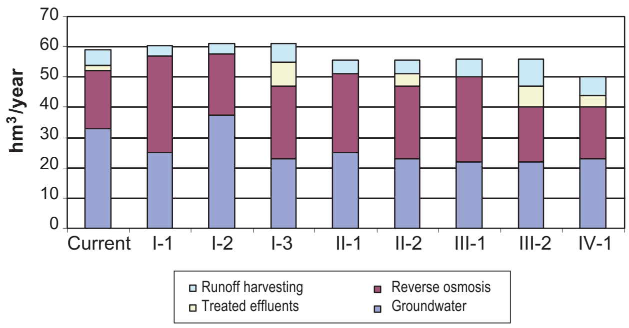


FIGURE 56
Comparison of redistribution of supply for all scenarios and strategies



SCENARIO ASSESSMENT AND STRATEGY IMPLEMENTATION

The above four scenarios cover the most probable limits of demand based on current trends and projections of the main water-using sectors. For each of the scenarios, there is one or more strategies for achieving the overall vision of the proposed water-policy. Table 17 presents the overall potential of each strategy for achieving this vision. However, each strategy will result in changes in Malta's water governance. Each strategy has a different level of risk associated with it and, as such, each strategy will have different impacts on users and the Maltese economy as a whole.

Thus, the implementation of each strategy will need clear political and economic decisions to be taken that will direct the country's socio-economic and environmental development in the coming years. These decisions cannot be postponed in favour of the

TABLE 17
Strategies with the potential to achieve all or part of the vision as stated in the water policy statement

Scenario		I			II		III		IV
Strategy	1	2	3	1	2	1	2	1
Levels of groundwater and surface-water use regulated according to sustainable abstraction levels	√	X	√	√	√	√	√	√
Sea-level and perched aquifers restored to a status that represents a strategic reserve equivalent to 18 months of demand	X	X	√	X	√	√	√	√
Water quality of all aquifers within permissible limits	X	X	√	X	√	√	√	√
Widespread use of local solutions (e.g. cisterns, pollution control)	X	X	√	X	√	√	√	√
High levels of collective responsibility (at all levels) for managing and protecting Malta's water resources	X	X	√	X	√	X	√	√
Potential to achieve all aspects of the vision	X	X	√	X	√	?	√	√

X - No
√ - Yes

"business as usual" demand scenario. The "business as usual" scenario is unacceptable because it is impossible to identify a supply strategy that is consistent with the vision (at least as described in this report).

The way in which these decisions are implemented and their impact on users will also depend on what happens to water demand as this is the main driving force behind each scenario. However, the overall strategic vision adopted will be reliant on the enactment of new legal provisions. It is anticipated that the new regulations to be introduced will require the inclusion of measures for:

- raising awareness of the poor condition of the sea-level aquifers and the potential consequences of continued mismanagement;
- the regulation of existing water users and sources in such a way that respects the hydrogeological integrity of the aquifers;
- the introduction and allocation of water supplies to users for purposes considered as beneficial to the economic development of the country;
- the recognition of sectoral priorities in groundwater use based on the social, economic and environmental benefits to be derived from such use;
- the introduction of cost-recovery mechanisms that take into consideration the environmental benefits derived from water using activities.

Chapter 11
Next steps

Malta's groundwater resources are poor and threatened by overexploitation and pollution. Reversing this trend requires a clear understanding of the situation that can guide policy decisions and help in setting up the necessary legal, institutional and implementation mechanisms. This report is an attempt to provide a clear picture of the situation and trends in Malta's water resources, and to identify the challenges that lie ahead. Time is of the essence. The process of putting policy into practice has to start as soon as possible if current trends are to be reversed and Malta's overall water-resource base brought to a position from which long-term sustainability can be assured.

The preparation and publication of this report are parts of the review and consultation process that were initiated in the framework of FAO's assistance to the MRA in the preparation of a comprehensive set of groundwater legislation. This report is the culmination of a round of collective and individual consultations with key stakeholders.

What is now needed is the vigorous support of all Maltese to promote a national water policy. A policy document has been prepared in parallel with this report in support of a national water policy consultation. Once endorsed by all stakeholders, it will serve as the basis for the development of a set of legal, institutional and operational instruments and programmes aiming at guaranteeing a sustainable supply of groundwater for the benefit of the Maltese community as a whole.

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Sustainable water resources are vital to Malta's long-term prosperity. Every sector of the economy depends on secure and sustainable access to water. A comprehensive review of Malta's water resources was carried out in 2004 by the Malta Resources Authority with the collaboration of the Food and Agriculture Organization of the United Nations. The Malta Water Resource Review is intended to provide a strong and objective factual knowledge base on the status of the islands' water resources and trends in water use. It is hoped that it will serve as a platform for discussion among stakeholders and contribute to the development of both a national water policy and a groundwater management strategy for Malta.