WaterStrategyMan
EVK1-CT-2001-00098

DELIVERABLE 14

REVIEW OF EXISTING WATER MANAGEMENT PLANS

Prepared by

NTUA

March 2004

Contents

1. Preface

This document presents the work undertaken in the case study regions in Task 8.1 of the WaterStrategyMan Project, "Review of Existing Water Management Plans". The purpose of the task, as defined in the contract is *"to review the proposed and existing water management plans in the regions, and develop the base case scenarios against which all water management scenarios will be compared."*

The Task was undertaken separately by all the Case Study Partners of the Project under the coordination of the NTUA. Each Case Study Partner undertook the analysis of their respective Case Study Regions:

- The National Technical University of Athens, Greece,
- ProGeA s.r.l., Italy,
- The Hebrew University of Jerusalem, Israel,
- The Water Development Department of Cyprus,
- INSULA, Canary Islands – Spain,
- AIOLIKI Ltd, Cyprus, and
- The University of Porto, Portugal.

The present document compiles the findings in the six Case Study regions. The data collected will be used as the Base Case scenaria against which alternative water management strategies will be evaluated in the next year of the Project.

2. Introduction

2.1. The WSM Project

The WaterStrategyMan Project aims at contributing to the solution of water shortage problems in arid and semi-arid regions of Southern Europe. The decline of water resources and increasing demand for freshwater cause threats to the environment and provoke conflicts between competing and conflicting users, even in comparatively water-rich areas. Appropriate water management tools, decision-making practices and thoroughly-planned interventions are necessary for increasing the availability of supply and/or managing the growing demand, and the project seeks to develop and evaluate strategies and guidelines towards integrated water resources management in the Southern European Regions.

The steps in which this task is being undertaken are the following:

1. The formulation of a Typology for arid and semi-arid regions, highlighting the commonalities and gaps among regions of southern Europe, and defined in terms of water deficiency types,
2. The conceptualising of these into the corresponding water management Paradigms, relevant to the regional context, and addressing:
    - Water supply options,
    - Water uses,
    - Economic and environmental frameworks, and
    - Water cost recovery policies.
3. The selection of a set of representative regions that will be used to analyse and evaluate Integrated Water Resources Management (IWRM) options,
4. The definition of six complementary and non-overlapping Case Studies according to the:
    - Regional context,
    - Paradigm context, and
    - Water deficiency type of the analyzed regions.
5. The adaptation of tools able to analyse quantitative and qualitative impacts and intersectoral competitive water use, and to describe potential responses and water policy consequences,
6. The suggestion of appropriate responses to water stress and implementation alternatives,
7. The development of improved water management strategies, and

8. The formulation of widely applicable guidelines and protocols for their implementation.

A prerequisite to the process of Strategy formulation is the assessment of the water resources and related activities of each region. This includes a description of water-related policies in the region as well as the country in question, identifying and analyzing issues in water resources management, and collecting data on the physical aspects and wide variety of factors that influence the development of water resources. The present document describes the outcomes of this task in each of the six Case Study regions.

The six regions selected for Case Study Analysis, and that are presented in this document were:

- Paros Island in the Cyclades complex was selected in Greece, where the main water stress issue is the peak in demand during the summer months, due to the high tourist influx onto the island. The existing infrastructure capacity is stretched during that period and is often insufficient to cover demand at peak times, leading to temporary shortages that in return are damaging to tourism.
- The Limassol area was selected in Cyprus, in order to analyse the effects of the competition for water resources between tourism and agriculture, the two major sources of income of the island, and determine the potential for a compromising water management solution that will be beneficial to both sectors.
- Belice Basin in Italy was selected, where the major water stress reason is the peak in demand during the summer, due to irrigation demands in the region.
- Tel- Aviv and the Arava region were eventually both selected for Israel, to be analysed with respect to the conflicts arising between the provision of water for urban water supply and for agriculture irrigation in a country where water is a very scarce and valuable resource.
- The island of Tenerife (Canary Islands) was selected in Spain, where the year-round high water demand is caused by a tourist influx much larger than the local population, demanding large infrastructure that nevertheless needs to be paid for by the locals.
- Finally, Ribeiras do Algarve was selected in Portugal, where despite the relative abundance of water resources, salinity of the underground aquifers is a rapidly intensifying problem due to the over-abstraction of water for use in golf courses and other tourism-related uses.

2.2. The Review of Existing Water Management Plans

The analysis of the current and proposed management plans included both field work and the collection of data by the Case Study Partners in their respective regions. The field work undertaken mainly involved detailed consultation with the local stakeholders and end-users, with respect to their perceptions on issues spanning the appropriate allocation

of available resources, the potential for water resources development and the effectiveness of the current practices.

Stakeholders and end-users participation is a key factor in the WaterStrategyMan Project, and an important aspect that distinguishes the process of strategy formulation. Stakeholder participation involves those who are affected by or involved in water resource management decision making. In the process of strategy formulation, it ensures transparency and accountability for decisions and promotes commitment to the decisions made. It provides unique insight and hands-on experience in the issues of the region in question, and a range of responses potentially not identified under different circumstances.

A significant step of the WSM methodology for Strategy Formulation was therefore to approach stakeholders and decision makers in the duration of Task 8.1, and to collect their opinions on Water Management Plans in their regions, discuss the regional development goals, which should guide the entire process of formulating the strategy, as well as their own perception of the problem and its solutions. They provided a wide overview of the specific issues that they have had to deal with, and identified solutions that they have successfully (and unsuccessfully) employed, and proposed their own specific development goals in their respective sectors, which are valuable in projecting the future demand.

The data collection undertaken involved the compilation of a database of:

- Water resources and hydrological data, including rainfall.
- Demand and consumption data and forecasted trends.
- Infrastructure, networks and water allocation data.

All available past and present proposed management plans were reviewed, and the collective data were entered into the GIS Database used by the DSS.

3. Existing Water Management Plans in Paros Island

3.1. Introduction – Background of Water Management practices

The island of Paros is one of the most popular tourist destinations in the Cycladic Complex. During the summer months the seasonal population is almost three times greater than the permanent population (from 10,000 to 30,000 or 35,000). An interesting fact is also that during the winter months only 50% of the permanent registered population lives on the island.

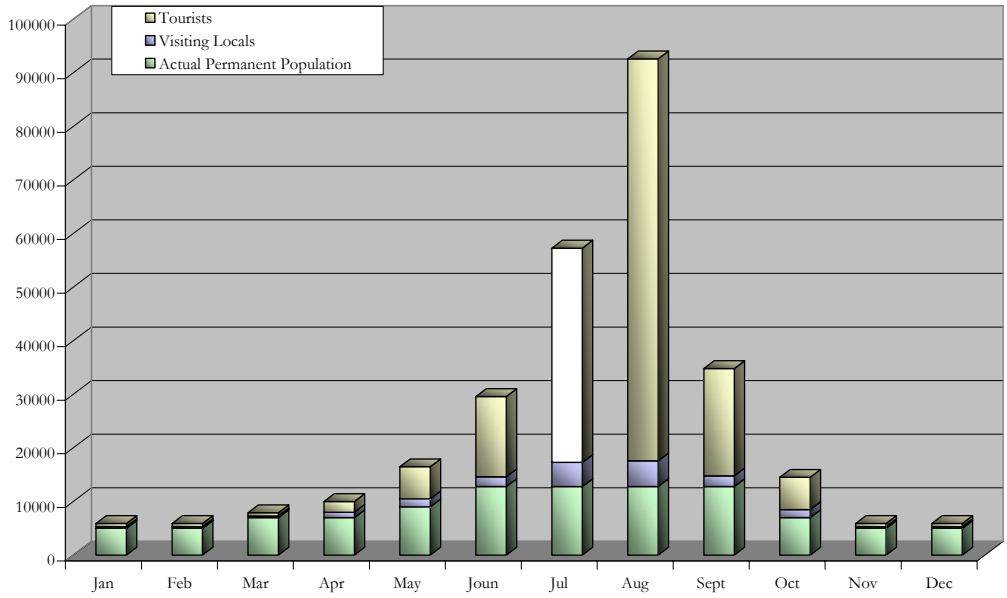

Figure 1. Permanent and Seasonal Population per Month

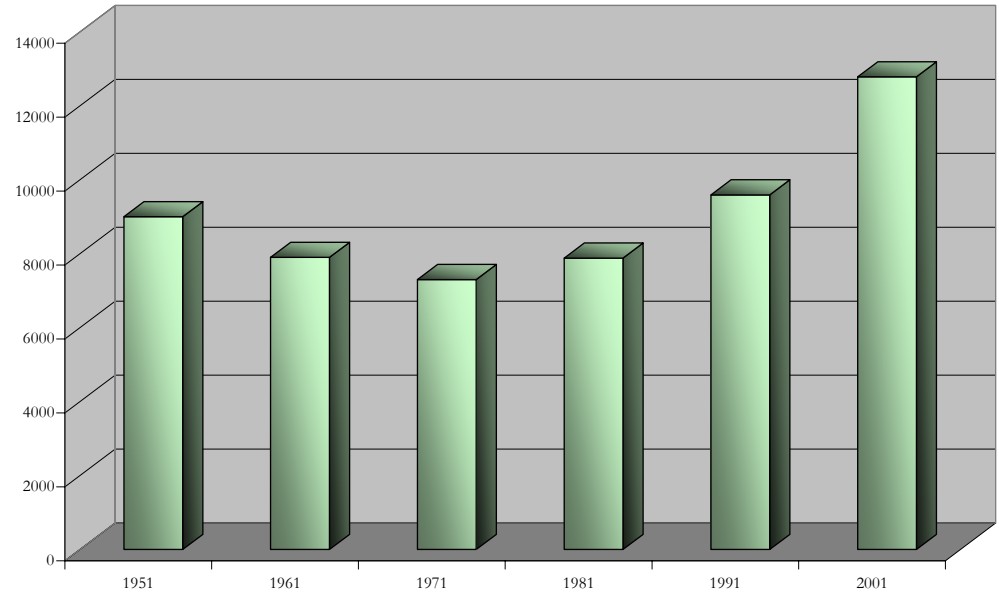

Figure 2. Permanent Population Development

The development of tourism and the consequent prosperity of the island began slowly in the early 1960s, after many years of decadence. Since 1950 the local inhabitants were mainly farmers and fishermen. Between 1950 and 1965 there was a large emigration trend and a great population decrease. In 1970s a reverse to this emigration trend took place due to tourism that grew rapidly during the 1980s, bringing about changes in the traditional way of living. Unfortunately this development took place without planning and control, leading to the problems that the island is facing today, both economic - offer of accommodation being greater than demand of accommodation - and environmental - great seasonal pressures applied on water resources. Simultaneously, the agricultural activity that to a large extent had been abandoned was enhanced by the tourist development, and the demand for local traditional products (for example local wines).

The island of Paros has the potential to combine multiple activities. Both tourism and agriculture can offer a prosperous future for the inhabitants under suitable planning and control.

3.2. Description of existing infrastructure

The people of Paros, in order to satisfy the domestic and agriculture demand, primarily used water from springs and wells - an easy and relatively inexpensive solution – or, less frequently, stored water in rain reservoirs. This practice was abandoned because of the tourist development that created the possibility of high profits by room rentals, so that the inhabitants chose to pay high prices for water rather than build reservoirs, as they could build rooms instead. When the demand grew significantly, they pursued the construction of private and public drills, as the central administration delayed the construction of new and large scale infrastructures (supply networks, dams, etc.). At the time, such interventions did not require any planning or control, and salinisation or aquifer depletion commonly resulted from them. Today 58 drills are in use, which cover 95% of the island needs in drinking water, with daily withdrawals of 4,000 m^3 in the winter and 12,000 m^3 in the summer, reaching 14,500 m^3 during the high peak period in mid August.

Although Paros does not have significant run-off, water storage during the winter months in order to be used in the dry summer months is a viable option. There are some private initiatives for the purchase of small tanks (from 2 m^3 to 50 m^3), mainly by the owners of lodgings in order to ensure supply during the peak season. The island economy is viable enough so that projects such as the construction of small dams can be easily financed. At present one small dam has been constructed and a second is in the planning stage of feasibility study, under the supervision of the Ministry of Agriculture. In order to decelerate run-off, seven interception walls have been constructed along a torrential current in the region of Naousa.

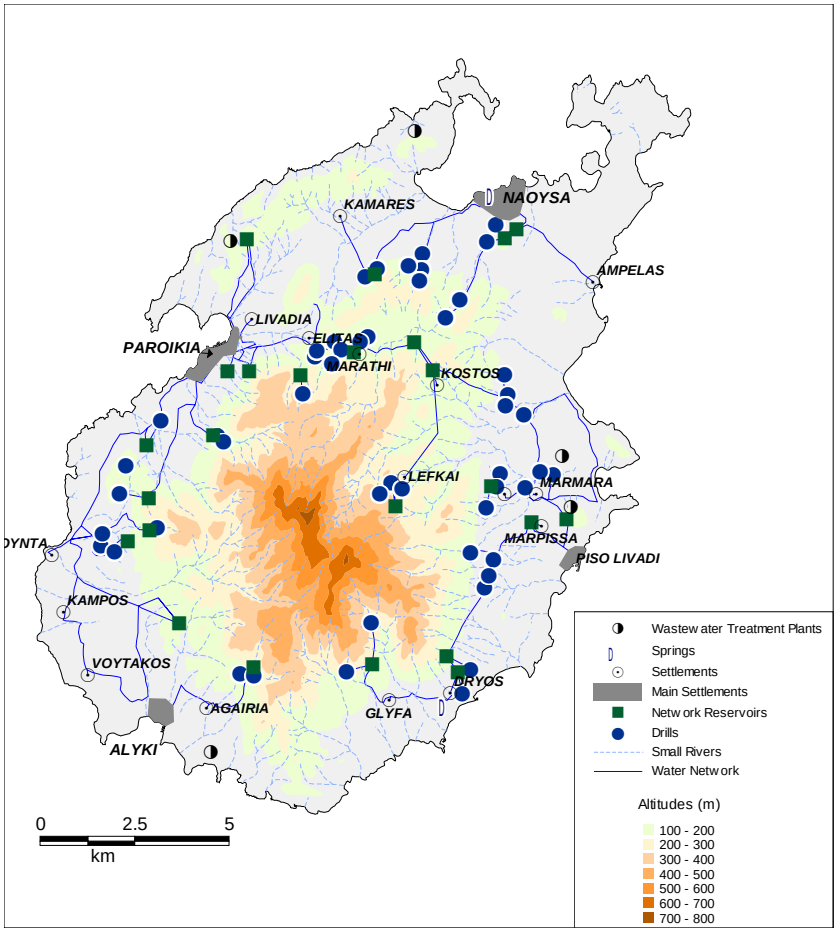

Figure 3. Water Network of Paros

On the island, one desalination plant with 1,450 m^3/day capacity operates in Naousa, where there is a brackish spring with a relatively stable and substantial supply of 2,000 m^3/day throughout the year.

Water transfer in containers has only been used twice so far, about twenty years before the present.

Aquifer enhancement is being considered, as the main water resource of the island is groundwater. For this purpose, seven interception walls have been built in the area of Naousa and one interception and storage dam has been constructed in the Tourlos area, which however is not yet operational.

3.3. Existing Water Management Plans

Since 1999 the island's water resources have been under the administration and management of a municipal office (DEYAP) and maintenance and control follow a centralized and better organized decision-making path than before.

Figure 4 analyses the DPSIR functioning and current water resources management in Paros.

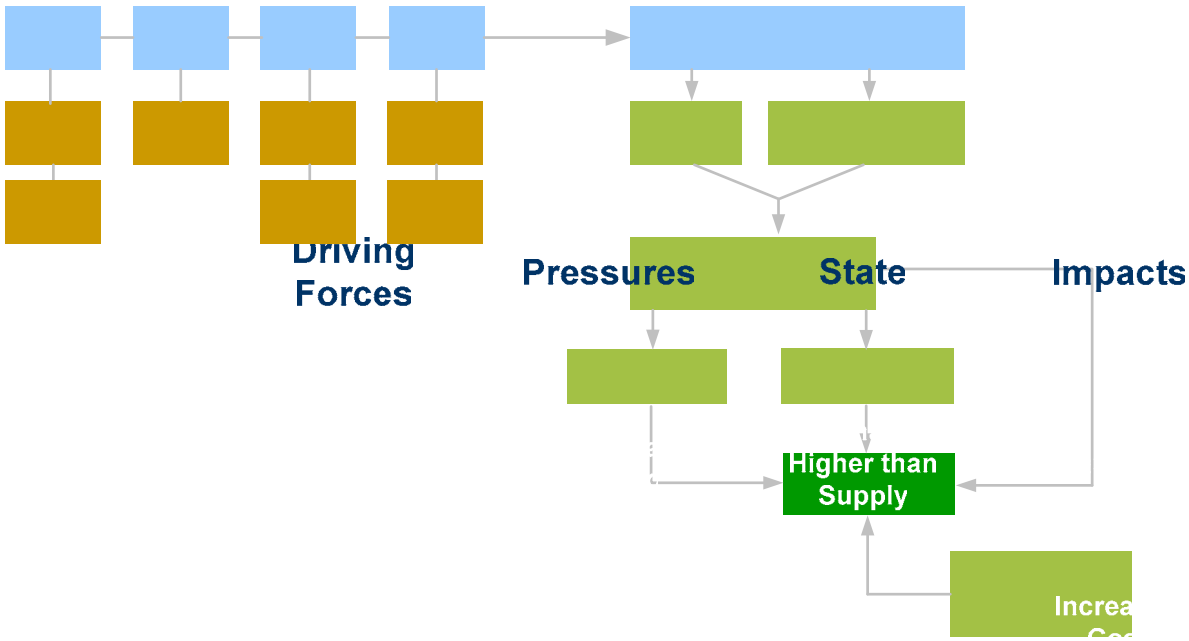

Figure 4. A DPSIR analysis and the dominant water management practices in the island of Paros

3.4. Description of the local stakeholders and the selection of stakeholders approached

Stakeholders are all those who affect, and / or are affected by the policies, decisions or actions of a water resources management plan. The groups of stakeholders that were identified and selected for consultation in Paros were:

- The Municipality of Paros. It represents the local authorities who take part in the decision making processes regarding water management.
- The Municipal Office of Water Supply and Sewerage of Paros. It is the administrator of the island's water resources and has an overall responsibility for the type of activities or measures considered and proposed.
- The Union of Agricultural Associations. It represents the traditional agricultural character of the island, and is directly involved in water use through irrigation and is also directly affected by water allocation.
- The Union of Room Owners. It represents a significant amount of the population. Many of the locals are involved in tourism, as well as a main activity, as it is the main source of income for the island; tourism is also responsible for the seasonal peak on water demand.

3.5. Consultation procedure

Field research and analysis was considered necessary prior to approaching the stakeholders. Besides data collection, the research group was able to form a global view

of the situation and define the circumstances that led to the current responses used to cover water deficit on the region.

Regarding stakeholder involvement in decision making the following steps that can be split in two tasks are necessary:

Task 1:

- Identify potential stakeholders.
- Select the set to be approached.
- Organize awareness meetings and discussions.
- Identify opinions, wishes and expectations.

Task 2:

- Formulate the above into water resources management scenarios.
- Evaluate scenarios.
- Formulate a proposal of the new strategies.

Stakeholders can be all that will be affected by, have interest in, or can influence decisions regarding water production, allocation and use. The different levels of involvement were a decisive factor of the final selection. Two categories of stakeholder groups were distinguished. The first category was stakeholder groups that promote the system and the second those who benefit from the system. Both categories interact and influence the system.

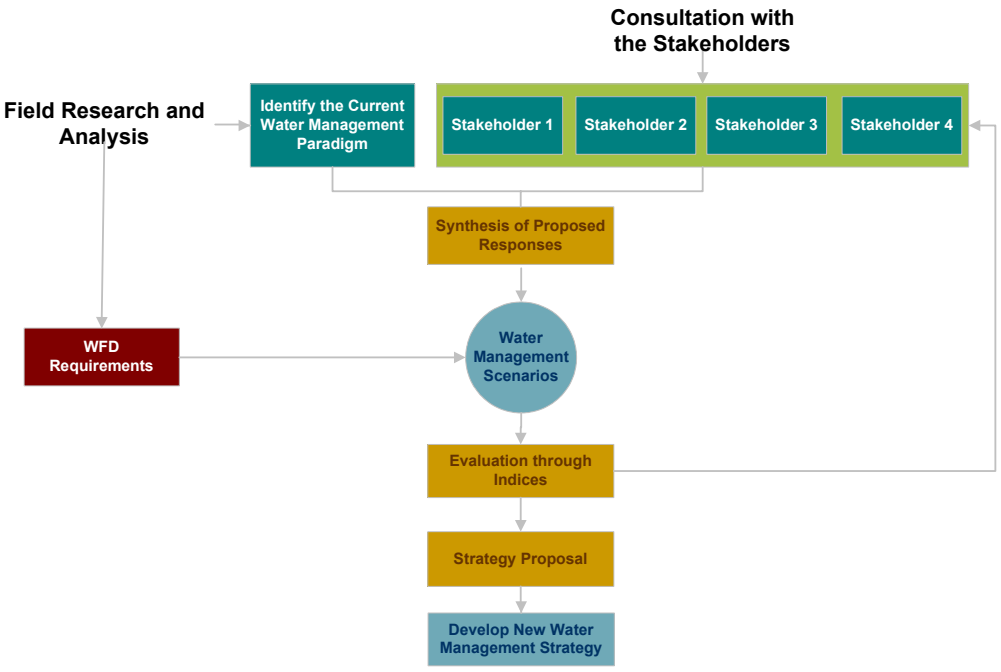

Figure 5. Method of Approaching Shifting Water Resources Management

Consultation and awareness meetings with the selected stakeholders followed. During these meetings, opinions, wishes and expectations were discussed. Also, a review of the available data was undertaken, as stakeholders can be excellent sources of data on their field of interest.

Some of the stakeholders are to be approached again in a further stage of the strategy formulation (Task 2), the proposed scenario evaluation stage. Their opinion on the final selection of scenarios will help decision makers select the optimum strategy, in both technical and societal aspects.

3.6. Consultation results

The stakeholders proposed different (alternative) approaches to water resources management that will be used during the new strategy formulation. Three proposed scenarios emerged, based on the stakeholders' opinions, wishes or expectations.

The Municipality of Paros

In the year 2000, a study was carried out on the behalf of the Municipality for the development of a Master Plan regarding water supply and sewerage in the island of Paros. The proposed shifting Strategy concentrates on supply enhancement through structural interventions, such as:

- New drillings / Boreholes,
- Infrastructure improvement (reservoirs, networks),
- Interception walls for aquifer enhancement,
- Remote monitoring of the supply system,
- Dams and Reservoirs (additional, in case the other measures would not meet demand).

Figure 6 illustrates the water management approaches that are proposed in the Master Plan.

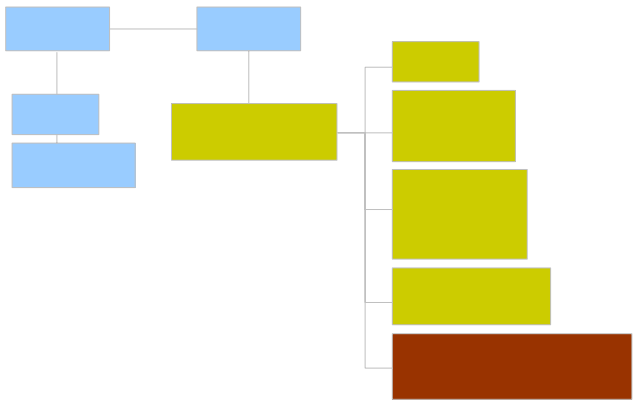

Figure 6. Master Plan approach (Markantonatos 2000)

Driving forces that lead to these proposals are:

- For Supply Enhancement:
  - Infrastructure funded by the central and regional government without input by local community,
  - No costs to local population,
  - Tourist industry promotion,
  - Public opinion has major importance.

The Municipal Office of Water Supply and Sewerage of Paros

The plans made by the Water Utility for more efficient use of the island's water resources and their future reservations include:

- Supply Enhancement through:
  - New drillings / Boreholes,
  - Infrastructure improvement (reservoirs, networks),
  - Construction of desalination plants.
- Demand Reduction through:
  - Water saving / Conservation,
  - Legal / Regulatory / Administrative Measures,
  - Metering.
- Socio – Economic Constraints through:
  - National Water Policy,
  - Public Participation / Involvement,
  - Conservation Campaigns.

Regarding supply enhancement, structural measures are the most common. Other than drills, the rest are financed by the state, after a study is submitted and approved. The annual increases in water and sewerage bills are used by the regional authorities as a measure towards demand reduction along with fines for over – consumption or misuse of water. However, this policy faces serious opposition from the water users. Socio-economic measures include public participation and involvement in issues regarding water management and conservation campaigns. The establishment of a National Water Policy Organization is also a preferable option.

Some of these measures are already used, while others are still under consideration.

Figure 7 illustrates water management approach that is proposed by the Water Utility.

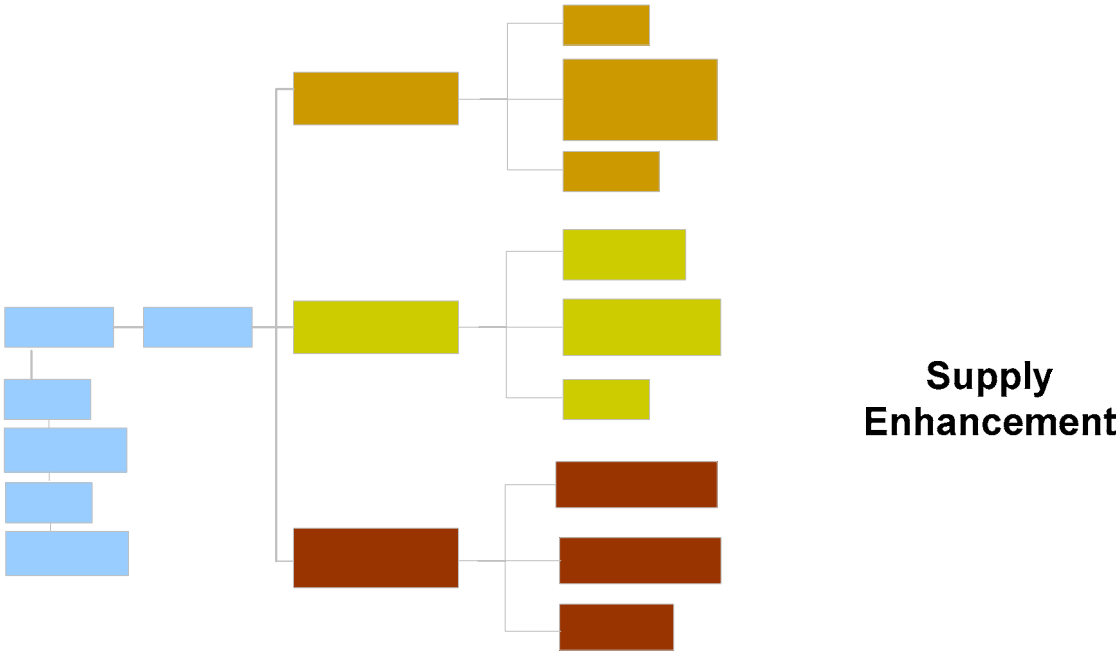

Figure 7. Water Utility Proposal for a new Water Resources Management approach

Driving forces that lead to these proposals are:

- For Supply Enhancement:
  - Increase of the sustainable supply.
- For Demand Reduction:
  - Limited water availability,
  - Need to reduce waste of water.
- For Socio – Economic Measures:
  - Pricing only covers operational cost recovery,
  - Necessity of public participation to improve conservation.

The Union of Agricultural Associations and the Union of Room Owners

The proposal for water management practices from agricultural associations and room owners is alike, as their perceptions of water resources management are similar. Both stated that an adequate solution for the water scarcity would be the construction of desalination plants.

Farmers are interested in using new techniques that will help to reduce the irrigation, and expressed the opinion that desalination of brackish springs would be a convenient solution.

Regarding the potential for a shift in tourism activities, the owners are positive to the extension of the tourist season and the turn towards alternative tourist activities all year round.

Figure 8 illustrates the water management approach proposed by these two stakeholder groups.

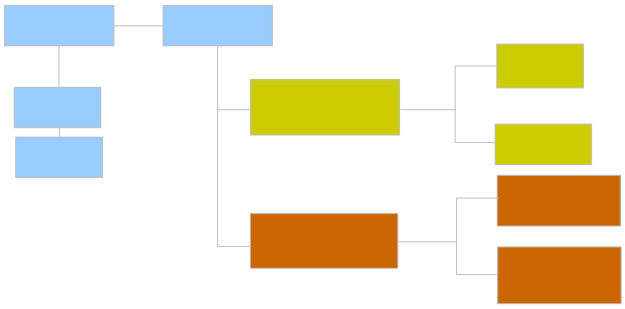

Figure 8. Agriculture and Tourism approach on Water Resources Management

Driving forces that lead to these proposals are:

- For Supply Enhancement:
  - Necessity for a water services standard (tourist industry),
  - No direct cost for infrastructure development,
  - Limited cost for water services provision (no cost for farming).
- For Demand Reduction:
  - Awareness of the limitations in supply and the potential benefits of water conservation.

3.7. Formulation of a new proposed Water Management Paradigm based on the results of the stakeholder consultation

The Strategy that will be developed will result from a synthesis of the current responses regarding water management, the responses proposed by the stakeholders and the requirements of the Water Framework Directive that can be implemented in this specific area.

Figure 9 illustrates a set of practices that form an example of a Strategy. The set was selected from the stakeholders' proposals - mainly structural interventions that enhance supply – and Water Framework Directive requirements that can be implemented in Paros. Environmental, social and economic constraints were included and considered in the approach.

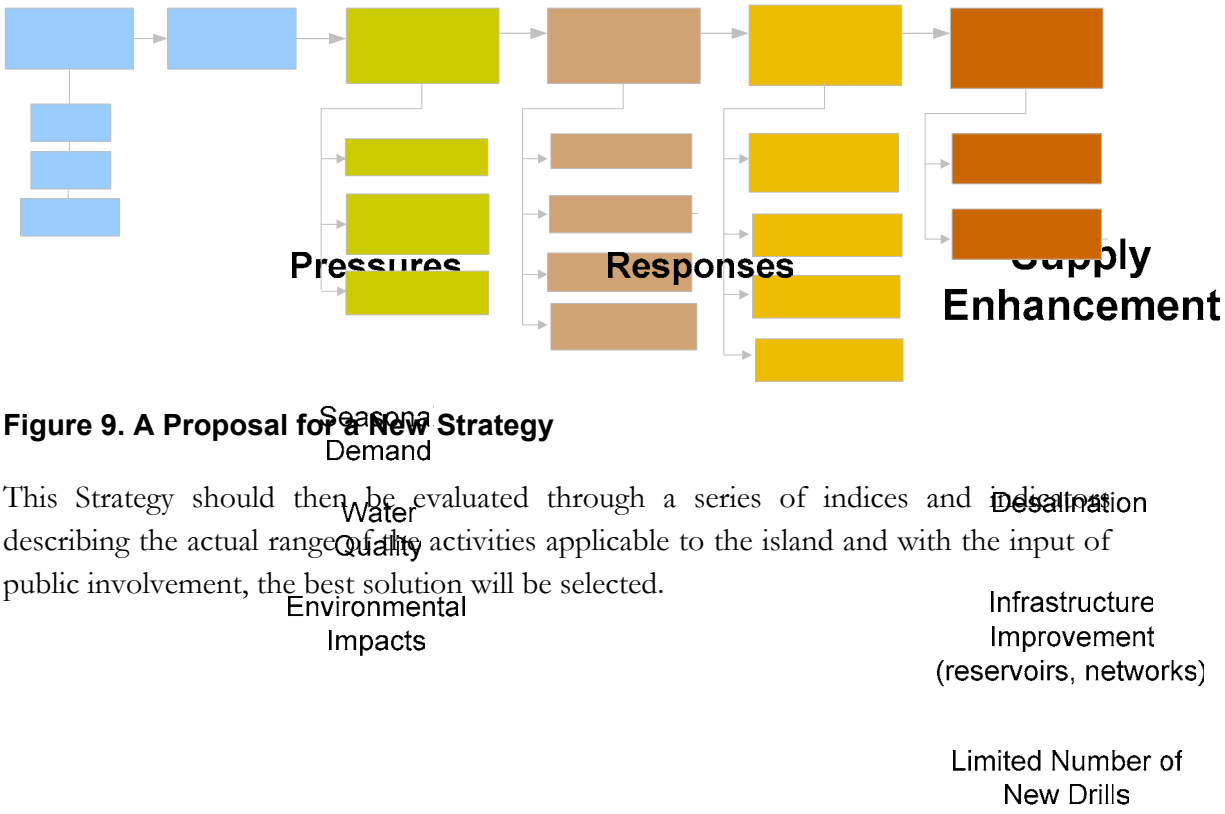

Figure 9. A Proposal for a New Strategy

This Strategy should then be evaluated through a series of indices and indicators describing the actual range of the activities applicable to the island and with the input of public involvement, the best solution will be selected.

4. Existing Water Management Plans in the Limassol region

4.1. Introduction – Background of Water Management practices

Cyprus is an arid to semi arid island state situated in the north-eastern Mediterranean. The renewable freshwater resources of the island are highly constrained. They are characterized by a strong spatial and temporal scarcity caused by the seasonal distribution of precipitation, and the topography.

Figure 10. Cyprus in the Mediterranean

Although a large number of various water supply investments and interventions have been made such as surface water dams, groundwater exploitation, interbasin water transfers, desalination and reuse of tertiary treated effluent, Cyprus is still a long way from reconciling the demand to the availability of water. Competing demand and the dynamic competitive tension between agriculture, urban growth including tourism, and the environment are challenging the existing water management practices in the island.

The selected representative region, Limassol region, is depicted in Figure 11 and is characterised by water scarcity problems, as well as by its social and economic characteristics which result in conflicting and competing water uses (water for the tourist industry – domestic demand – agriculture) and the complexity of the water system.

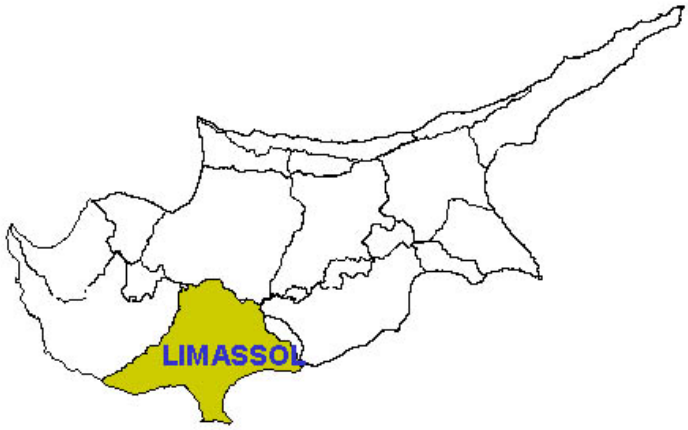

Figure 11. The selected Limassol region

The conflicting and competing uses as a result of the area's development pattern, pose great pressures on water management responses, since Limassol region is one of the main tourist destinations in Cyprus, whilst on the other hand the agricultural production in the area accounts for more than 50 % of the fruit trees, 50% of the vegetable and 60% of the table grapes production of the country.

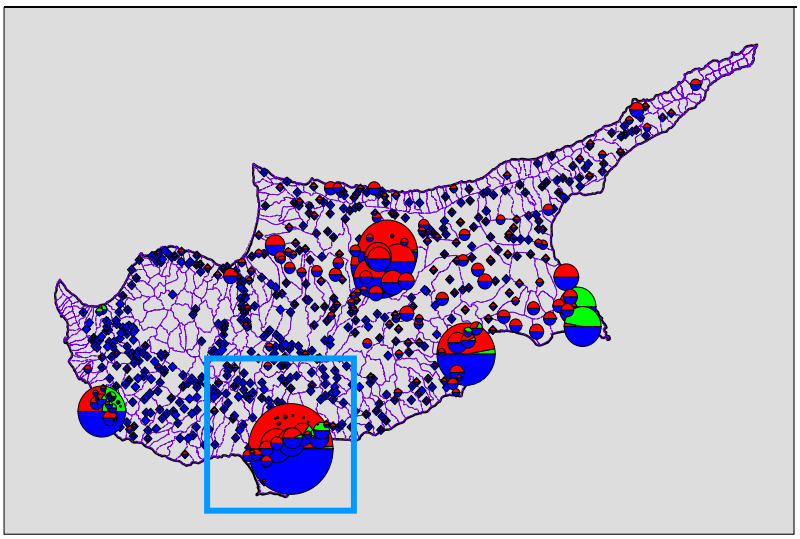

Figure 12. Permanent Population Development

4.2. Description of existing infrastructure

The domestic consumption of the region accounts for almost 12.8 mi m^3, whilst the domestic water consumption for the tourism (seasonal population) accounts for 3.6 mi m^3 in 2000 which is almost 26 % of the island's total seasonal consumption. The domestic consumption is supplied from surface waters after treatment in the Limassol Water Treatment Plant (almost 7.8 mi m^3), and from groundwater -boreholes and springs (almost 8.2 mi m^3).

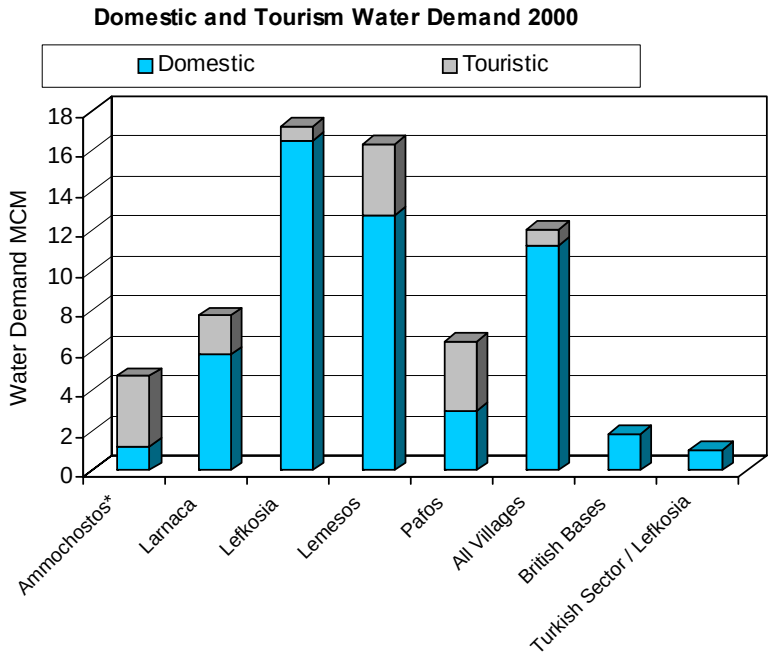

Figure 13. Domestic and Tourism demand (2000)

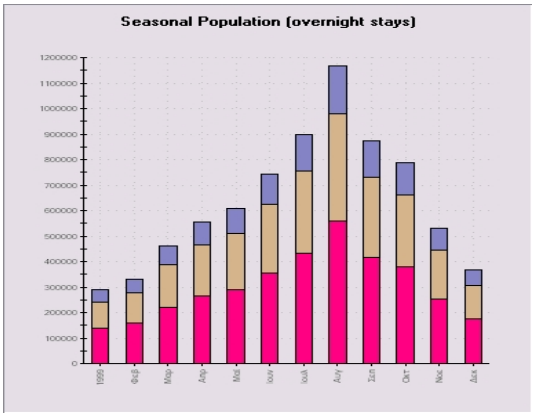

Figure 14. Annual Seasonal Population Distribution

Irrigation water demand in the region accounts for almost 31 mi m^3 from which 24mi m^3 were supplied from the major government irrigation schemes (Figure 15).

The annual water demand for animal husbandry in the region accounts for 820.000 m^3.

Industrial demand in the region accounts for 1.5 mi m^3 or 43% of the total industrial demand of the island.

Environmental demand in the region accounts for 4 mi m^3 (3 mi m^3 groundwater, 1.5 mi m^3 municipal domestic and 0.5 mi m^3 treated effluent).

The sources of water supply in the region include:

- Surface water stored in the three dams of the region, namely the Kouris Dam (of a total capacity of 115 mi m^3), the Polemidhia Dam (of a total capacity of 3.4 mi

m^3) and Germasogeia Dam (of a total capacity of 13.5 mi m^3) which is used for domestic and irrigation purposes.

- Certain quantity of the stored surface water resources is treated and used for domestic purposes in the Limassol Water Treatment Plant which has a capacity of 40,000 m^3/day with a potential capacity of 80,000 m^3/day. The plant receives raw water from the Kouris Dam and supplies water to the Limassol city, some villages west of Limassol and to the British Bases of Akrotiri.
- Ground water extraction from a number of boreholes to be used for domestic and irrigation purposes.
- Treated effluent from the Limassol Sewage Board Treatment Plant used for agricultural and landscape irrigation.

The irrigated in the region fall in two categories: Areas within the Major Government Irrigation Schemes of the region (Akrotiri West and Germasogeia-Polemidhia) and areas outside the Government Irrigation Schemes.

4.3. Existing Water Management Plans

The current strategy for ensuring adequate water supply for all uses, responding to the current conditions of water deficit, is based on a combination of a number of policy options including supply enhancement, demand management, social-developmental policies and institutional policies.

Figure 16 analyses the DPSIR functioning and the current water resources management in Limassol region.

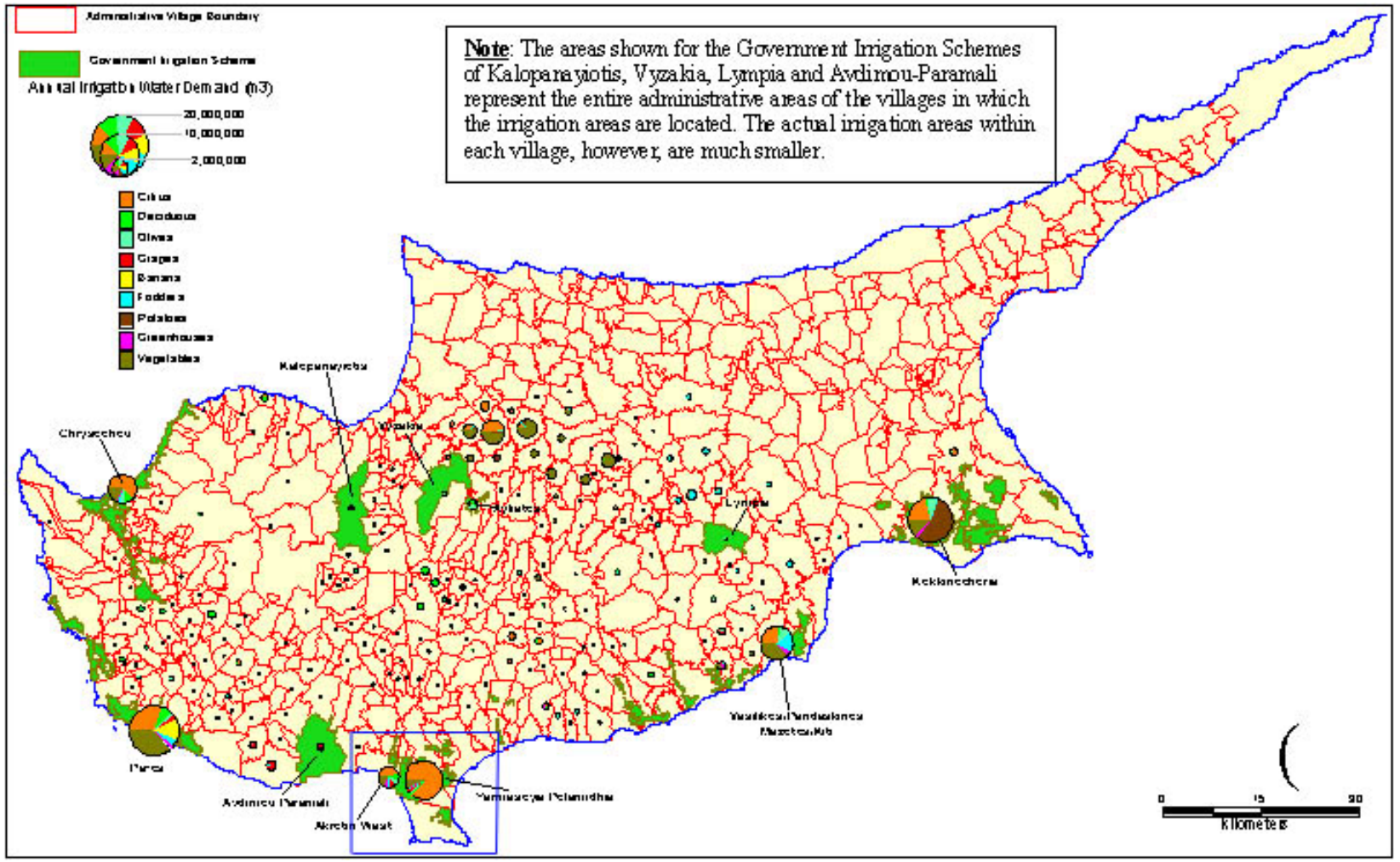

Figure 15. Annual Irrigation Water Demand (m^3) for Government Irrigation Schemes and Villages per Crop Category

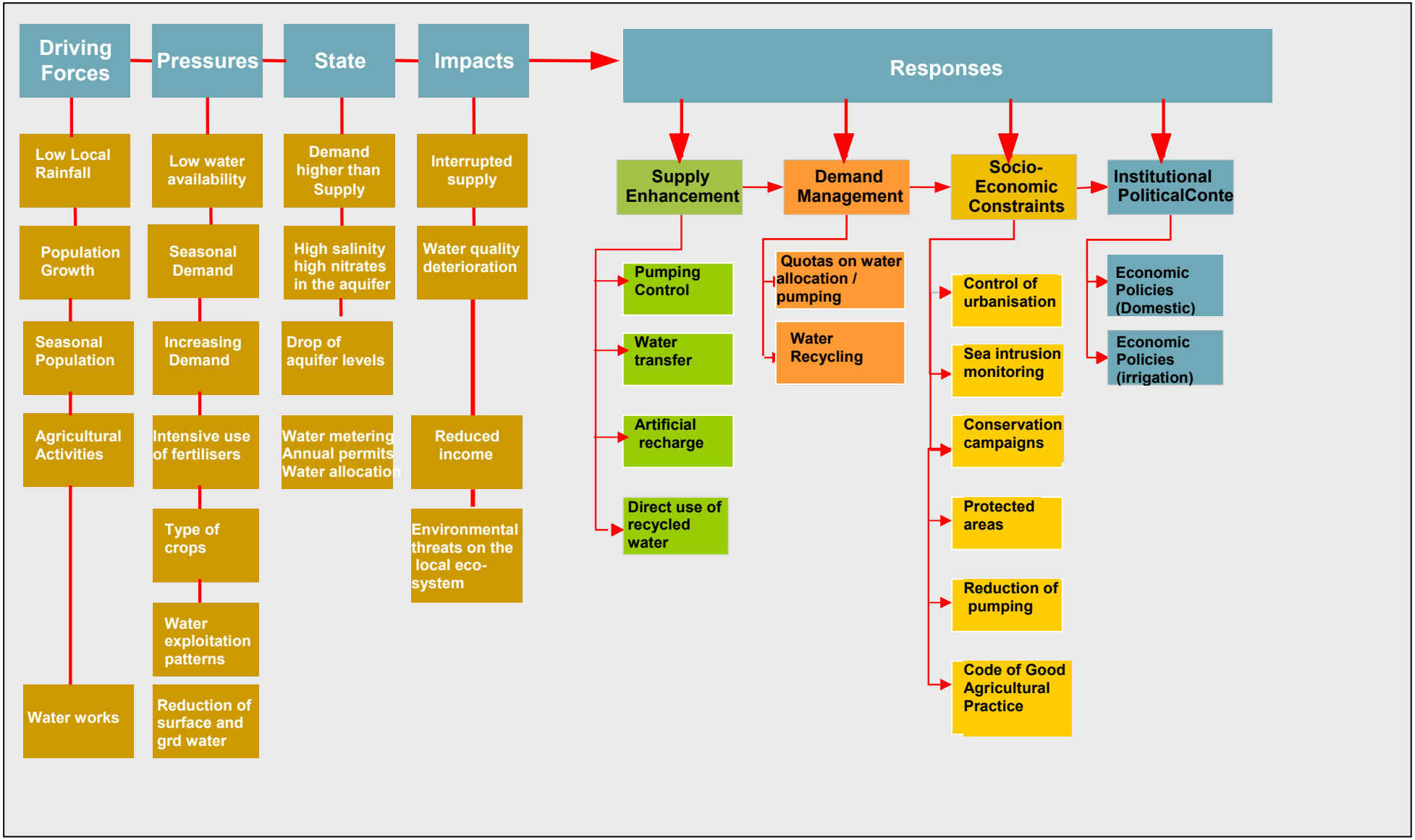

Figure 16. A DPSIR analysis and the dominant water management practices in the Limassol region

Supply enhancement

Efficient pumping control:

The groundwater levels are monitored on a monthly and bi-monthly basis from a network of approximately 200 boreholes since 1960, 85 to 100 of which are regularly sampled. The groundwater pumping is quite well monitored through water meters that are observed every month. About 90% of the annual extraction is metered and recorded at monthly intervals. The area is well surveyed and studied. A good database exists and numerous studies have been performed including groundwater modelling.

Water transfer from surface reservoirs:

Until 1998 part of the irrigation requirements of the area were covered by water from the Germasogeia dam. Since that year the Germasogeia-Akrotiri pipe has been used to transfer recycled water to the Polemidhia dam and as a consequence no water transfer is possible from the Gerrmasogeia dam anymore. Due to the water deficit problems, water is transferred from the Kouris dam (~ 6 Mm^3 in 2002).

Artificial recharge with water from surface reservoirs:

Water from Kouris dam is transferred to the area in order to recharge the aquifer at selected locations. This policy option depends on the available quantities of water in the dam (in 2002 2.6 Mm^3 were transferred, compared to only 42,000 m^3 during the drought period of 1998)

Direct use of recycled water:

Currently a major project using tertiary treated effluent (up to 6 million m^3) from the Limassol Central Sewerage Treatment Plant is in operation for irrigation purposes. The recycled water is stored in Polemidia dam during the winter period, while during the summer period it is used directly for irrigation.

Exchange of pumping for domestic supply with desalinated water:

A major desalination plant of 20,000-40,000 m^3/d capacity is planned for commissioning by 2004 to be built at the western part of the area. Surplus water that may arise from the operation of this plant will allow a better coverage of the agricultural demand and will also allow the built up of strategic reserves in the groundwater aquifer which are already to a very low level.

Coordinated program of releases from Germasogeia and Kouris dam for artificial aquifer recharge:

The small Germasogeia riverbed aquifer has been turned into a natural treatment plant for domestic water supply without the need of complicated and expensive surface water treatment requiring chemicals, qualified technical and managerial personnel and the necessary civil engineering structures. Since the construction of the Germasogeia dam, recharge of the aquifer depends on controlled releases from the dam and its spills, and supplementary on releases from the Kouris dam (6.5 Mm^3 in 2002 compared to 2.3 Mm^3 in 1998). The complete cut-off of natural replenishment by the construction of the dam

and the proximity to the sea, coupled with the increasing extraction from the aquifer made necessary the development of a coordinated programme of releases from the dam for artificial recharge to cope with the extraction and minimise groundwater losses to the sea. With such action the sea intrusion is controlled and at the same time an efficient use of the scarce water resources is made. This conjunctive use of surface and groundwater reservoirs enabled a dramatic increase in the extraction from this aquifer (more than three times its active storage capacity is being pumped annually) deferring the need for an expensive treatment plant for many years. Groundwater is pumped for the domestic water supply of the Limassol town, for the surrounding villages, and the tourist zone. This aquifer is the only source of domestic water supply of the local village communities and the tourist zone.

Demand Management

Application of special measures for water allocation (quotas):

A quota system is applied on an annual basis for the allocation of government irrigation water in the Akrotiri area, on the basis of the current groundwater conditions and the content in the surface reservoirs. The quota system in conjunction with penalty charges for over withdrawals contributes to the efficient use of the water. Under conditions of water scarcity, especially during droughts, priority and preference is given to covering a higher proportion of the domestic supply followed by greenhouse agriculture and permanent crops. Seasonal crops under these conditions are reduced dramatically.

Application of special measures (water conservation law) to control drilling and pumping on an annual basis requiring water metering (quotas):

Special permits are issued on an annual basis governing the quantity of the water to be pumped. Preference is given to areas with problems of getting water from existing irrigation schemes.

Water recycling (Limassol Central Sewerage Treatment Plant):

Quantities of tertiary treated effluent (from the Limassol Central Sewerage Treatment Plant - LCSTP) are transferred at the Kouris river "Delta" area to recharge artificially the Akrotiri aquifer. It is expected that 5.25 Mm^3 of recycled water per year will be produced during the first stages of the operation of the LCSTP, and 10.6 Mm^3 per year at later stages.

Social – Developmental Policy

Implementation of Good Agricultural Practice Code regarding use of fertilisers and pesticides:

The provisions of the Code of Good Agricultural Practice are applied through the Akrotiri area. The code includes: control of fertilizer use, use of improved irrigation systems and preparation of irrigation schedules, relocation (wherever is possible) of animal husbandry units, slurry collection, mechanical separation and land application of piggery waste, on-going farmer training programmes, etc.

Strict control of urbanization within aquifer through Town Planning zoning and of domestic sewage management:

A fast growing urbanisation within the Gernasogeia aquifer area (the aquifer is crossed by the Limassol-Nicosia highway, by local important roads, the main SCP pipeline, the main pipeline and the irrigation network of the Germasogeia dam, the main pipelines of the Limassol-Amathus raw and treated sewage, the local sewage system, etc.) and tourist development are causing concern about the environmental conditions (mainly the possible deterioration of the quality of groundwater) of this highly susceptible aquifer. As a result this is considered a high risk aquifer. A number of protection measures have been applied including strict control on the planning zones of the area. Germasogeia Municipality was one of the first Municipalities to be connected to the Limassol Central Sewerage System.

Reduction of pumping for the domestic supply and replacement with water from other sources:

The WDD is examining alternative potable water sources for the areas depending on the Germasogeia aquifer, in order to reduce the pumping from it and use it as a strategic reserve.

Increased monitoring of sea intrusion propagation and adjustment of artificial recharge regime accordingly

The hydrogeological regime and the water balance of the Germasogeia aquifer are "regulated" by controlled releases from the dam into the river valley and continuous monitoring of sea/fresh water interface (conductivity logs are kept for 10 boreholes).

Development of protection areas around wells and well-fields

Due to the susceptible character of the Germasogeia aquifer, all the wells and boreholes in the aquifer are surrounded by a protection zone within which development is prohibited.

Institutional Policies

Implementation of block tariffs, seasonal prices and over-consumption penalties to domestic consumption:

The Water Boards and the local Authorities and the area set progressive block tariffs, seasonal prices and over-consumption penalties to promote domestic water consumption efficiency and water conservation.

Adjustment of water pricing to reflect true cost of irrigation water:

Contrary to the costs of domestic water that is almost full charged to customers, the price of irrigation water covers neither the full financial nor the economic costs. The present tariff for the Akrotiri area is Cy £0,06 / m^3 which is equivalent to 22,3% of the weighted average unit cost of water, although the Loan Agreements with the World Bank dictate that the price of the water should be at least 38% of the weighted average unit cost. As a result the WDD is examining the case to revise the prices upwards to reflect

the true cost of the water. This will promote efficiency and water conservation measures contributing towards a sustainable water management alleviating the current water shortage problem. Such an approach complies also with the provisions of the new Water Framework Directive of EU, although it is well understood that its implementation will be very difficult.

4.4. Description of the local stakeholders and the selection of stakeholders approached

The person or group with a direct interest, involvement, or investment to changes, are defined as stakeholders. For this project, the stakeholders are people either representing others or are those directly affected by any changes that may be applied to the water management strategy in Cyprus. It is thus considered of great importance to understand the problems, needs and current situation faced by each of the groups. The groups that were identified and selected for consultation, and are being approached in Limassol region were:

- The Water Development Department.
- The Water Board of Limassol.
- The Sewerage Board of Limassol: The Limassol Sewerage Board (SALA) was established in 1980, and its main functions are the construction, operation and maintenance of the Limassol sewerage network, for the collection and treatment of liquid waste of the wider Limassol area, as well as the construction of the basic infrastructure for the rainwater runoff collection system. SALA operates a tertiary liquid waste treatment facility, located in Moni-Limassol, providing on an annual basis, more than 6 mil m^3 of reused water for agricultural purposes.
- Municipalities and villages of the region, representing a significant amount of the population. Many of the locals, apart from their main activity are involved in tourism as well, as it is the main source of income for the island, and responsible for the seasonal peak on water demand.
- End users :
  - The Cyprus Farmer's Association. The Cyprus Farmer's Union, established in 1948 represents a large majority of the Cypriot farmers. Its main objectives are to promote the successful and socially considerate agriculture, while ensuring the long-term viability of the rural community. It represents the traditional agricultural character of the island, and is directly involved in water use through irrigation and is also directly affected by water allocation.
  - The three big farmers of the region, namely Tskistou Agricultural Estate, Lanitis Agricultural Estate and Fasouri Agricultural Estate.

4.5. Consultation procedure

The main subjects discussed with the stakeholders chosen to visit were:

- Current situation – water supply used and any problems faced,
- Suggestions – for the improvement of the situation, and solutions to the problems being faced.

For each of the stakeholders chosen, some research was performed to find and comprehend the opinions and the problems faced. This allowed the researchers to visit the stakeholders prepared for the discussion of specific issues.

4.6. Consultation results

The stakeholders proposed different (alternative) solutions to the problems of water deficit or quality. The solutions depended on the problems faced by each one, and their awareness on the impact any measure would have to the island as a whole.

The Water Development Department perception of the new strategy

The proposed shifting Strategy concentrates on structural and non-interventions, such as:

- Supply side
  - Increase available supply (treated effluent),
  - Build groundwater quantities – maintain strategic reserves.
- Demand side
  - Demand reduction (adjust cropping pattern),
  - Water saving (further reduction of the water losses).
- Socio-economic environment
  - Need for public participation in order to improve water conservation,
  - Incentives and disincentives to conciliate water availability with demand,
  - Groundwater pricing mechanism to discourage preference on this resource,
  - Water tariffs for irrigation to reflect true costs allowing an adequate cost recovery.

The Water Board of Limassol perception of the new strategy

The perceptions of the Water Board of Limassol for a new strategy for more efficient use of the region's and the island's water resources and their future reservations include:

- Supply side:
  - Adequate drinking water (1st priority),

- Sustainable distribution of the water on a national level,
- Objections for new desalination plants,
- Utilisation of the treated water in the agriculture and the tourism sector,
- Abandon the abstraction of water from boreholes – receive equal quantities from the Water Treatment Plant.

- Demand side:
  - Demand reduction (adjust cropping patterns – substitution of local agricultural production with imports),
  - Water saving (further reduction of water losses).
- Socio-economic environment:
  - Water tariffs for agricultural purposes are very low,
  - Need for public participation in order to improve water conservation,
  - Reasonable water tariffs for potable water.

The Sewerage Board of Limassol perception of the new strategy

The perceptions of the Sewerage Board of Limassol - Amathus for a new strategy for more efficient use of the region's and the island's water resources and their future reservations include:

- Supply side:
  - Improvement of treated water quality.
- Institutional context :
  - Act as a distributor of the treated water (formation of a company at a national level for this purpose).

The Municipalities perception of the new strategy

The perceptions of the Municipalities for a new strategy for more efficient use of the region's and the island's water resources and their future reservations include:

- Supply side:
  - Objections for the recharge of the Kouris Delta aquifer with treated water,
  - Environmental concerns for a new desalination plant,
  - Low quality of treated water – Improvement of the quality.
- Socio-economic environment:
  - Need for public participation in the operation of the WWTP in order to accept treated water for agriculture.

The End Users perception of the new strategy

The perceptions of the Municipalities for a new strategy for more efficient use of the region's and the island's water resources and their future reservations include:

- Necessity for a national Water Authority,
- Public participation / involvement,
- Treated water pricing mechanism,
- Subsidies for the irrigation water,
- Awareness campaigns for the safe use of the treated water for irrigation,
- Coverage of the seasonal demand (tourism activities) with desalinated water,
- Ensure the good and stable quality of the treated water,
- Improvements of the distribution system,
- Prioritising demands.

4.7. Formulation of a new proposed Water Management Paradigm based on the results of the stakeholder consultation

The Strategy that will be developed will result from a synthesis of the current responses regarding water management, the responses proposed by the stakeholders and the requirements of the Water Framework Directive that can be implemented in this specific area. The proposed shifting strategy aims at balancing the various pressures on water demand due to the conflicting water uses pertinent in the region (domestic – irrigation – tourist activities).

Figure 17 illustrates a set of practices that form an example of a Strategy. The set was selected from the stakeholders' proposals – including structural and non-structural interventions related to demand and supply side – and Water Framework Directive requirements that can be implemented in Limassol region. Environmental, social and economic constraints were included and considered in the approach.

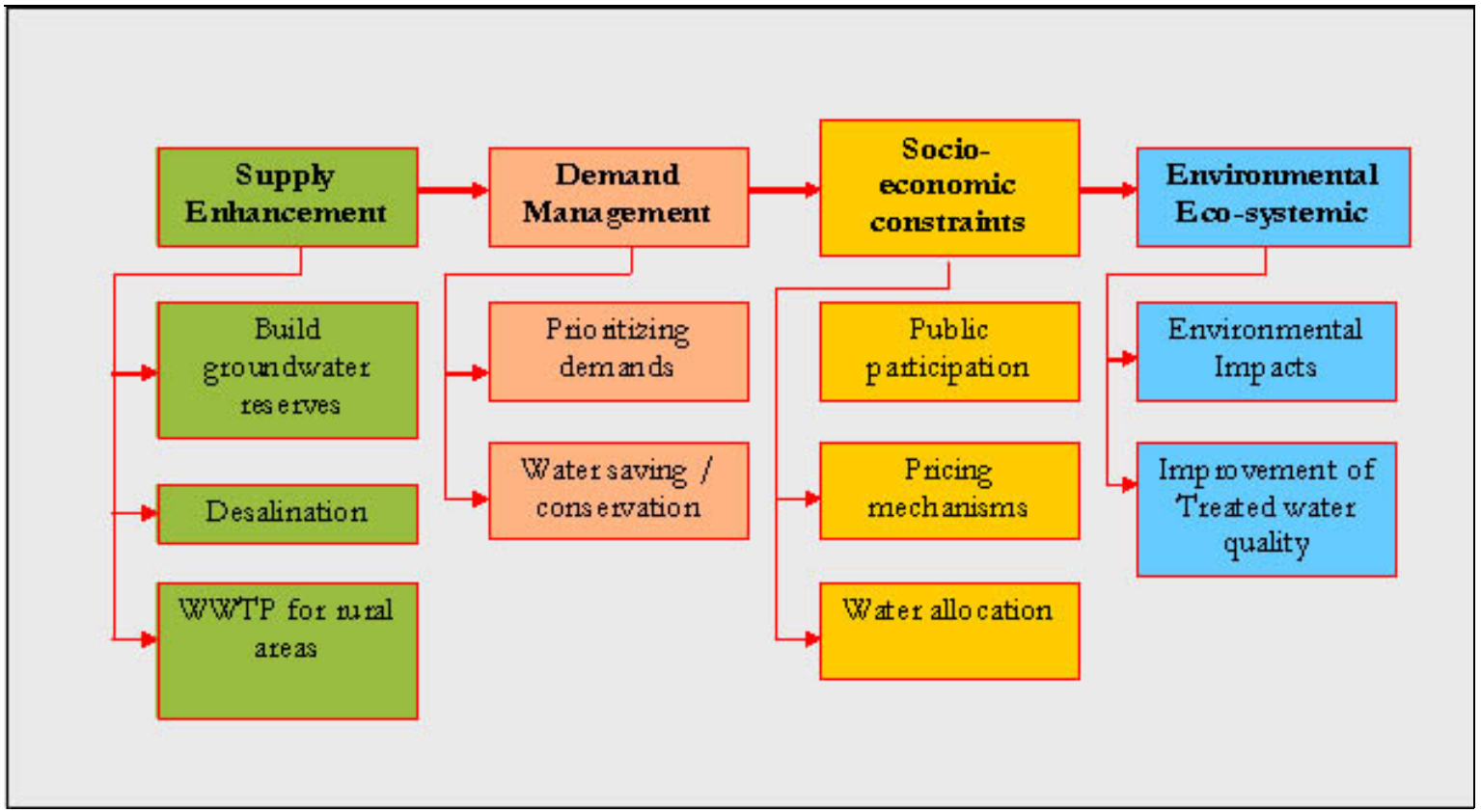

Figure 17. The proposed shifting strategy

Proposed Water Management Interventions

Interventions related to Supply Enhancement

GOALS	INTERVENTIONS
Domestic and tourist demand will be met by surface water – Agricultural demand will be met by surface water freeing the burden on groundwater	SE1: Minimization of groundwater abstraction for drinking water SE2: Upgrade Program of the existing Water Treatment Plan
Maintain irrigated agricultural practice using water from dams and treated water only, to allow aquifers to recover	SE3: Construction of a WWTP for the western rural areas SE4: Minimization of groundwater abstraction for irrigation

Interventions related to demand management

GOALS	INTERVENTIONS
Adjust cropping pattern to less water demanding crops suitable to the climatic and water conditions of the country. Within this promote high income crops Prioritizing irrigation demands during water	DM1 : 1st priority permanent crops 2nd priority seasonal crops

Interventions related to the socio-economic context

GOALS	INTERVENTIONS
Discourage preference on the groundwater Resource	SE1 : Increment of groundwater tariffs to the level of surface water charges
Water tariffs should reflect the true water costs allowing an adequate cost recovery	SE2 : Review of irrigation water allocation criteria
Conciliate water availability with demand	SE3 : Gradual increase of irrigation water prices to reflect true costs (cost recovery) SE4: Introduction of incentives and disincentives to conciliate water availability with demand

Interventions related to the Environmental Eco-Systemic Context

GOALS	INTERVENTIONS
Improvement of treated water quality	E1: Additional infrastructure at the WWTP

This Shifting Strategy should then be evaluated through a series of indices and indicators describing the actual range of the activities applicable to the region and with the input of public involvement, the best solution will be selected.

5. Existing Water Management Plans in the Belice Basin

5.1. Introduction – Background of Water Management practices

The geographic area chosen for the application of the decision support system (DSS) for the Water Strategy Man project, within the Italian case study, is the irrigated district of Garcia Arancio. This area is located on the southern coast of Sicily, in the province of Agrigento. This district was named after two artificial reservoirs that provide almost the whole water supply needed for irrigation. Such reservoirs are the Garcia Lake, located on the left branch of the Belice River, and the Arancio Lake, resulting from the artificial catchment built on the Carboj River. The irrigated area of Garcia-Arancio, together with the nearby Gorgo-Verdura-Magazzolo and Valle dei Platani e Tumarrano districts, are part of the territory managed by the Consorzio di Bonifica (Land improvement co-operative) no. 3 – Agrigento. The Consorzio di Bonifica is a co-operative founded in 1995, pursuant to 45/95 Act, Sicily Region, which establishes the merging of existing associations into a single body to manage water resources used for irrigation in the three districts mentioned above.

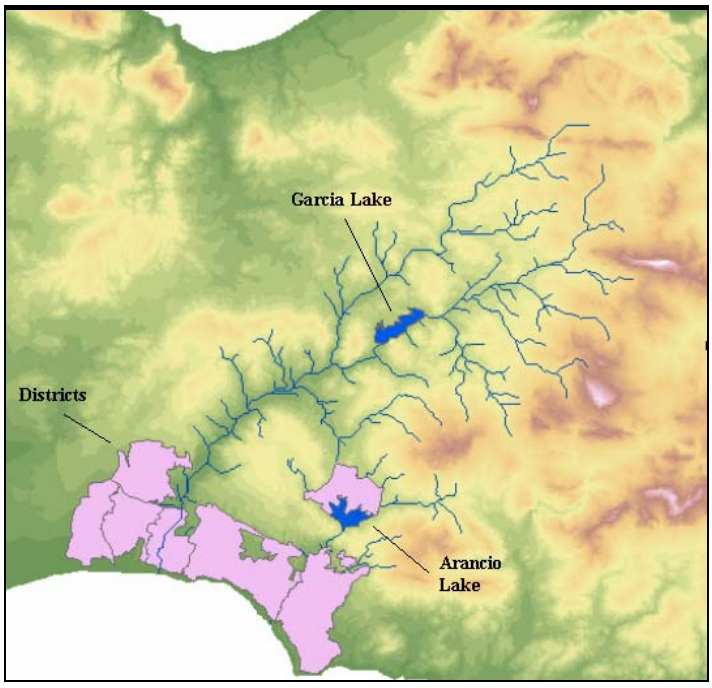

Figure 18. The case study location

The Arancio Lake was formed in 1952 as a consequence of the building of a dam on the Carboj River. This lake served as a basin for irrigation purposes for the nearby territories. It was managed by the Consorzio di Bonifica Basso Belice (Land Improvement Co-operative Basso Belice), a local authority set up in that same year and located in Menfi. Originally, the territory falling within the competence of the co-operative was 8,904 hectares wide, including the towns of Castelvetrano (3,988 ha), Menfi (3,687 ha) and

Sciacca (1,228 ha). In 1990 it was extended to Montevago, S. Margherita Belice, Sambuca di Sicilia e Partanna, totalling 35,000 ha.

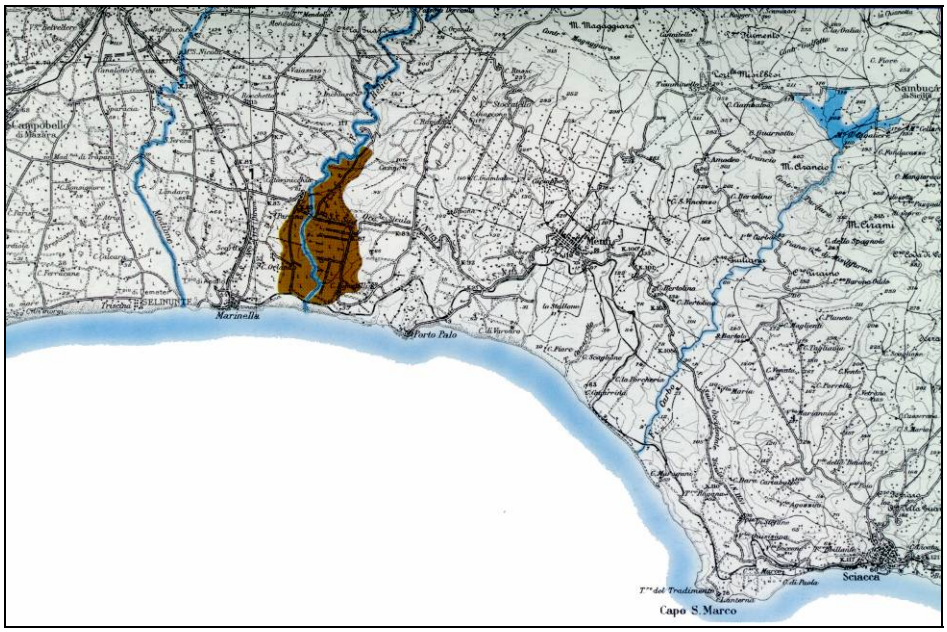

Figure 19. The Basso Belice zone was the first irrigated area managed by the Consorzio

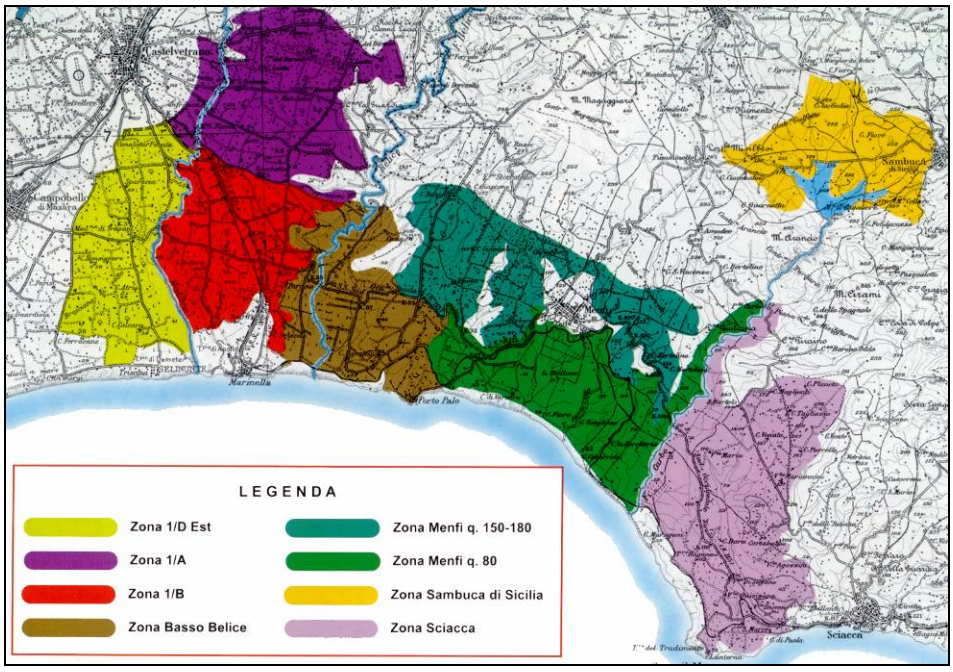

Figure 20. The irrigation districts in 1997

The effectively irrigated area has increased from 700 ha in 1957 to 12,165 in 1991 and to 17,099 in 1997. The Arancio Lake has increased the local water availability: With time, this has also affected the type of cultivations grown in the area. In fact the most frequent cultivations were, typically, sowing cultures and almond grove, which do not demand big

amounts of water. Little by little they were replaced by viticulture and artichoke plantations that provided a better and plentiful production thanks to the increased provision of water. Originally, an irrigation network of hydraulic grade line canals was used. The first pipelines were built in the 1960s, enabling fields located at a higher altitude to be irrigated drawing water from the Arancio Lake. The areas that first benefited from this system were Sambuca di Sicilia and Menfi. In the same years a weir was built on the Belice River in the Margio Rotondo area. The pipelines and the weir together could then serve a further 1,000 ha area in the surrounding territory. In the 1980s the Consorzio Basso Belice started to replace 850 km of hydraulic grade line canals with a pressure line. This work made the water transport system more efficient, while at the same time it minimised water consumption. In the past, the pipeline network was regulated at users' requests. It currently works under a fixed rotating shift scheme put into place to meet specific water provision needs. Thus the diameter of the outlet pipes and therefore the network building cost could be both reduced. At the end of the 1980s the irrigation network in operation was 1,280 km long, and included 430 km of pipelines while the remaining 850 km were hydraulic grade line canals. By 1993 the whole network was made up of pressure line: it was possible to start the automation of the irrigation system; to introduce new methods of irrigation – such as the sprinkler and drip irrigation; and to cultivate those unused parts of the fields previously occupied by the canals.

The automation of the irrigation network has improved the water supply system and has even reduced its cost. The water supply is directly controlled by the operators, who can immediately identify any breaks in the network, and consequently any water leakage. On the other hand, the user can check at any time the effective volumes of water supplied. Water is supplied according to a shift plan determined in agreement with all the users. The amount of water served depends on the kind of cultivation grown and the extension of the area to be irrigated. The main and secondary water supply systems of the Consorzio are provided with flow meters, electronic valves and sluice valves operated by a computer network. On-site computers, located near the junctions of the network, control up to 189 valves each.

Between 1977 and 1985 the artificial dam of Garcia was built on the Belice Sinistro River. Water from the Garcia Lake was used for irrigation and domestic purposes in the provinces of Palermo, Trapani and Agrigento. At the beginning of the 1990s the Consorzio Basso Belice Carboj had a water supply pipeline built between the Garcia and the Arancio lakes, so that the Arancio Lake could be supplied with more water to irrigate other portions of land. In 1993 the water pumping plant of the weir on the Belice River was enhanced in order to improve the existing water resources used for irrigation, to meet the increasing demand, and to face possible drought periods. The Belice pumping plant was connected to the network of the Arancio Lake in order to supply the lake with water during the winter season.

5.2. Description of existing infrastructure

The existing infrastructure for water management in the Garcia-Arancio irrigated districts compounds of the artificial lakes Garcia and Arancio, the Belice River, and a network of pipelines connecting them each other and supplying water to the existing users in the zone. Hereunder a short description of the lakes and rivers, which represent the water resource system of the entire district, follows.

Belice River

The Belice Basin covers an area of about 967 km^2, in the administrative territory of Palermo, Trapani and Agrigento provinces. It borders with the Modione and Freddo River Basins at the west, with those of Jato and Oreto at the north and with those of Verdura and Carboj at the east. The Belice River is divided into three branches, the Right Branch, the Left Branch, and the stretch after the confluence near the town of Poggioreale, each one defining sub-basins. The Right Branch has a length of 55 km and flows from The Northern part of the Basin. Its basin covers an area of 227 km^2. The Left Branch has a length of 57 km and comes from Mount Leardo and Mount Rocca Busambra and is supplied by torrents Fosso and Bicchinello. Some of its tributaries are Corleone River and the torrents of Batticano and Realbate. The sub-basin has an area of 407 Km^2. After the confluence the river extends for 50 km up to the Sicily Canal and receives water from Senore torrent.

Garcia Lake and connected aqua ducts

The Garcia Lake is an artificial lake created on the Belice Sinistro River with the building of the Garcia dam. The dam was built during the years 1977-1985; its reservoir has an upstream watershed of 366 km^2. The maximum capacity of the lake is 80 million m^3, while the useful capacity is 63 million m^3. The average yearly water availability has been recently estimated at 55.2 million m^3.

The Garcia reservoir is managed by the Consorzio di Bonifica (Land improvement Co-operative) no.2 Palermo, in collaboration with EAS, Ente Acquedotti Siciliani (local authority in charge of aqueducts in Sicily). The reservoir supplies several areas of the provinces of Palermo, Trapani and Agrigento with water for irrigation and domestic purposes. The current total amount of drinking water resources of the Garcia Lake is 10 million m^3. It is almost equally divided between the two big aqueducts of Montescuro Ovest and Favara di Burgio, both managed by EAS and connected to the purification plant of Sambuca di Sicilia. The Montescuro Ovest aqueduct is provided with a yearly water supply of 4.7 million m^3, which is 35% of its water demand. The remaining 65% is covered by the water springs of Montescuro, next to the mountain chain Sicani.

The Montescuro Ovest aqueduct supplies water to some of the towns in the provinces of Palermo, Trapani and Agrigento. Some towns, such as Castelvetrano, Partanna (Trapani), Sambuca di Sicilia and Santa Margherita di Belice (Agrigento) are included in the WaterStrategyMan project.

The water supply for the Favara di Brugio aqueduct is provided by the water springs in the town of Caltabellotta, while the Garcia Lake provides about 5 million m³ per year, namely 33% of its water demand. Menfi and Sciacca are among the towns of the Agrigento Province served by the Favara aqueduct. However, for the case study purposes these cities are part of the Garcia Arancio territory.

As far as irrigation is concerned, the Garcia Lake supplies about 14 million m³ to the Consorzio no. 1 Trapani; 8.9 million m³ to the Consorzio no.2 Palermo, partly given to the Dagala Renelli irrigated area with an extension of 1,289 ha; and 26.3 million m³ to the Consorzio no. 3 Agrigento. In particular in the latter case, water from the Garcia Lake can be gravitationally transported down to Arancio Lake: it represents the main irrigation resource of the Garcia - Arancio territory.

Arancio Lake

The Arancio Lake was built in the years 1951-1952 on the Caboj River, on a hill about 15 km from the coast. It served as a water supply basin for the irrigation of the surrounding farmlands. The lake is provided with water from the upriver section of the Carboj River, the Rincione Torrent, from other minor torrents and during the wet season also from the water supply pipeline from the Garcia Lake. The lake is managed by the Consorzio di Bonifica (Land improvement Co-operative) no. 3 Agrigento in collaboration with ESA, Ente di Sviluppo Agricolo Siciliano (local authority for the agricultural development in Sicily). Its capacity is 32.8 million m³, its surface is 3.7 km² and the total upstream watershed area is about 205 km². The useful volume is 30.8 million m³ and is entirely for irrigation. The Arancio Lake represents the main water resource of the Garcia Arancio district managed by the Consorzio di Bonifica no.3 Agrigento, a branch of Menfi.

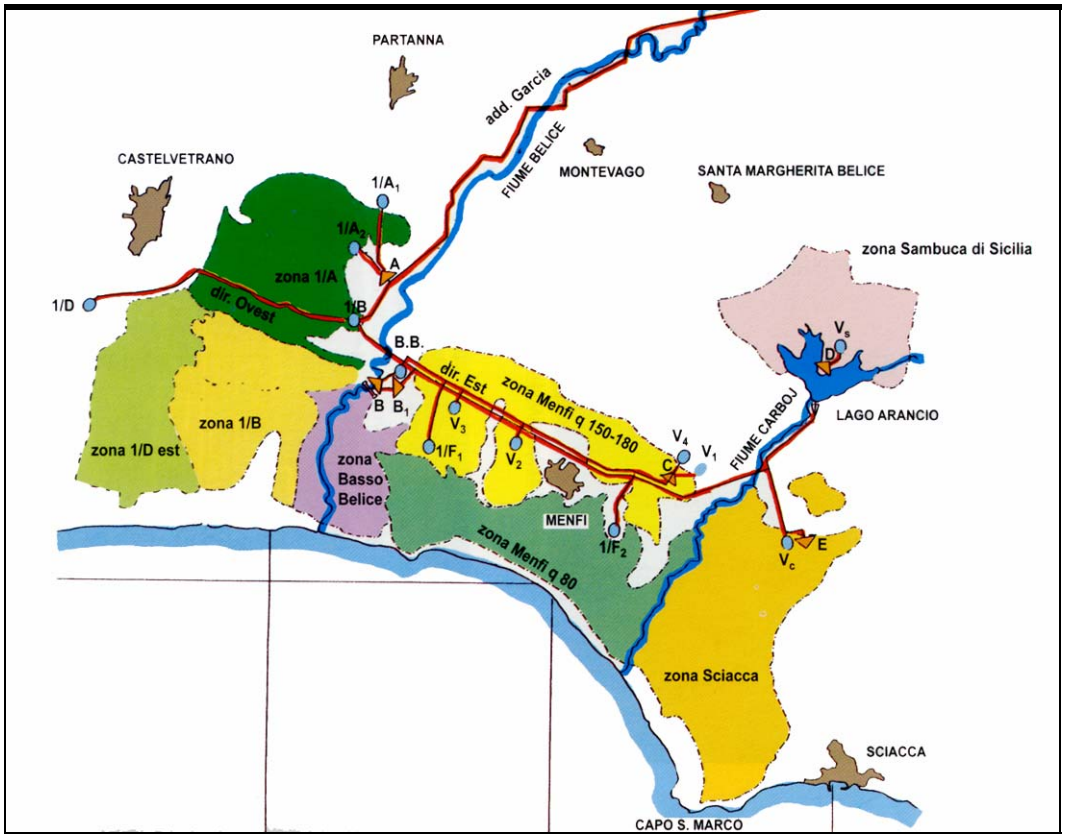

Figure 21. The hydraulic scheme of Garcia-Arancio-Belice

Main Pipeline Connections

In 1993 the water supply pipeline that connects the Garcia reservoir to the Arancio Lake was completed. The main conduit is made of steel, with a diameter ranging from 2,300 to 2,500 mm. It stretches southwards for 26 km, along the course of Belice River. On its lower end, the main water supply pipeline divides into the East and the West branches. The East branch goes through the irrigated area of Menfi, parallel to the coast, and reaches the Arancio Lake. The conduit is 17 km long, with a 1,600 mm diameter. It supplies the Arancio Lake during the dry seasons. Moreover, two storage tanks supply the district of Menfi, a territory under the management of the Consorzio. The West branch stretches for 17 km to Castelvetrano district and ends in a storage tank. This tank supplies with water for irrigation purposes not only the Garcia and Arancio territory, but also other outside areas that are managed by the Consorzio of the nearby Trapani Province.

5.3. Existing Water Management Plans

The surface water resource of the Garcia and Arancio reservoirs represents the most important source of water supply, both for irrigation and for domestic use. As far as water management by Consorzio 3 Agrigento is concerned, water is supplied to the relevant irrigation districts from the two lakes and from the Belice River. The Arancio Lake was exclusively built for irrigation purposes: with 32.8 millions m³ available yearly, it represents the primary water source in the area all the year round. The Arancio Lake is

refilled with water from the Garcia reservoir on the Belice River. The refilling operation is generally done during the summer, when water demand reaches its highest level. Since the capacity level of the Garcia Lake is 194 m, while the Arancio Lake's is 179 m, the connection between the two reservoirs through the supply network (Principal, East and West supply pipelines) is done gravitationally without further energy cost. According to their needs, Garcia Lake water can be conveyed to the districts of the Garcia-Arancio territory through the storage tanks and the pumping stations on the East and West branches.

During the winter months water requirements are also fulfilled with water from the Belice River. Water is pumped into the East water supply pipeline to the Arancio Lake, as a refill, or directly to the final users. The water management of the Garcia-Arancio-Belice territory is supported by the remote control centre at the Menfi branch.

The Garcia-Arancio irrigated district is divided into four sub-districts, namely Castelvetrano, Menfi, Sciacca e Sambuca di Sicilia. Hereunder some details about the water management of each sub-district are given.

The Castelvetrano area includes from 1997 four different zones: 1/A, 1/B, 1/D Est and Basso Belice, all located in the administrative territory of towns Castelvetrano and Partanna.

Zone 1/A is 2,745 hectares wide. Water service for irrigation is operating from 1992 and makes use of a distribution network of 214 Km, made up of steel conducts. This network is provided with water from the main pipeline connected to the Garcia Lake: water is pumped from the pipeline towards two storage reservoirs located at an altitude of 240 and 190 m. The Zangara pumping station comprises six pumps of 100 m head, and input power of 684 KW, allowing the transfer of 748 l/s. The internal distribution network has been designed for a computer-based delivery of a 15 l/s discharge, and according to a fixed rotating shift scheme.

Zone 1/B is 2,189 ha wide. Irrigation water comes from the tank 1/B that has a capacity of 40,000 m^3 and is at the south end of the main Garcia adductor, where it splits into the West and East branches. The tank feeds an internal network of 155 Km, which is computer-based and under the remote control of the agency headquarter. The network operates since 1993 and carries a discharge of 15 l/s by gravity.

Zone 1/D Est is 1,946 ha wide and is served since 1999. It gets water from the West branch, whose ending is the 1/D tank of 90,700 m^3. The distribution network has the same characteristics of the zone 1/B's.

Zone Basso Belice was the first irrigated area in 1952 under the competence of the newly founded Basso Belice-Carboj Agency for Land Reclamation. In the 1950s the distribution network was made up of grade line canals, replaced in 1964 by the actual pressure line. The irrigated area of about 1,130 ha is served by a network of 125 Km, which conveys a discharge of 5 l/s, through conduit diameters of 150 and 1,000 mm. Water is supplied to the BB storage reservoir either by gravity, by the East branch, or by

pumps from the weir on the Belice river. In the Basso Belice zone the water service is on demand (no shift schemes) and supply is not computer-based.

The Castelvetrano irrigated district has a total irrigation network of 494 Km with an average efficiency of 0.8. The maximum cultivable area is 8,010 ha.

The irrigated district of Menfi comprises two separate areas, at an altitude range of 0-80 m a.s.l and 150-180 m a.s.l. respectively, each one having its own storage tanks and irrigation network. The 0-80 m zone, of about 3,360 ha, is one of the first irrigated areas of the Consorzio, being served by grade line canals in the 1950s and by a pressure line. The internal water network works by gravity, has a length of 255 Km and is provided from the East branch of the Garcia adductor through the tanks 1/F1 and 1/F2 of 12,200 m^3 and 28,000 m^3. The water supply works actually under a fixed rotating shift scheme, while in the past the Consorzio allocated water to each user according to the estimation of the actual water required by the types of crops and irrigated areas. The 150-180 m zone, of about 2,000 ha, has a distribution network of 230 Km including pipelines of various diameters (range 150 mm – 900 mm), and involves the four storage reservoirs, V1, V2, V3 and V4 of the total capacity of 23,900 m^3. The water delivery is not controlled automatically and works by gravity for the 150 m areas, while water is pumped to the users of the 180 m. A discharge of 20-24 m^3/s is available to the users of the district. The maximum cultivable area of the Menfi district is about 5,360 ha and is covered by a total network of 485 Km.

The Sciacca district lies on four altitudes, 80-150-180-220 m a.s.l., covering 3,925 hectares of irrigated land over 17,040 of surface area. The distribution network has a length of 311 Km, with pipelines made of different materials such as steel and PVC, and measured with diameters from 355 to 1,000 mm to supply a discharge of 15 l/s. 50% of the irrigated area is at an altitude lower than 100 m and receives water by gravity from the Caricagiachi storage tank, in turn fed directly by the Arancio Lake. Water is carried to the upper sites of the zone by pumping stations.

The fourth district belonging to the Garcia-Arancio area is the Sambuca di Sicilia. These lands are located in the surroundings of the Arancio and are irrigated directly from the lake by pumping water up to the Vs storage tank of a 5,000 m^3 capacity, and then from the tank to the internal irrigation network. The pipelines lie for a total length of 200 Km and are designed for a 16-18 l/s discharge. The maximum cultivable area of the Sambuca di Sicilia district is about 1,750 ha.

According to the tariff plan approved by the Consorzio in the 1998, the local crops are divided into seven classes based on their own water requirement, and a maximum supplying water volume per season has been defined, which corresponds to a specific price of water. The management rule usually applied by the agency says that the tariff does not change as long as the customer asks for up to 10% more water with respect to the defined max agreed volume. Any volume exceeding this 10% is sold at 0.12 €/ m^3.

The water price for industries, Hotels and animal breeding sites is about 0.31, 0.51 and 0.72 €/ m^3, respectively.

Since the Consorzio started operating in the area, the applied irrigation methods have changed from surface to sprinkler and drip irrigation, thus reducing manpower needs and increasing both efficiency indexes and water savings. The sprinkler method is actually used for crops such as fodder plants, grass for hay and orchards, whereas drip is for vines, olive trees, artichokes, peppers and tomatoes.

The water supply to the agricultural users is performed upon previous submission of applications on dedicated entry forms. One month before the irrigation season starts, usually in March, each water presents a detailed request for water to the Department for Irrigation of the Consorzio. This submission regards only annual crops, as the areas and the types of perennial cultivations are already known. On the basis of all the requests that have reached the department in time, the weekly or fortnightly turns of irrigation are fixed. The total amount of water supplied to the single user is estimated according to the type of crops and the respective cultivated areas. At the end of the irrigation period for annual crops, the computers of the remote control automatic centre provide the data about water volumes actually delivered.

5.4. Description of the local stakeholders and the selection of stakeholders approached

The local stakeholder contacted for the Italian case study of the Water Strategy Man European Project is the local water authority, directly involved in the water management of the Garcia-arancio irrigated district, namely Consorzio 3 Agrigento – Agency of Menfi. This authority was founded in 1997, when the water management for irrigation of Sicily region was organized in eleven macro-zones of competence, overlapping the administrative territories of the provinces.

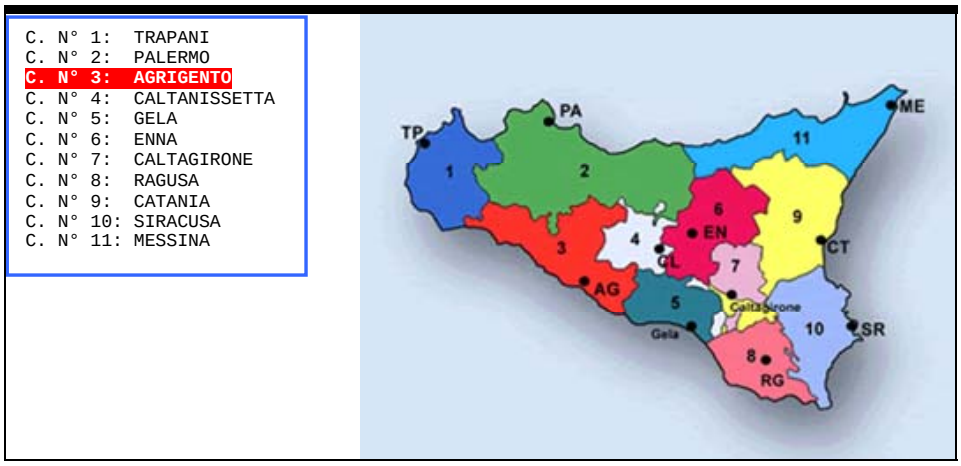

Figure 22. The eleven Consorzio of Land Reclamation of Sicily

In the territory of Consorzio 3 Agrigento (C3A), there are 42 Commons of Agrigento, 2 of Trapani, 6 of Caltanissetta and 6 of Palermo. The total area is about 280,139 ha, of which 43,778 hectares are equipped for irrigation, 33,033 ha is the cultivable area and 10,745 ha is the actual irrigated area. An area of 1,123 ha is equipped with a network of

pipelines extending for 29 Km, while the rest of the area is covered by networks of open surface canals.

The C3A controls and administers eight different districts for irrigation. The first is Garcia-Arancio, the one under study in the WSM project. Three of them are indicated as the Gorgo-Verdura-Magazzolo District: the Sosio-Verdura derives its name from the two rivers Sosio and Verdura, the Gorgo and the Castello are related to the homonymous present reservoirs. The Turvoli, Valle Platani and S. Stefano Quisquina are indicated as the Valle Platani-Tumarrano District and concerns the Valley of Platani and Tumarrano rivers. The last district managed by C3A is the S. Giovanni–Furore, the name coming from the two reservoirs supplying the area.

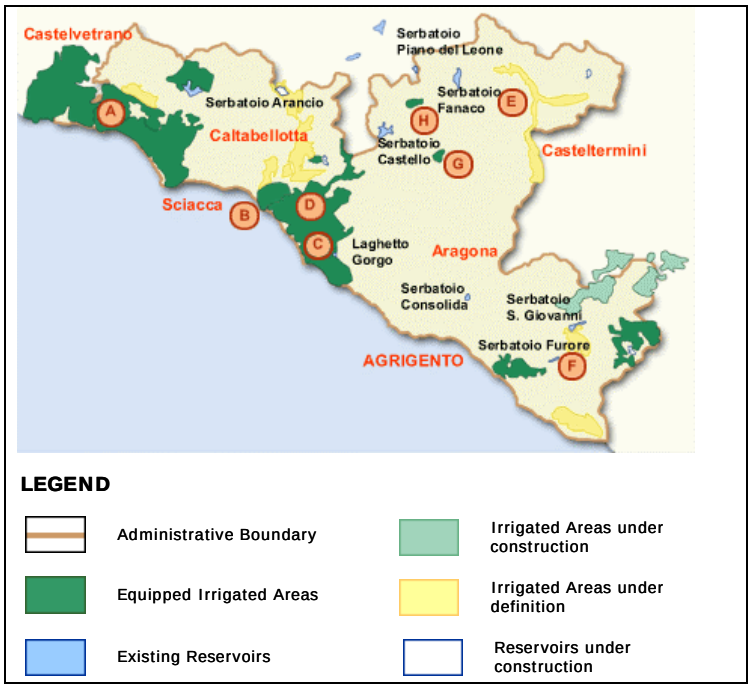

Figure 23. The eight different districts for irrigation under the C3A administration: (A) Garcia-Arancio; (B) Sosio-Verdura; (C) Gorgo; (D) Castello; (E) Valle Platani; (F) S.Giovanni-Furore; (G) Turvoli, (H) S.Stefano Quisquina;

The Consorzio 3 Agrigento is responsible for land reclamation and for some institutional activities. Among the reclamation schemes and works, C3A carries out:

- Conservation and protection of soil and of its hydro-geological structure, with particular attention to soil consolidation, slopes stability, prevention of hillside erosion and landslides;
- Preparation and adaptation of free-hold lands and related drainage networks;
- Monitoring and protection of surface and ground water used for irrigation and animal breeding;
- Building of infrastructures for pumping, delivery, transfer and distribution of irrigation water;

- Maintenance of infrastructures;
- Landscape care and preservation of the agrarian ecosystem.

The involvement of the C3A authority in institutional tasks regards:

- Preparation and adoption of land reclamation plans;
- Surveillance and inspection of compulsory private works as provided in the reclamation plans;
- Processing of indexes of water quality, and analysis an definition of acceptable standards for agricultural uses;
- Design of public works of regional competence.

The activities of the Consorzio are distributed among five different offices, three of which are the technical: Department for Irrigation, Department for Land Register, and Department for Works Programming.

The Department for Irrigation operates the water distribution network in terms of ordinary maintenance, administrative issues, analysis of water demands, and definition of the water volumes to be supplied to each user.

The Department for Land Register handles the census of all the landowners in the administrative territories of the Consorzio. It also works with the Regional Office for Agriculture and Forests finalizing decisions about the land dispossession oriented to new public works for reclamation.

The Department for Works Programming is responsible for the preparation of the three-year plan of public works to be implemented, and for the design phase of the work. It collects and processes the data defining the state of the territory and the available water resources. It also handles the monitoring of the infrastructure and indicates the needs of maintenance.

5.5. Consultation procedure

Field research and analysis was considered necessary prior to approaching the Consorzio di Bonifica 3-Agrigento, Menfi branch, is the final user of the Decision Support System (DSS) in the Garcia-Arancio case study. They were contacted at the beginning of the project and they immediately showed great interest in being involved in the application of the DSS software as well as on the study methods of the WSM project.

Being the Menfi agency actively operating and responsible for the Garcia-Arancio district, this territory has been chosen as the application case study of WSM system, leaving out the other two areas controlled by the Consorzio 3, namely the Gorgo-Verdura-Magazzolo and Valle dei Platani e Tumarrano. The intentions of the local authority is to involve these areas in the application of WSM tool in the next future, provided that the present job achieves positive results and the agency is satisfied with them.

There are many reasons for the choice of this agency as a stakeholder. They were available to take part in the project, and also they have been managing the agricultural activities of that territory for more than 50 years. They supported the development of such areas by improving economic and human resources. Moreover, they developed knowledge of the use of available water resources, as well as of the needed structures to cope with an ever growing water demand.

In the course of some meetings with the staff of the Consorzio, seat of Menfi, an analysis of water resources available in the area was completed, together with the description of how water is supplied for irrigation purposes. The following are the main points submitted to the Consorzio: the DSS approach to the integrated management of resources, the methods of analysis for water availability and irrigation demand scenarios, and the development of the system interface and priorities in water volumes location. The different views of the case study have been shown in the form of nodes and links on the map. This analysis was useful in order to find out what data was already available for DSS application, and which had to be collected and possibly re-processed.

5.6. Consultation results

The agency 3 Agrigento described how important automated irrigation was for the reduction of management costs and for the users' satisfaction. Another advantage was the development of the territory in terms of general improvements and even of its size. They were particularly focused on water saving strategies, presenting methods such as drip irrigation. They were also interested in how to grow plants under difficult water supply conditions. The general trend in the management of water resources is the combined use of available resources, possibly by building line connections among the water sources of the study area and between these latter and those of the surrounding areas. This makes it possible to take water from water-rich areas to drier ones, and to store it in reservoirs, particularly during the wet seasons. In this way water is easily available even at peak times in water demand, especially during irrigation periods.

Another important element for the Consorzio is the energy and maintenance cost of pumping stations. These stations convey water to Arancio Lake through the weir of Belice River, and then take water from the lake up to the most elevated areas of the territory. A project for the utilization of wind power as a source of energy for water pumping stations is also under study.

5.7. Formulation of a new proposed Water Management Paradigm based on the results of the stakeholder consultation

Within the development plan of the district for the medium-short term, building of new connections between existing water resources has a primary role. The S. Carlo project concerns the construction of a main supplying pipeline, 35 Km long, to carry water from outside the Garcia-Arancio district towards the storage tank named Caricagiachi and the Arancio Lake. This hydraulic structure is a dual-purpose. First, water will be delivered to

the irrigated areas of the Sciacca Province by gravity, thus saving the energy actually used to pump water from Arancio up to the Caricagiachi tank. The second objective of the S. Carlo project is to cover the water demand peaks in the neighbouring irrigated district of Gorgo-Vedura-Magazzolo, providing water from the Arancio reservoir. S. Carlo is a location in the territory of Burgio City, East of the Arancio Lake. Here a hydroelectricity plant receives water from the upstream Gammauta artificial reservoir, built on the Sosio River, an attribute of the Verdura River. The return flow of the plant is discharged in a downstream section of Sosio where another hydropower plant, namely Favara Plant, is placed. The S. Carlo Plant is also going to get water from another eastern reservoir, Castello Lake, by means of another new connection by the Consorzio. With the new supplying pipeline of the S. Carlo project, the lakes Arancio, Gammauta and Castello will be inter-connected, allowing flexibility in the water resource allocation and transfers between the two neighbouring irrigated districts of Garcia-Arancio and Gorgo-Vedura-Magazzolo.

The search for alternate ways to supply water, aiming to increase the energy availability for new future pumping plants is a major issue for the Consorzio no. 3 Agrigento. The S. Carlo project goes this direction by considering the replacement of an energy consuming delivery scheme, as it is the storage tank Caricagiachi, with another one not consuming at all (transfer by gravity). The exploitation of the wind energy is a further solution as well, which is a practice already adopted in some areas of Sicily. Wind power plants in the Western part of the region are: a) the Sclafani Bagni station, around Palermo, that is equipped with 11 aerogenerators providing 660 KW each, and b) the Caltabellotta station, located in the Gorgo-Vedura-Magazzolo District and comprising 10 generators of 750 KW each. Feasibility studies are being implemented in order to build a new wind power plant in proximity of the Arancio Lake. This structure will provide energy to some existing pumping stations such as the one at the Belice weir, actually consuming a pretty high amount of energy to refill the Arancio during the winter season.

Other interventions to be implemented in the Garcia-Arancio concern the replacement of the remaining open surface canals with pressure lines and the completion of computer-based infrastructures. Besides, new supplying networks and irrigation equipments are being built in the new agricultural site located at the north of Menfi.

6. Existing water management plans in Tel Aviv and the Arava Region

6.1. Introduction – Background of Water Management practices

Israel is located on the Eastern Shore of the Mediterranean Sea. It is bounded on the north by Lebanon, on the northeast by Syria, on the east by Jordan and on the southwest by Egypt. Its southernmost tip extends to the Gulf of Aqaba, an arm of the Red Sea. Israel covers 21,946 sq. km (8,473 sq. mi.).

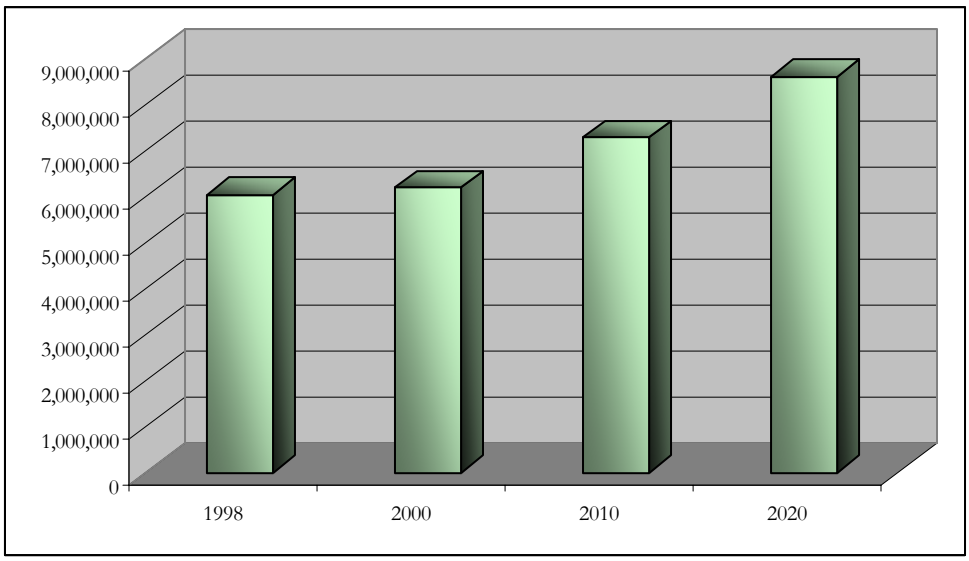

Figure 24. Permanent Population Development and Projection

In principle, for the purposes of analysing its water resources and management Israel can be examined as a single geographic entity because of:

- Freshwater: The National Water Carrier (NWC) connects all major sources of freshwater into a single network. Water can be transferred from one region to another, so that water from one aquifer may be used in a different geographical region. In addition to the NWC which transfers water from the Sea of Galilee in the north to the centre and the south of the country (Negev), there are some additional major pipelines:
  - Connection of the coastal aquifer (in the west) to the Jerusalem metropolis,
  - Connection of the NWC to the Northern Coastal Plain and Western Galilee (in the north), and
  - Connection of the Hula Valley (near the source of the Jordan River) to the Mountains of Galilee.
- Recycled water: The Shafdan, a plant for the treatment of urban and industrial effluent of the greater Tel Aviv metropolitan area (which includes more than 30% of the country's population), is responsible for transferring recycled water to

the southern region (Western and Northern Negev) for agricultural use. Two large additional networks convey recycled effluent from the Jerusalem metropolis to the Negev Plain and from the Haifa metropolis to the Western Jezreel Valley, respectively.

- Pricing policy: Water prices by quality and sector (agricultural, industrial, urban) are more or less uniform throughout the country.

However, for the current study two sub-regions were selected, Tel-Aviv and the Arava.

6.2. Description of existing infrastructure

Tel Aviv Region

The region is located in the coastal plain on the eastern shore of the Mediterranean Sea (and it lies above the coastal aquifer. In terms of population, the Tel Aviv region is the largest in Israel with two million people, 30% of the total population. The region has 160,000 dunam (1 dunam = 0.10 hectares) of cultivated agricultural land, 5% of the total cultivated land in the country. The region's water economy is therefore characterized by relatively high domestic and industrial consumption, and relatively low agricultural consumption. About two thirds of the fresh water is supplied to the region via the national water system operator by the national water company, Mekorot. The remaining third of the fresh water is provided by private producers from the coastal aquifer. In the future, this region is slated to receive a significant amount of desalinated sea water.

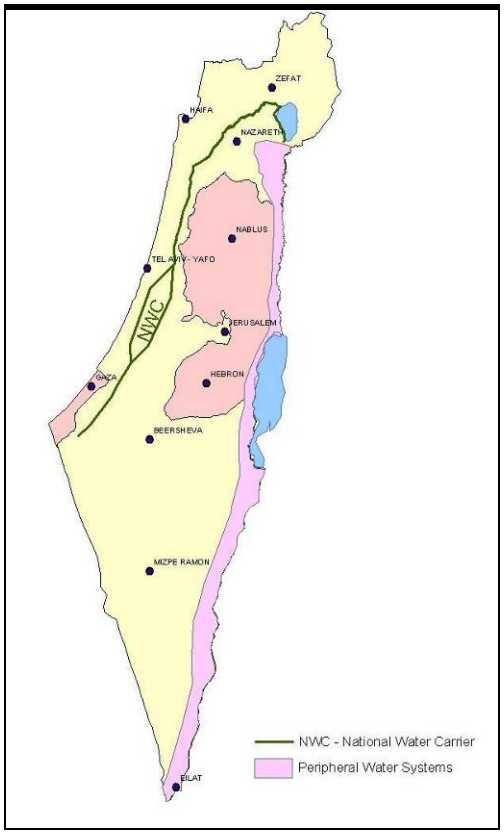

Figure 25. Water Network of Israel

Domestic consumption is similar to the national average (100 m^3 per capita per annum). This consumption is expected to increase by 20% with the development of metropolitan parks and the improvement in quality of life. The quality of the freshwater is good, with a salinity level of 150-250 mg chlorine per litre. In the future, the use of desalinated water will lead to an improvement in the water quality. The region's large population creates the potential for a large supply of recycled water for agriculture. In addition, high quality treated waste water can be used for irrigation of metropolitan parks and for rehabilitation of streams like the Yarkon River. The climate in the region is Mediterranean, semi-arid, with annual precipitation of 450 mm.

Arava Region

The region is located at the south-eastern tip of Israel, between the Dead Sea and the Red Sea. The region is sparsely populated, based mainly on the tourist city of Eilat at the southern tip. The remaining population is scattered in rural villages. Land prices are low and there is no demand for additional urbanization. Domestic per capita consumption in this region is particularly high, for two reasons:

- Dry climatic conditions lead to heavy evaporation and a greater demand for garden irrigation and drinking water.
- A large part of the population lives in rural settlements, where large amounts of water are needed for private and public gardens.

Climatic conditions in the region: arid climate, very low precipitation (up to 10 mm rain per annum), aridity index 0.65. The climatic conditions favour intensive cultivation of vegetables, flowers and date palms. Some 40% of the greenhouses in Israel are located in this region.

The water supply system in the Arava is not part of the national water system. The region receives water from local sources only, via the national water company Mekorot. Drillings in the centre of the region (Faran drillings) yield water of reasonable quality - up to 350 mg chlorine per litre. Drillings in the southern Arava yield low-quality water of 600-1,100 mg chlorine per litre. It is important to note that the Red Sea is a unique coral reserve of great ecological value, and it is therefore essential that waste water be recycled for agriculture and not be disposed of in the sea.

6.3. Existing Water Management Plans

Tel Aviv Region

There is no private ownership of water in Israel. By the Israeli Water Law of 1959 all water sources are publicly owned and their utilization is controlled by the Water Commissioner. The allocation of water is administrative: the commissioner issues permits for production (extractions) to suppliers as well as allocations (quotas) for agricultural consumers.

Prices of water delivered by the national company Mekorot are set by the government, and are determined in a procedure which is open to political pressure (skilfully applied by the agricultural lobby). Viewing water prices not as an allocation instrument, but as a means to improve income distribution, water charges depend on the type of use: farmers pay the lowest prices, industry pays higher prices and households pay the highest. Within each sector prices do not depend on location: users in all parts of the country face the same prices, regardless of the supply price of water. Private water suppliers are subject to quotas but can set prices independently.

The actual planning of water allocation made by the Water Commission follows several stages:

- Predicting annual water demand by sector and region (including, of course, that of Tel-Aviv), given the actual water prices.
- Determination of "red lines" for each of the major water sources and the implied total production permits of fresh water;
- The gap between aggregate demand and total supply of fresh water is bridged via investments in the water economy aimed at:
    - increasing the volume and flexibility of the within-region and between-regions conveyance systems of fresh water,
    - development of additional (environmentally safe) water treatment plans, reservoirs and conveyance systems;
    - improving the quality of fresh water as well as of the recycled effluents; and, in the longer run,
    - desalination of sea water.

The current management practices result in:

- Continuous pressure on the governmental budget to increase the share allocated to investments in the water economy, and continuous pressure of the budget department of the Ministry of Finance to increase water prices, including the prices for agricultural use.
- The above pressure to raise prices is balanced by the agricultural lobby which is very influential in Israel. The main interest of the farmers is to receive as large as possible an allocation of fresh water at the lowest attainable price. The consequences of the success of the agricultural lobby have been over-utilization of water for many years, hydrological deficits, the intrusion of seawater into the coastal aquifer, contamination of reservoirs, and the reduction of the carry-over capacity of the system. A major part of the hydrological crisis is also an environmental crisis, with continuous pollution of the rivers, aquifers and other natural resources. Serious ecological damage affecting unique natural resources and landscapes often results.

These detrimental effects are among the major reasons for the current severe water crisis. Although still very influential, the agricultural lobby lost some of its political power in the last two decades.

Additional conflict in the water economy exists between the agricultural and the urban sectors regarding the purification standards for disposal set for the cities by the government. Another conflict is over the allocation of the costs and the benefits associated with recycling between the generators of sewage (the municipalities) and the agricultural users. An additional conflict is the issue of assurance for the municipalities that the farmers will not reduce usage suddenly (due to an economic crisis for example) and leave the cities with treated water that cannot be disposed of.

New and forthcoming partial privatization of water supply is a potential source of conflict between the government-owned company, Mekorot, and private entrepreneurs on two issues: the control of the supply of newly developed water resources (mostly desalinated sea water and recycled wastewater) and the responsibility for the operation of the intra-cities water systems (currently operated by the cities themselves).

The current paradigm is the result of inefficient institutional and administrative mechanisms for water allocation and of a poor decision making culture (hydro-politics). The above-mentioned unsolved ongoing conflicts partially paralyze the water economy. This is especially true in a run of dry years (as in 1998-2001) in which many of the problems become more severe. The main quantitative expression of the current crisis is the severe reduction in the ability to produce freshwater from the aquifers (approximately 500MCM) without operating additional wastewater reclamation systems and desalination plants. The agricultural sector bears the brunt of the cuts (since the demand of the other sectors is rigid), and its allocation was recently reduced by about 40%.

To conclude, Israel (with the Tel Aviv region being a representative example of the situation associated with the national water system) is an example of a developed water economy experiencing a man-made water crisis. There has been neglect, much need to be repaired, and attention must be paid to changing circumstances. A sustainable growth of the water sector requires a new paradigm. Fortunately, the fundamental structure of the sector is sound and the basis for reform exists.

Arava Region

The prices for all the water supplied by Mekorot, fresh and saline, are determined within the national framework. Saline water is cheaper than fresh water, in accordance with the salinity level. The price for recycled water for agriculture covers the operational and the capital costs of Mekorot, after discounting state grants.

The desalination plant of Red Sea water provides water for the local population in Eilat, the only city in the region.

The utilization of recycled waste water produced in Eilat for irrigation is insufficient and inefficient, due to lack of adequate storage facilities and conveyance systems as well as

poor institutional structure. The potential to recycle wastewater produced in the rural villages is not utilized as well.

6.4. Description of the local stakeholders

The following is a partial description of the entities involved in regulating and allocating resources to the water economy. The large number of parties involved is most apparent, as are the implications of the subsequent bureaucratic maze that hinders initiative and change.

- Water Commission (Min. of Infrastructure - Until 1996-Min. of Agriculture):
  - Aquifer pumping policy (Operations Comm. of the Hydrological Service),
  - National & regional planning of installations (Planning Division), and desalination tenders,
  - Allocation of quotas for all water types (Consumption Division),
  - Encouraging saving water in the various sectors,
  - Approval of wastewater reclamation projects,
  - Participation in setting water prices,
  - Equalization Fund.
- Ministry of Agriculture:
  - River drainage and flood prevention (Drainage Division),
  - Grant approval for investment in irrigation projects (Investment Administration),
  - Right of veto on water prices.
- Ministry of the Environment:
  - Initiation and approval of all river administrations' projects (in conjunction with the Jewish National Fund-KKL),
  - Authorization for irrigating with recycled wastewater above aquifers,
  - Authorization to dump wastewater into rivers and the sea.
- Ministry of Health:
  - Purification standards for all water types and all their uses,
  - Authorization for irrigating areas adjacent to wells.
- Ministry of the Interior:
  - Municipal Water Company Law,
  - National linear schemes (TAMA-34) for water and sewage,

- Setting local authority water prices (approval by the Min. of Finance),
- Approval of district linear schemes (TAMA) for development of rivers and their environs.

- National Sewage Administration (Min. of Infrastructure):
  - Approval of sewage treatment facilities,
  - Allocation of funding to local authorities for sewage treatment.
- Ministry of Finance (Budget Division):
  - Approval of Mekorot water prices,
  - Allocation of financial resources (including subsidies} to the water economy and Mekorot,
  - Initiation of many structural changes in the framework of the "Arrangements Law".
- Ministry of Justice:
  - Defending the State in Supreme Court appeals, especially in precedent-setting cases (numerous cases arise in the water economy),
  - Approval of legislation drafts.
- Parliamentary Finance Committee:
  - Approval of water prices (there is a strong agricultural lobby in this forum.),
  - Approval of structural changes in the framework of the "Arrangements Law" and the national budget.
- Parliamentary Economic Committee"
  - Established sub-committee on the water economy crisis. It is a parliamentary investigative committee that is to submit recommendations.
- Jewish National Fund (KKL):
  - Provides funding for reservoirs after having been approved. Implementation usually carried out by them,
  - Partner in the River Restoration Administration and in funding.
- Israel Lands Administration (Ministry of Infrastructure):
  - Allocation of land for wastewater reservoirs and desalination plants.

Many of these bodies are divided into sub-divisions having authorization and regulatory powers. Various branches of the same body frequently do not adhere to a uniform policy.

6.5. Selection of stakeholders approached

There is no private ownership of water in Israel. By the Israeli Water Law, all water sources are publicly owned and their utilization is controlled by the Water Commissioner. A single government-owned company, Mekorot, provides approximately 60% of the total water supply; regional cooperatives and municipalities and private well owners supply the rest. Decision making and management relating to the water economy take place in many forums. The process is greatly affected by special interest groups, each pulling in its own direction. The main stakeholders in the water arena relevant for our analysis are:

1. The Water Commission, which is the authority in charge of managing the water system. The authority is headed by the Water Commissioner, who is appointed by the government. The commissioner issues permits for production (extraction) to suppliers as well as allocations (quotas) to agricultural consumers. The latter is coordinated with the Ministry of Agriculture and requires his agreement.
2. The Water Council is a national entity appointed by the government to advise the Minister of Agriculture on a wide range of water issues, including water pricing. It includes representatives of interest groups and its decisions are subject to political pressure (hydro-politics), skilfully applies by the agricultural lobby.
3. Mekorot. Israel's national water company, responsible for most of the supply and maintenance activities, including the operation of the National Water Carrier. In effect, Mekorot is the only entity with significant financial and operational abilities in the field of water resources.
4. The Ministry of Agriculture. The Minister of Agriculture is in charge of implementing many water laws, can promulgate secondary legislation such as determining norms for agricultural water use. The Minister's influence on governmental decisions on water pricing and on the Water Commissioner's decisions (regarding the allocation and distribution of water quotas) is crucial.
5. The Ministry of Finance is responsible for the overall budget and for the allocation of financial resources (including subsidies) and to the various entities involved in the water resources. This ministry continuously supports a policy of raising water prices for farmers as a means of saving fresh water, reducing water subsidies, and increasing the efficiency of water use.
6. The Ministry of Health is responsible for determining standards for purification for all water types and their uses. This includes authorizing recycled wastewater irrigation of lands overlying groundwater aquifers. The Ministry of the Environmental Quality is responsible for preventing water pollution and protecting water resources from contamination.

7. Farmers (agricultural water users). As mentioned above, decisions on water prices are made in the political arena and are affected by pressure from interest groups. Each attempts to affect public decisions in its favour. The farmers' representatives are the strongest and most influential interest group. The main interest of the farmers is to receive large allocations of water, to be supplied at the lowest attainable price. Water is a significant input in agricultural production in arid and semi-arid regions like Israel, and many farmers strongly support their representatives in the political arena. The agricultural lobby is very well organized, and so far, its influence on water policies and pricing decisions has been significant. The share of water costs in the budget of households or in the cost of manufacturing is relatively small. Therefore urban and industrial water users have only little incentive to organize political lobbies and, in effect, they do not comprise a strong opposition to the agricultural lobby.
8. The Ministry of the Interior is in charge of the local authorities. By controlling their budget, the Ministry supervises the local authorities' water and sewage activities. Urban water consumption has the highest priority in the allocation of fresh water resources. The industrial sector also has high priority.

6.6. Consultation procedure and results

During the second year of the WSM project we had relatively extensive face-to-face discussions with representatives of almost all the above-mentioned stakeholders. We also visited several agricultural fields, three large modern sewage-treatment plants and the pumping area of a private water supplier in the central region. The list of the stakeholders approached and the main outcome of the discussions are summarized below.

The Water Commissioner and the head of the planning department in the Water Commission

The Water Commissioner's interest is to preserve the current institutional situation under which the vast majority of Israeli water resources are managed at the national level. Plans for the future (with execution subject to severe budget constraints), include: increasing the flexibility of water transfer between the various regions around the country; increasing the reliability of supply to all sectors; increasing the available storage and transportation systems for recycled waste water for agricultural use and raising the required purification level of the waste water to be used for irrigation above unconfined aquifers (including desalination of waste water); allocating massive funds for sea water desalination plants (the plan is to desalinate about 400 million cubic meters per year no later than 2010).

The Chairman, the chief engineer and the head of the central region of the national water company, Mekorot

Mekorot is the national water company, which operates the nationwide water system. It is a governmental company which operates on the principal of "cost plus." As water

prices (determined in the political arena and not controlled by Mekorot) paid to the company by its agricultural, industrial and urban consumers do not fully cover the costs of water production and transfer, the company is subsidized by the government. The subsidy is equal to the uncovered costs plus a "fair benefit" for the company. Mekorot's role in the overall financial turnover of water resources reaches about 80% of the industry's business activity, since it operates a water system at high cost, conducts water for long distances and pumps water to high places. Currently, the company is the only entity with significant financial and operational abilities in the field of water resources, i.e., it is a powerful monopoly. The current institutional situation under which all major water sources are operated by Mekorot within a framework of one very large national system helps the company to preserve its monopoly power and the company objects to any major institutional changes. The company's major aims include: supplying the demands of all consumers in a reliable way according to the priorities set by the Water Commissioner (the consumers with the highest priority are the general public for domestic consumption, the industrial sector also has high priority; agricultural consumers are of the lowest priority); improving the quality of fresh water as well as of recycled waste water, increasing the market share of the company in the plants for recycling wastewater; winning at least some of the public contracts to build and run plants for sea water desalination; and connecting as many private (as yet non-existent) desalination plants as possible to the national water system.

The General Director and the head of the planning department of the Ministry of Agriculture

Agriculture in Israel is seen by many as an enterprise whose national value exceeds its contribution to GNP via food production, which justifies governmental support. It contributes to security by protecting the country's lands, especially in peripheral areas, and by supplying food in times of emergency. It also contributes to the environment by protecting open spaces and preserving the natural and social landscape. In addition, its use of water has been and still is flexible, utilizing water from various sources and at various levels of qualities. Thus, it can serve as a safety net for supplying water to local authorities (i.e., households) in times of emergency, since it utilizes a large amount of fresh water. Some of the major goals of the Ministry of Agriculture relevant for the present analysis are: setting uniform agricultural water prices in all regions of the country; increasing the current purification level of recycled wastewater to suit irrigation of all crops and over all soil plots, and charging the additional associated costs to the producers of the wastewater (i.e., to the cities); preserving the current size of the agricultural sector, especially in peripheral areas (water subsidy is an important policy tool in obtaining this goal); preserving open agricultural spaces and natural landscapes (in the absence of a water subsidy, some of the green lungs may turn yellow); "fighting" the wide coverage in the written and electronic media of the recent water crisis (coverage which has emphasized increased tension between farmers and local authorities concerning the fairness of uneven water pricing, with farmers paying about 50% of the price paid by the urban sector).

The referee for water and sewage in the budget department at the Ministry of Finance

The Ministry of Finance is responsible for the overall budget and for the allocation of financial resources (including subsidies) to the water economy and to Mekorot. Structural changes and major developments (such as massive recycling of sewage and desalination of sea-water) cannot be carried out without the approval of this ministry. The traditional position of the economists in the budget department of the Ministry of Finance is that there is no water shortage in Israel, and all that is required is to increase water prices so that demand does not exceed the available supply. They constantly call for basing the water allocation on an efficient price system that includes the shadow price or scarcity rent of water and does not vary by sector. In addition to the reduction of subsidy for agricultural water, the expected reduction in agricultural water consumption associated with increased water prices may ease public pressure for an urgent and large scale investment in expensive desalination plants partially subsidized by the government, and a consequent reduction of governmental expenses. The Ministry of Finance recognizes the special contribution of agriculture to the national goals of protecting the country's lands and the open spaces and preserving the natural and social landscape, and therefore agrees to keep subsidizing it, but not through the medium of water.

The Ministry of Health's southern district sanitation engineer and the vice General Director of the Ministry of Environmental Quality

The sanitation engineers of the Ministry of health are responsible, among other things, for granting permits to farmers to irrigate with recycled waste water and to prohibit irrigation of agricultural crops and irrigation of soil plots overlying groundwater aquifers by recycled waters that were not treated appropriately. In practice their requirements significantly affect farmers' plans regarding irrigation with treated wastewater. The Ministry of Environmental Quality is responsible for preventing water pollution and protecting water resources from contamination. The Ministry promulgates regulations, prohibitions and restrictions on the location and establishment of polluting facilities over or near water resources and determines the quality of water for various purposes including the quality of floodwater and recycled waste water used for rivers rehabilitation.

Active farmers and farmers' representatives

Most farmers do not adopt the economic point of view represented by the Ministry of Finance, and they act to advance their short run goals. They request a quota-based allocation of potable water and water price adjustments (i.e. subsidy) based on the ability to pay. At the same time, they advocate the expensive expansion of supply mainly by desalination of sea water in order to reduce water shortage. Some farmers claim that agriculture will collapse if it had to pay the full cost of water production. Some farmers' representatives claim, based on past experience, that any "final" agreement on water pricing with the Ministry of Finance is just an opening for endless future negotiations and they do not trust this ministry to fulfil its promises in the long run.

Farmers are complaining about the monopoly power of Mekorot and claim that the company's costs (especially the capital costs) are too high. They also claim that the majority of the recent investments in the national water system were made in order to guarantee a reliable stable supply of good quality water for the urban sector while the agricultural sector benefits nothing from these investments but is asked to share the costs (via an increase in water prices). As for irrigation with recycled wastewater the interviewed farmers pointed out the competition between farmers in the central and in the peripheral regions. Most of the urban and industrial sewage is "produced" in the coastal plain (which includes Tel Aviv's region), in the centre of the country, while most of the irrigated areas are located in the periphery. The costs of constructing new networks to transport the recycled water (assuring that it will not be mixed with freshwater) and the costs required to prepare new facilities to store excess treated water from winter to summer are of major importance. The spatial distribution of aquifers and the environmental costs associated with irrigation that may pollute the underlying groundwater, should also be considered for the allocation of wastewater. There is also hot conflict between the agricultural and the urban sectors regarding the purification standards for disposal set for the cities by the government. Another conflict is about the allocation of the costs and the benefits associated with recycling between the generators of sewage (the municipalities) and the agricultural users.

The vice director of Tel Aviv's city council - head of the city water department

The municipality's major interest is to supply high-quality drinking water with a low level of chlorides and at a low cost. Therefore, Tel-Aviv prefers to obtain its water supply mostly from local drillings, using water from external sources as little as possible (transported by Mekorot from the Sea of Galilee via the National Water Carrier). Tel-Aviv is willing to build and operate its own desalination project (because desalinated water is of the best quality), but only if this is economically justifiable, i.e. less expensive than buying water from Mekorot.

6.7. Formulation of a new proposed Water Management Paradigm based on the results of the stakeholder consultation

Tel Aviv Region

- Intensifying the reclamation of wastewater for agricultural irrigation and for river rehabilitation: A large scale transition in agricultural water use from good quality water to reclaimed urban and industrial waste water is expected in the forthcoming years. This shift requires the development of many more environmentally safe water treatment plants, reservoirs and conveyance systems. The urban water economy from the city gate to the consumers, to the treatment plant and to final disposition is becoming as big as the economy of fresh water and it is growing steadily. The current trend calls for stricter adherence to water purity standards. An inter-ministerial committee of director-generals recently

issued a report recommending substantially stricter purification standards for recycled wastewater in the near future. Cost-benefit analysis of the above-mentioned large-scale transition should take into consideration:

- The spatial distribution of aquifers and the environmental costs associated with irrigation above them, which may pollute the underlying groundwater.
- The question of how the costs and the benefits associated with recycling should be allocated between the generators of sewage (the municipalities) and the agricultural and ecological users.
- The question of how municipalities can be assured that the farmers will not reduce usage suddenly (due to an economic crisis for example) and leave the cities with treated water that they cannot dispose of.
- At the farm level one should investigate farmers' incentives to adapt crop varieties to water of lower quality and evaluate the negative environmental externalities associated with sustained use of treated wastewater.

- Reform in water allocation Practices - Allocation by prices: The goals of a reform in water pricing are to increase the overall efficiency of water allocation to the agricultural sector, by raising water prices to an "economically efficient" level, and at the same time to give farmers incentives, via adequate land-dependent cultivation subsidies, to strive towards the national goal of protecting the land and preserving the landscape. The efficient prices should reflect the long run costs of water supply, including the scarcity value of water, and the environmental costs associated with water production and/or water use. More specifically, the analysis of the reform in water pricing should cope with the following questions:
  - How should prices vary by water quality? The quality requirements for urban consumption are much higher than the requirements for agricultural use, but water in Tel Aviv's region is supplied via the same national conveyance system. Should the prices for the agricultural and the urban sectors be identical? Should farmers pay the extra costs required to meet the standards of urban use?
  - How should prices vary by reliability of water supply? The supply to the urban and industrial sectors in Israel is reliable while the supply of fresh water to the agricultural sector is reduced in dry years. In other words, weather uncertainty implies uncertain supply to the agricultural sector.
  - How should the spatial variation of water prices reflect the spatially variable extraction and transportation costs? If equity considerations imply a homogeneous price for water of a given quality, one should evaluate the "efficiency cost" of the equity requirement. It should be noted that a homogeneous price implies cross-subsidization among users in different regions.

- In addition to sending signals to water users about the full cost of water supply, prices should also cover the costs of supply. In the case that total revenues collected by the suppliers exceed (fall short of) the total costs of supply, rebate to users (governmental subsidy to water producers) should be considered.

- A massive desalination of seawater.
  - Desalination of seawater is another important action that will be taken in Israel within a few years and will significantly affect the supply of fresh water for the region.

- Reform in the administrative responsibilities for the water sources.
  - We plan to examine the impacts an institutional and economic separation of Tel Aviv's water resources from the national water system and operating it as a closed or balanced economic entity. Among other things, such a reform will imply the termination of importing and exporting water via the National Water Carrier; increasing local supply of fresh water via seawater desalination, determine prices at the regional level which will cover local costs and more.

Arava Region

The general principle is to introduce regional administration of the water sector, with institutional and economic separation of the Arava water resources from the allocation and pricing policies determined at the national level. The water development plans for the region are mainly for pooling and transferring waste water.

The details of this principle are threefold:

- All water supplied to the city of Eilat will come from the existing desalination plant with price equal to the marginal cost of desalination. In the more distant future there is a possibility that the desalination plant in Eilat will be enlarged.

- Wastewater "produced" by the city of Eilat will be recycled for agricultural use. In addition to the building of adequate recycling plants, this also requires the construction of storage and conveyance facilities. Most of the financing should come from governmental funding, since preserving the ecology of the Red Sea and preventing its contamination by wastewater is a public interest.

- Water prices for agriculture will be determined independently of the national system so as to reflect the specific cost of their production. Prices of recycled waste water will be determined by negotiation between the city of Eilat and representatives of the farmers.

It should be noted that as the Arava region borders with Jordan, the water production balance – drillings and water production from the local aquifer – is affected by the peace treaty with Jordan.

7. Existing Water Management Plans in Tenerife

7.1. Introduction- Background of Water Management practices

Two phases must be distinguished in the last century history of water management on the island of Tenerife. The first one corresponds to the period characterised by a progressive predominance of intensive agriculture of export crops, always based on high-water demanding crops. The second one starts with the consolidation of a tourist development exponentially growing, starting from the beginning of the seventies. Destinations such as Balearics, Hawaii and Canaries are, in this order, the pioneer tourist destinations in the application of the new system of "all inclusive" packets defining what is nowadays called mass tourism.

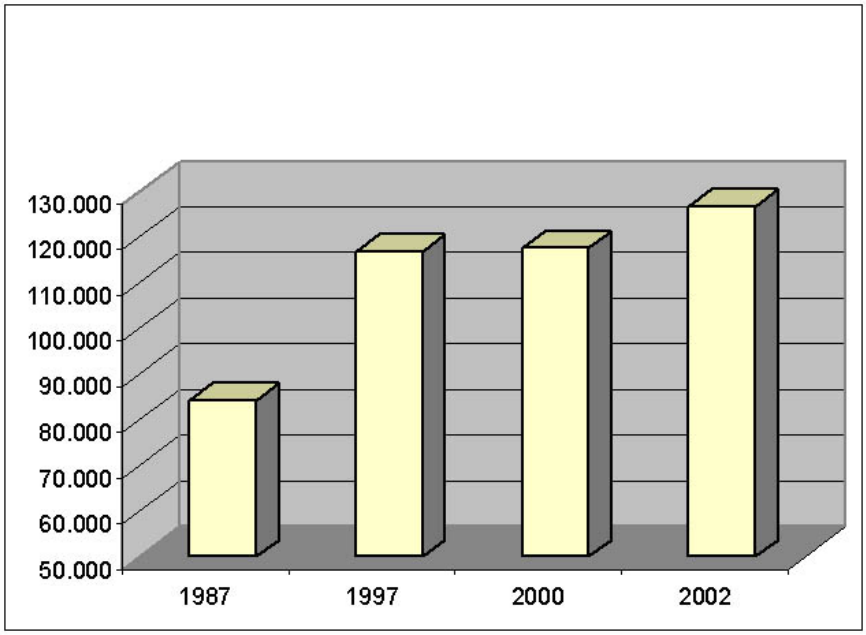

Figure 26. Evolution of Tourist accommodation - Source: ISTAC

Before the first phase, corresponding to the predominance of subsistence crops, some rights dealing with water management had already been consolidated, such as inheritance or "Datas" (property granting) conceded after the conquest of the islands. During the 19th century collective companies of water management appeared, the so-called "Groundwater Research, Use, and Exploitation Companies". From that time the key phenomenon of massive exploitation of groundwater began, through the building of deep galleries (some reaching 7 Km), of wells of similar depth and diameter, as well as a complex channel network allowing the spectacularly increase of irrigated areas with a consequent colonisation and re-distribution of the population all over the island. In the time of one century a singular water culture appeared. As a reference datum, it is noteworthy to add that on an island of 2,032 Km^2, more than 1047 Km of galleries are made (Figure 27).

The investment effort faced by private initiatives through the "Water Communities" (Comunidades de Agua) created the first basic premise regarding water management, stating that water belongs to "whomever causes them to flow", setting the bases of the differential issue of water private property, shaped recently in the Canary Islands Water Law. Groundwater was therefore the basic resource, reaching its maximum in the year 2000, where they represented 91.1% of the total water resources exploited. This is a significant datum if the fact that the Spanish average is 13.3% and the Canary Islands' average is 79.4% is taken into account. Public initiative during that period was centred in the exploitation of surface waters, with a poor success. This duality of private/underground and public/surface is maintained until the present.

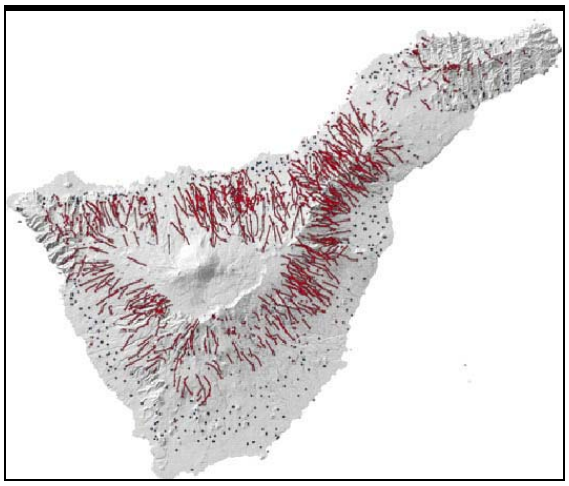

Figure 27. Source: ISTAC

The last phase corresponds to the progressive increase of the new island's specialisation: tourism. Growth numbers are spectacular, going from 0.5 million international arrivals at the end of the 1970s to surpassing the barrier of 4 million arrivals in 2001 (Figure 29). Figures 26 and 28 show the increase in tourist inflow, as well as the increase in number of places (Figure 26 shows official records for 2002, although recent studies state that the actual number is around 180,000), representing the biggest investment phenomenon of the last years in the Spanish coasts.

In parallel, the increase in tourist activity leads to several phenomena involving water availability and reallocation. On one hand, a population increase without precedent was produced, the result of 1.9 jobs per occupied tourist bed that brings the island to the highest positions of immigration in Spain; in three decades the permanent population alone was doubled, reaching at present 800,000 inhabitants. On the other hand, tourist development of the south of the island, contrasted against the stagnation of the Northern side leads to a redistribution of population and activities, and, as a consequence, a big change in the model of allocation of water resources. Traditional crops started to decline and agricultural water is directed fundamentally to export crops and "out of season" productions (banana, tomatoes, and flowers). At present, in fact, of 18,162 ha cultivated, 14,180 are irrigated crops, although it should be mentioned that the

new policy aiming to stop communitarian subsidies to export crops such as bananas can substantially change the agricultural production scene.

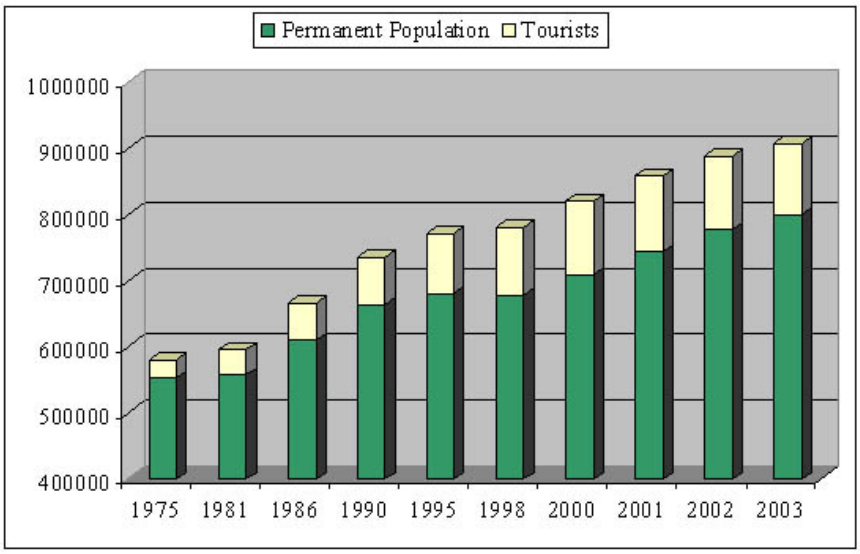

Figure 28. Sources: ISTAC – Cabildo de Tenerife

The combined effect of increased tourist activity and maintenance of high water-demanding crops in the last decades is highly alarming. Overexploitation of the island's aquifer is confirmed, and more detailed information on risks and actual situation from pioneer studies such as SPA15 and MAC21 is emerging. Public initiatives have appeared with a new institutional-juridical framework that is beginning to approach, even if a bit late, the clearly unsustainable situation.

The impact of this new framework is perceived in several fronts, and important changes have been recorded in relation to the 1980s when all waters were private and assigned to the different uses through free market mechanisms. Firstly, drilling of new water-galleries is paralysed, and a new perspective, based on the previous authorisation of new drillings and a process of rationalisation of water transport through the building of new, closed conduits, have begun. The new framework also brings a final consensus on the most urgent issues regarding water exploitation, which is translated in the final registration of groundwater catchments into the Public Water Registry. At the same time, the Island Water Board starts to operate and the Insular Hydrological Plan is developed.

The last stage of water management is marked by the introduction of non-conventional water sources: re-utilisation of wastewaters, building of brackish and sea water desalinating plants.

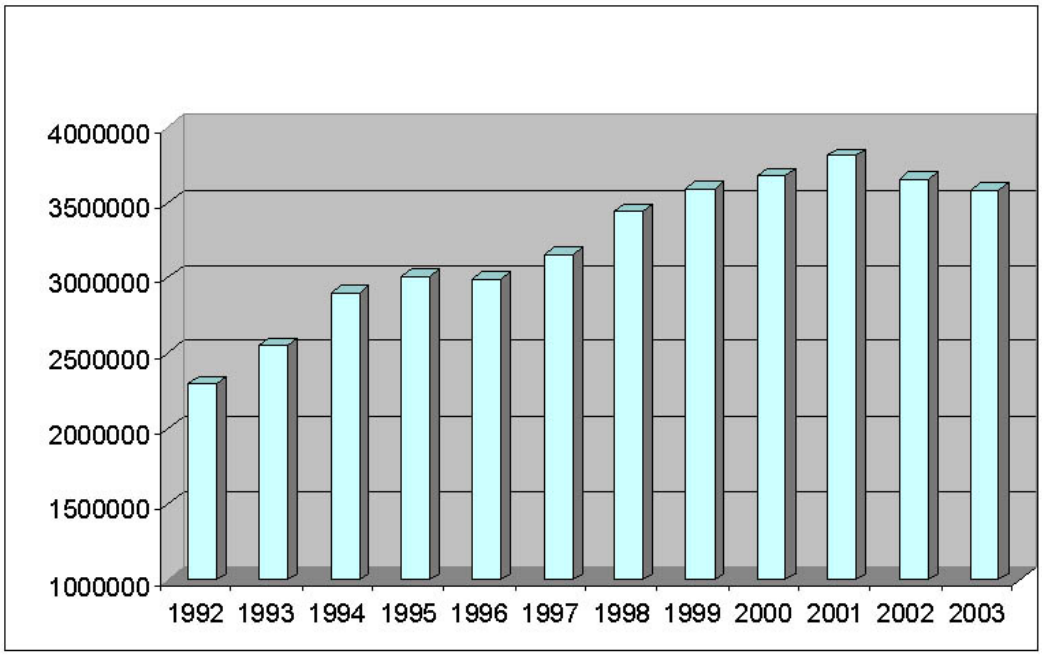

Figure 29. Tourist arrivals - Source: ISTAC

7.2. Description of existing infrastructure

The most relevant infrastructure for the exploitation of water is made up by horizontal, underground water galleries, which are more than 1,000. Island geology was favourable to store important reserves of groundwater that for decades have been the basic source of island development. Among all water galleries, only 170 stand out for their production, catching around 60% of the water extracted through this method. A fall of the phreatic level has brought a drastic flow reduction increasing with altitude, starting a process of depletion of upper galleries.

Well drilling meant a higher step in the existing infrastructure, and has initiated a higher degree of flexibility to the situation of strict equilibrium between consumption and water resources available exclusively through the galleries. At present the island relies on some 500 wells for a total of 102 km of depth as a whole. In both cases of wells and galleries, production is progressively, albeit gently, declining in the last decades.

The high fragmentation of the water production system (mainly wells and galleries) and the extreme diversity of consumption points, has led to building an extensive conduit network, which like the drillings were mostly accomplished by private investors. It is an important and really complex infrastructure of 1,200 canals for a total length of more than 4,000 km, a great number of which are still uncovered. Out of these, the "basic general network" stands out, conveying most of the flow and made up by 36 main conduits for a total length of some 755 km, shaping an insular water distribution ring (Figure 31a). Figure 31b shows the diagram of flow transportation. Management of the whole network is private, and carried out by the owners through the "Water Communities". With regard to the urban supply network, the typology is highly varied since it is carried out through closed pressurised pipelines, most of them underground.

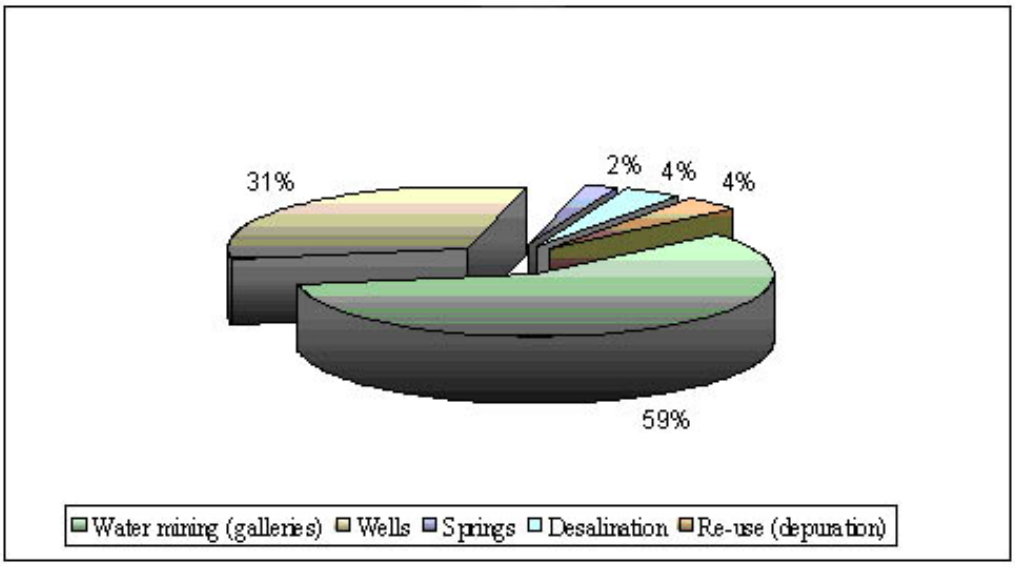

Figure 30. Water Production (hm ^{3} 2000) - Source: Tenerife Island Water Board

Among storage systems, there are outstanding infrastructures of surface water collection, built between 1940 and 1970, which had scarce success. These damming works sum up to 45 dykes with a total storage capacity of 5.13 hm^3. There are also irrigation reservoirs, which are so profusely distributed all over the island in such numbers that they are already a substantial part of the rural landscape. The small size of farms and specific irrigation needs have brought this type of constructions to a high degree fragmentation, so that in some areas of the island a density of 76 reservoirs per Km^2 can be observed (such as around Guïmar). The Hydrological Plan inventoried a total of 6,875 reservoirs, for a total capacity of 9.33 hm^3.

Water supply for urban consumption has been declared a public service conferred by law to the Municipalities. Almost 94% of water supplied is purchased, and the biggest problems regard the guarantee of supply, due to the insufficiency of regulatory reservoirs and the dependency to pumping stations which do not rely on the desirable reserve units.

Industrial water production relies on underground brackish water purifying plants and seawater desalinating plants. At present there are 17 plants of the former type (the hydrological Plan foresees a final production of 27 hm^3 for this type) and 28 desalinating plants (brackish and seawater, with a foreseen total capacity of more than 100,000 m^3/d).

This hydraulic infrastructure prospect is complemented by the important public intervention initiatives that are being developed:

- Development of a pond plan, taking advantage of existing natural geomorphological conditions for water storage, whose function would basically be to rationalise and regulate water transportation and distribution through the insular ring. 17 have already been built, with a total storage capacity of 4.18 hm^3, demonstrating high profitability and efficiency. Payment for storage is made through cession by users of a part of the water conveyed to the pond, whose

management is carried out by an autonomous body called "BALTEN", depending from the Island Government (Cabildo de Tenerife).

- Important investments in the basic transport network, aimed at renewing the main conduits of the insular ring, in order to avoid water losses.

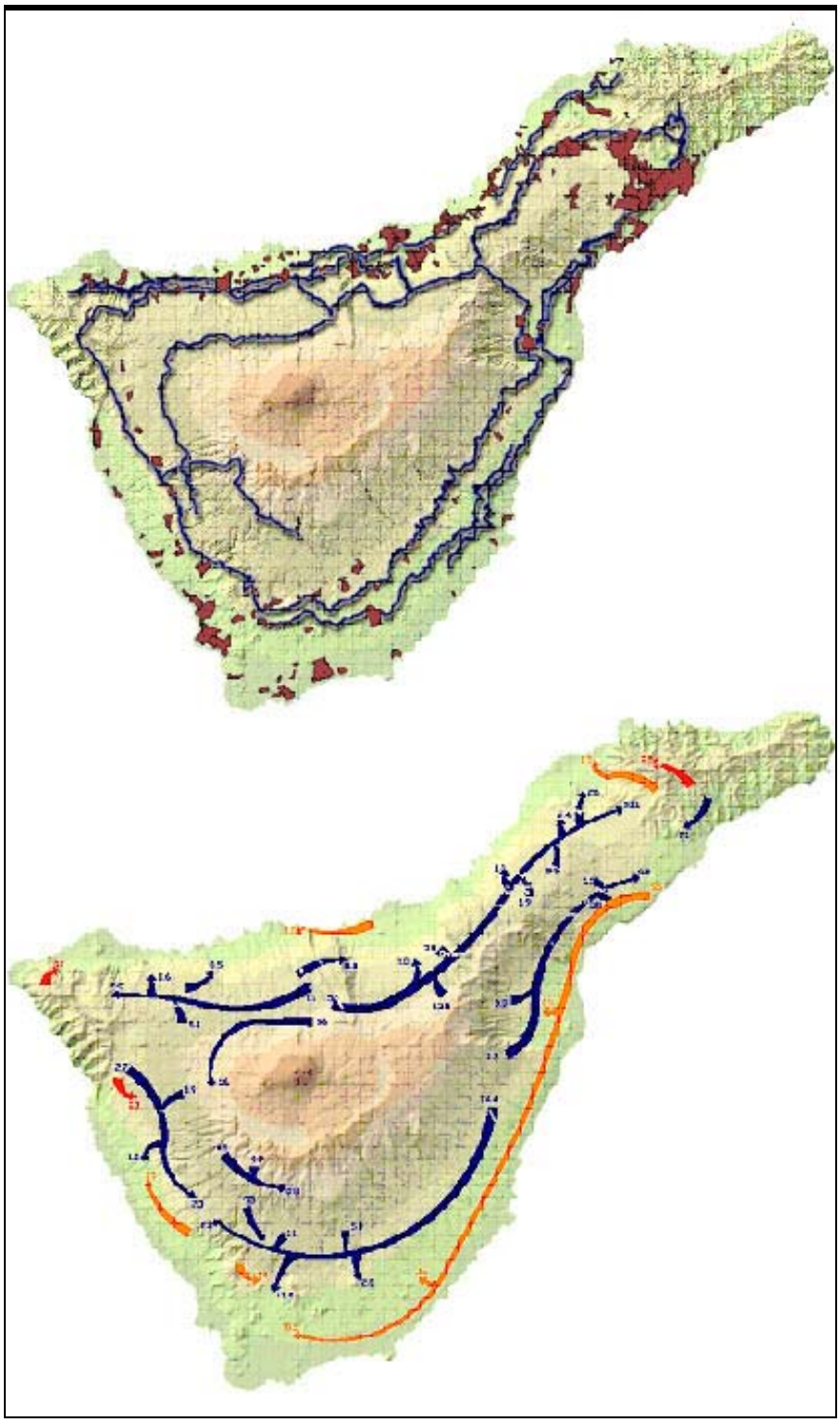

Figure 31. Source: ISTAC

- Development of infrastructure for the re-utilisation of wastewaters on the island, basically centred on building five big purifying plants and two closed conduits for water re-utilisation: the first one running from the capital (Santa Cruz de Tenerife) to the tourist area in the south of the island, and the second one to recollect waters from the tourist area Orotava valley and send them to the west.

The public initiative is completed through the construction of three large desalinating plants.

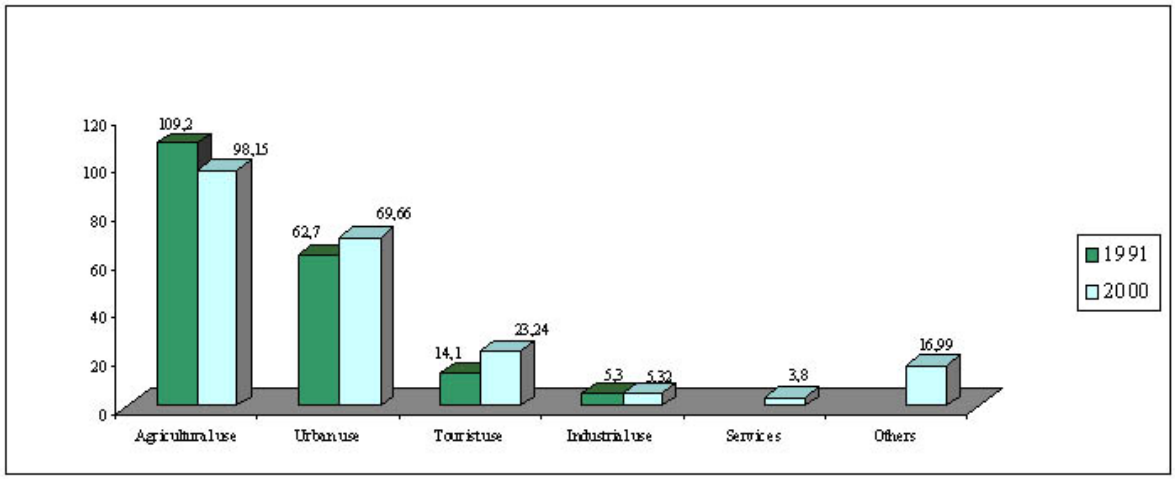

Figure 32. Annual water consumption (hm^3 1991-2000) - Sources: Tenerife Island Water Board - Tenerife Hydrological Plan

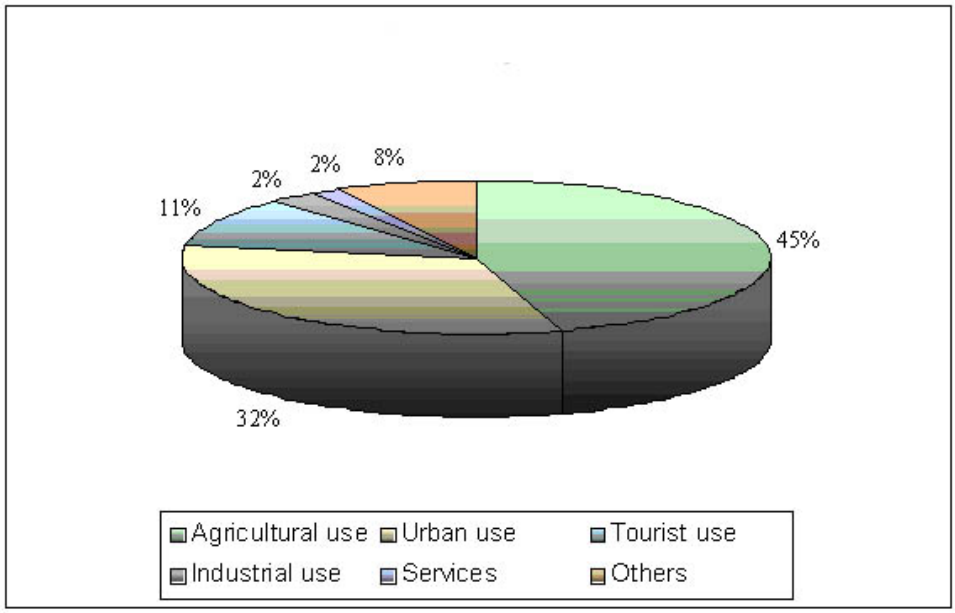

Figure 33. Water Consumption 2000 - Source: Tenerife Island Water Board

7.3. Existing Water Management Plans

In a DPSIR analysis, one can resume the situation in the island as follows:

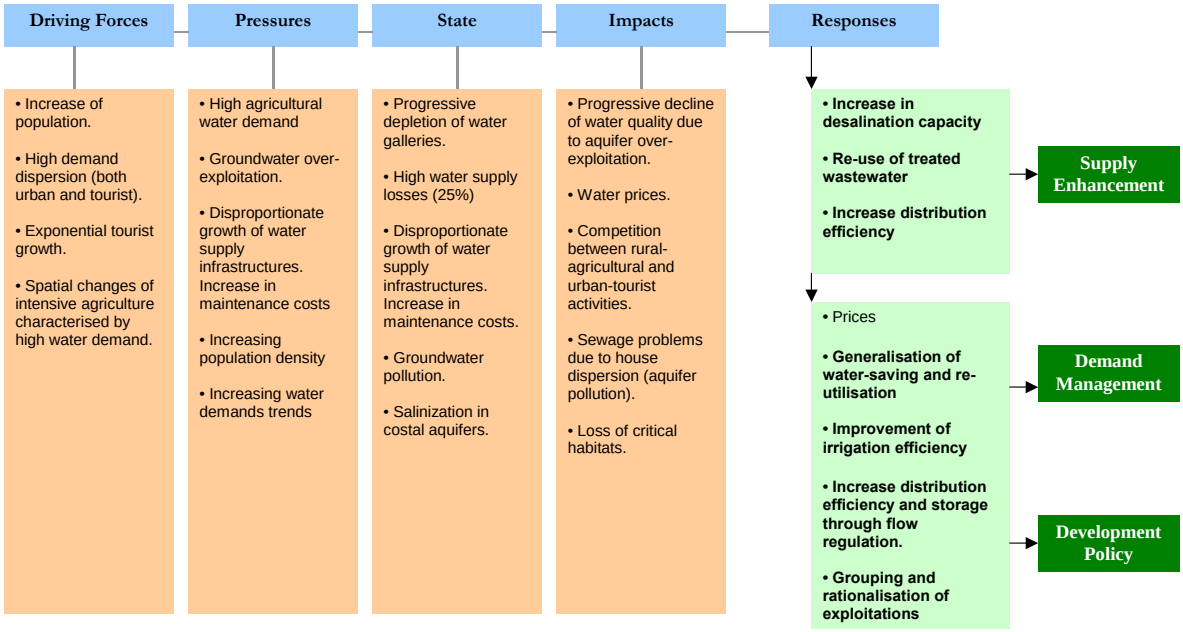

Figure 34. DPSIR analysis and the dominant water management practices in Tenerife

The current situation and foreseen measures are framed on a national-level planned water resources policy, especially developed at a regional and insular level. They correspond in outline to the guidelines of the Insular Hydrological Plan (PHI).

In the framework of the Spanish Water Law, the specific development of Basin Hydrological Plans is contemplated. In the case of the Canary Islands, owing to the islands' singularities, a specific framework is developed through the Canary Islands' Water Law (1987; 1999), that also affect the Hydraulic Public Domain normally reserved to the State.

The PHI (Insular Hydrological Plan) of Tenerife is based on the Canary Islands' Water Law that determines its role as a basic instrument for insular hydrological planning. This law establishes that the elaboration of the Plan is among the several competences of the Insular Water Board of Tenerife (corresponding to the "Basin Administration Bodies" of the National Law). The Hydrological Plan of Tenerife was definitively approved in 1997.

Within this context, the strategy of the Canary Islands Hydrological Plan is founded on the following principles:

- To promote a sustainable use of water resources on the basis of a medium-large term planning.
- To protect water ecosystems as an essential principle for a sustainable development.
- To guarantee a qualitatively and quantitatively appropriate water supply to achieve a sustainable development.

- To achieve the economic efficiency of water availability and use compatibly with social and environmental dimensions.
- Congruence between economic and environmental criteria and the design of an integrated management system, with a prudent use of regulatory and market processes.
- To advance in setting up innovatory and realistic policies on endowment and prices.

The PHI is the most specific instrument at the island level, and its determinations are framed into the big directives of the Regional Hydrological Plan.

Other sectoral plans involving hydrological planning are:

- The Tenerife Pond Plan (Plan de Balsas de Tenerife) that settles the strategy of ponds to regulate water transport.
- The Sanitary Infrastructure Plan affecting public water supply.
- The Wastewater Re-utilisation Plan.
- The Canary Islands' Plan of Infrastructures, that particularly affects aspects related with the improvement of the Basic Network, of the wastewater purifying plants and of the desalinating plants.

In addition to these planning instruments the general study frameworks that have determined the hydrological planning should be mentioned: the projects "Canarias SPA-115" (1974), MAC-21 (1980), and "Canarias Agua-20002 (1987). Furthermore, hydraulic planning has to be compatible with and it integrated by the Tenerife Land Management Plan (POT).

7.4. Description of the local stakeholders and the selection of stakeholders approached

Importance of water in all areas of island development as well as its extreme environmental and territorial implications, make the range of stakeholders quite wide. Nevertheless, the representative structure of the main related bodies allows reducing the selection:

- **Canary Islands Government.** Consultations with main officials responsible of those planning instruments and strategies more directly involving water resource management.
- **Tenerife Insular Water Board** (CIATFE). The CIAFTE is an Administrative, Autonomous Local Body ascribed to the Tenerife Island Government (Cabildo). This insular hydraulic administration is composed 50% by those private sectors strictly related with water (catchments concessionaires and owners, agriculture, consumers and users, entrepreneurs and syndicates); while the other 50% is

integrated by representatives of Public Administration (Insular Cabildo, Municipalities, Canary Island Government and concessionaires of public services). CIAFTE has large competencies in administration, direction and management of water resources, including the execution of main hydraulic works.

- **Canary Islands Water Centre**. Autonomous Organisation created to promote water science and technology. It was established in 1998 as a new institution by the General Direction of Water of the Canary Islands Government, and it is formed by the Insular Water Board and a wide representation of private companies with an interest in the Canary Islands water sector, including concessionaire companies at a municipal level.
- **Canary Islands Federation of Municipalities** (FECAM). The FECAM includes a Commission of Public Works, Territory and Environment that is charged of, among other issues, to lead the dialogue with the regional administration on issues regarding water infrastructures and general services.
- **Tenerife Service Associations** (Mancomunidades). They have a special importance since they were created to jointly face problems related with services, taking advantage of the scale factor. Most important issues they deal with are related with water supply networks, water quality control, water storage, and wastewater treatment.
- **ASHOTEL** (Tenerife Hotel Manager Association). This association groups most of the hotel sector and a wide representation of services. It includes a specific department covering water-tourist industry related issues, including aspects of quality and innovation.
- **Planning Department of the Ministry of the Environment of the Canary Islands Government.** It has a competency on all issues regarding water resource management, environment and ecosystem conservation.
- **O.A.L. Balsas de Tenerife** (Tenerife Water Ponds). It is charged of flow-regulating ponds, desalinating plants, big water conduits and re-utilisation of wastewater.

7.5. Consultation procedure

After the first stage during which stakeholders were identified, a process of three-level consultations began.

The first level corresponded to consultations carried out with the institutions with a competency on general and strategic planning, both in the regional and insular scope. Through the General Direction of the Environment of the Canary Island Government and the departments charged of developing the General Planning Guidelines for Canary Islands Sustainable Development, depending from the Presidency, consultations of a

strategic nature were developed, dealing with these instruments and with the identification of scenarios they are working on at a regional level, including the perspective of the Plan of Infrastructures. At the insular level, consultations were made to the officials responsible of the Insular Land Management Plan, with regard to the provisions and projections established for water resources. Consultations regarding water resources and environmental protection were included.

The second level of consultations corresponded to bodies and organisations responsible for direct implementation of water policy, with the participation of main water-related actors of all levels through the CIATFE (Tenerife Insular Water Board). It includes representatives of all competent administrations, as well as water owners, farmers, consumers, and syndicates; CIATFE is responsible of the follow-up and application of the Insular Water Plan. This helped guarantee reaching a high sectoral representation during the consultation process, examining the insular scene, as well as evaluating the important determinations of the Water Plan and their efficacy. Farmer associations and Water communities were integrated in this level.

The third level of consultations departed from the insular view of stakeholders and focused on more sectoral and specific consultations, but had special transcendence for the identification of new perspectives and on water management reality on the island. Aspects related to the introduction new sustainable technologies for water saving, quality, and production were approached with the Canary Islands Water Centre, as well as their actual market response. Issues related to services, important sewerage deficiencies, supply regulation, and, in particular, water treatment. Consultations in the framework of the debate on tourism guidelines were approached with the Hotel Manager Association (ASHOTEL), as well as the position of this sector and the voluntary actions of the tourist industry; the development department of this association, which oversees issues of technological innovation and quality, actively participated in these consultations. Finally, consultations with OAL and BALTEN were addressing specific problems of transports and storage of the Basic Network.

Consultations and meetings were carried out in this order, with the aim to explore thematic areas by category, isolate common demands end perspectives, and check the efficacy of planning process as well as the actual stakeholders' response.

7.6. Consultation results

From the stakeholders consultation different perspectives and expectations emerged. Commonest and most outstanding aspects regard the need to launch a programme of demand side management, limit groundwater resource exploitation supply the new deficits through the re-utilisation of treated water and increase in desalination.

Bodies of the Canary Island Government

The consultation outcomes were centred in focusing planning instruments and general orientations:

- Keeping groundwater exploitation balanced.
- Promoting quality of the water supply service.
- Establishing a socio-ecological balance for an equitable use of water resources.
- Guaranteeing main settlement supply through seawater desalination.
- Prioritising different demands.
- Developing a culture of water aiming at saving and efficiency.
- Limiting the increase and establishment of new high water-demanding activities.

Tenerife Insular Water Board (CIATFE)

Through the application of the Tenerife Hydrological Plan, CIATFE identified and proposed as main strategic objectives in terms of water resource exploitation, assignment and transport, supply, and production:

- Exploitation and conservation of conventional water resources:
  - Grouping and rationalisation of exploitations (galleries and wells).
  - Over-exploitation control.
  - Correction of saline intrusion through reduction of water extraction.
  - Reduction of aquifer pollution (nitrates fundamentally) attacking the source: change in aggressive agricultural methods and sewerage.
  - Enhancing quality of brackish waters from bad quality aquifers.
- Supply enhancement:
  - To promote the quality of the water supply service.
  - Introducing the policy of covering the increase of sectoral demands with industrially produced water: desalination and treated wastewater. Priority 1: treated wastewater, Priority 2: desalination.
  - Enhancement and correction of water quality for urban supply, in order to facilitate its re-utilisation.
  - Increase distribution efficiency and storage through flow regulation and network improvement within the insular ring.
  - Unification of supply service criteria.
- Demand management:
  - Improvement of irrigation efficiency, nowadays lower than potential level in spite of the big technological improvement.
  - Reduction of water losses through transportation improvement (25% at present).

- Socio-Economic Measures:
  - Urgent modification of pricing criteria, opting for the concepts of tax and binomial price.

Canary Islands' Water Centre.

The main foreseen interventions and improvements are:

- Permanent generalisation of new technologies aiming at saving irrigation water.
- Technological innovation in desalinated water production, including massive use of renewable energy sources.
- Development and maintenance of a system of effective indicators for a sustainable management of water resources.
- Urgent development of an efficient strategy on demand side management based on effective indicators. Strengthening this strategy through the generalisation of juridical regulations and of municipal ordinances in particular.
- Price policy updating, which will include externalities. Data indicate positive influence to consumption reduction through application of appropriate pricing policies.
- Generalisation of water culture at information and training level.

Federation of Municipalities (FECAM).

Generally speaking, it is not justified that part of the global water cycle is regulated as a public price (urban supply) and not the other services, which often avoid inclusion of externalities.

- Improvement of distribution networks, conduits and reservoirs.
- Need to improve efficiency of supply services through joint actions and agreements. Municipal management tends towards a deficit of the supply service due to lack of treasury.
- Unification of management criteria.
- Better control of water quality.
- Urgent need to complete sewerage network.
- Search for formulas at insular level to develop and maintain wastewater treatment plants.
- Establishment of service duality criteria: separation of distribution and other aspects (catchments, treatment, storage....).

ASHOTEL (Tenerife Hotel Manager Association)

A permanently outstanding aspect in consultations is that actual conversation on water supply and treatment is carried out at municipal level, often exceeding their capacity. The tourist sector understands that the problem needs to be dealt with at the municipal and local level.

- To include the culture of sustainable water use and management as a tourist space quality-enhancing factor.
- Generalisation of water-saving, treatment and re-utilisation installations in the whole tourist infrastructure.
- Limitation of tourist growth in function of available resources.
- Guarantee of supply as a basic factor of the tourist offer.

Planning Department of the Ministry of the Environment of the Canary Islands Government

Aquifer depletion and massive water transportation put the survival of important systems and landscapes in serious danger. The following possibilities arise:

- Control and eradication of subsoil polluting sources (agricultural and urban contamination).
- Establishment of minimal water reserves for basic ecosystem functionality (risk thresholds).
- Increase of woodland areas as basic collection source of renewable resources.
- Fixing the water resource section as an essential element within local Agenda 21 development both planned and already under way.
- Supporting a culture of water resource sustainable use.
- Control of wastes and basin pollution.
- Control of coastal pollution (emissions and effluents).

7.7. Formulation of a new proposed Water Management Paradigm based on the results of the stakeholder consultation

The Strategy that will be developed will result from a synthesis of the current responses regarding water management, the responses proposed by the stakeholders and the requirements of the Water Framework Directive that can be implemented in this specific area.

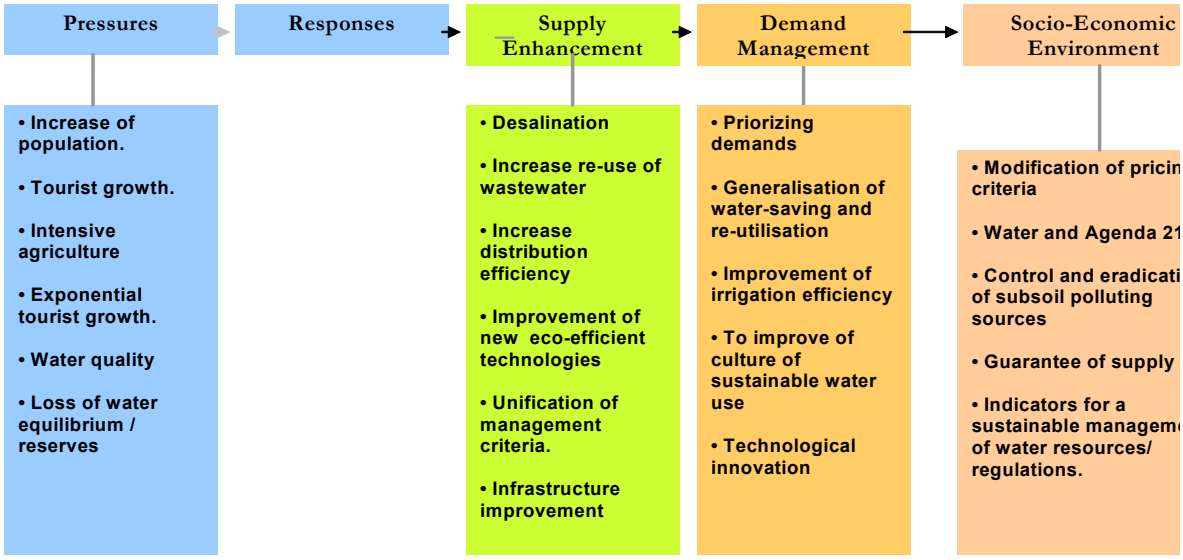

Figure 35. A Proposal for a New Strategy

8. Existing Water Management Plans in the Ribeiras do Algarve Basin

8.1. Introduction – Background of Water Management practices

The Ribeiras do Algarve River Basin suffered, in the last decades, deep changes in its demography mostly due to the important development of the tourist activity that created a new reality. In the 1980s, one could identify a productive structure based in three "basic" activities: agriculture, fishing and tourism. In the recent years, a polarization of the regional economy is happening, concentrated in the tourist offer and the connected tertiary activities, turning tourism and services into the backbone activities of Algarve's economy.

In 2001, the population in the Ribeiras do Algarve River Basin was about 350,000 inhabitants, about 3.5% of the total population of the country.

The demographic analysis is very important in this region since the seasonality of the territorial occupation leads to an increase of the population of 150% in some periods of the year.

In fact, Algarve is Portugal's main tourist region, hosting annually approximately 5 million visitors. In 2000 this region alone supported 39% of the national ranked hotel accommodation offer, 43.1% of overnight stays (14.6 million overnights), representing also the most significant contribution (33.5%) to Portugal's hotel income.

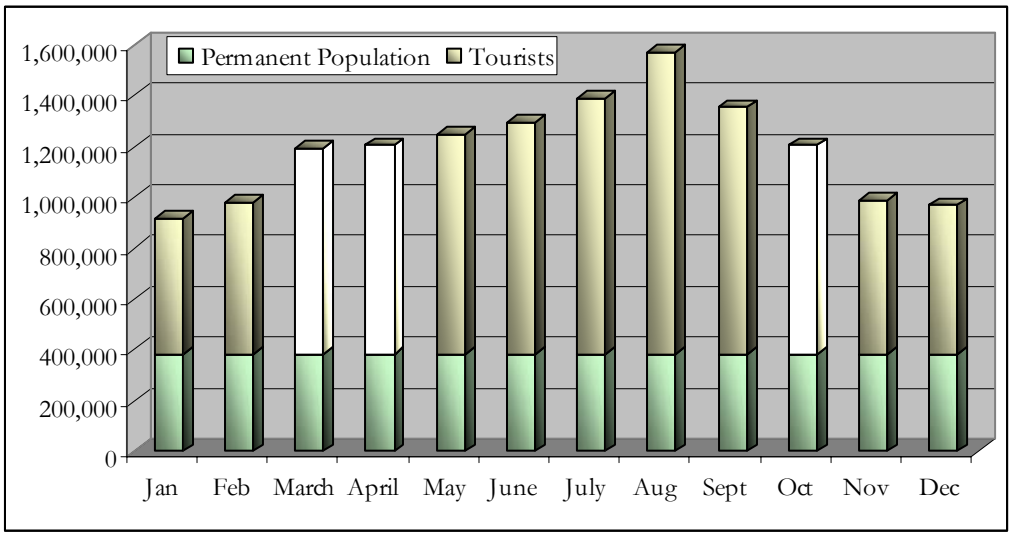

Figure 36. Permanent and Seasonal Population per Month (PBHRA, 1997)

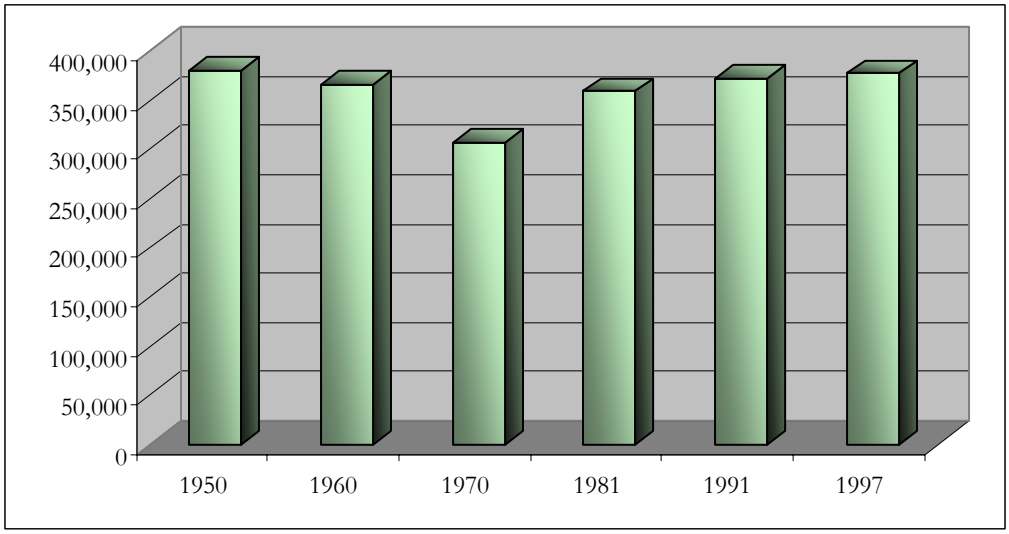

Figure 37. Permanent Population Development

One of the most specific demographic characteristics of the River Basin is the very unequal population distribution: most of the inhabitants are living in the littoral zone and the inland region is suffering from a deep process of desertification, associated with significant ageing of the population still living there. The analysis of the resident distribution evolution confirms the trend of the last decades: the disparity between an attractive littoral zone and a recessive inland region. This way, the pressure on water resources created by seasonal population is very strong, leading to water shortage problems during the summer months.

Agriculture is still important in this region, especially when compared with national figures. In the 1950s, agriculture in Algarve evolved, mostly because of the adoption of irrigation practices, encouraged by the State, through the construction of two dams and related infrastructure for agriculture purposes. This way, it increased the influence of the most developed and enterprising farmers, creating large public irrigated areas. After that, the State stopped investing in the improvement of the water resources in Algarve for agricultural use, compelling the small farmers to create cooperatives/associations, necessary to allow investments in drills, pipelines and reservoirs. This way, they created larger agricultural areas, with better irrigation infrastructures and equipment.

At present, both surface water and groundwater are used for agriculture. The agricultural area represents about 22,900 ha, 85% of that irrigated with groundwater.

Concerning urban water supply, there was an important change during the last few years. The creation of a Multi-municipal supply system inverted the previous trend of aquifers overexploitation. In fact, the supply is now mostly assured by surface water abstracted from the storage reservoirs in the region or imported from Guadiana River Basin.

8.2. Description of existing infrastructure

Traditionally, the domestic and agricultural demand was satisfied by groundwater resources. In fact, the aquifers assumed an essential role in the Ribeiras do Algarve River

Basin allowing the strong development of tourism and irrigated cultures. The available groundwater resources were sufficient to satisfy the different uses existing in the River Basin, and presented good quality. However, the combination of natural processes and overexploitation lead to salinisation and deterioration of the quality and forced to abandon the aquifers for urban supply. In fact, in the last few years, this assisted to the substitution of groundwater by surface water. The urban water supply was based on a large number of Municipal network systems, managed by Municipalities and supplied with groundwater. In 1999, the exploitation of primary water supply systems began, based on two inter-municipal companies: one for the west part of the basin, "Águas do Barlavento Algarvio" and another one for the east part, "Águas do Sotavento Algarvio". The important change is that the system is supplied entirely with surface water from the storage reservoirs existing in the river basin: Bravura, Arade and Funcho for the Barlavento and an importing from the more recent Odeleite-Beliche dams existing in the Guadiana Basin. With the operation of these two systems a significant improvement of the water quality was observed, allowing the aquifers to recover their initial capacity and quality and also regularity in the supply to be fairly achieved. In 2000, the two companies were joined into one, "Águas do Algarve, SA." aiming to serve most of the river basin territory in terms of water supply. Supply enhancement now depends on the construction of the Odelouca dam, an initiative of the National Water Institute (INAG) that will allow a significant improvement in water supply in the west part of the basin.

Since 2001, Águas do Algarve S.A. also has the concession for the primary network for wastewater drainage and treatment aimed to be operational by 2006.

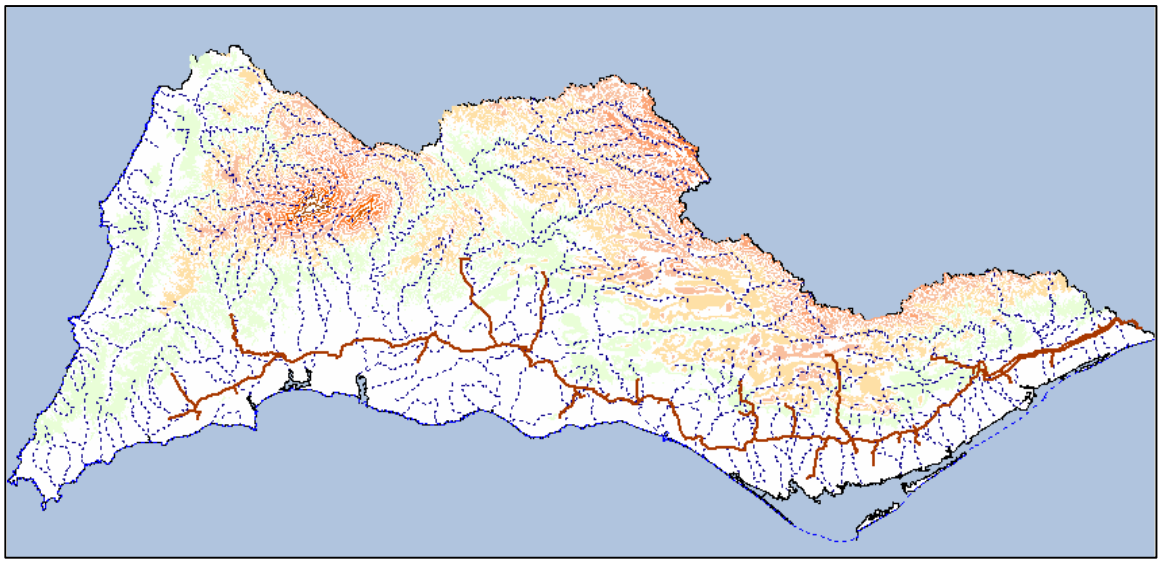

Figure 38. The Primary Water Supply System of the Águas do Algarve Company

The percentage of population served with water supply is currently 82%, but improvement is planned, aiming to achieve 95% in 2006. For wastewater drainage, the percentage is just of 73%, with 72% benefiting from treatment facilities. Urban water supply overall losses are currently high (average of 37%). It must be noted that the major

losses occur in the municipal networks. The average losses in the primary system are only 2 - 5%.

In agriculture, groundwater is still the main supply resource. Only the four public irrigation sites (see Figure 42) are supplied with surface water. There is a low overall efficiency in agriculture water use (about 60%). This use may be added to the one correspondent to the golf courses existing in the river basin as they may also be considered as a specific kind of irrigated culture. These courses represent an important economic activity and are mainly located by the sea. They are currently mostly supplied with groundwater, but the salinisation of the aquifers is making finding an alternative necessary, to eventually supply them with the outflow of wastewater treatment plants or by desalinized water, although that implies an important increase of the associated costs.

According to the Water National Plan, the total annual water consumption is 340 hm^3 (about 95 hm^3 returning back to the hydric environment), distributed as follows: 305 hm^3 of water are used in agriculture, 21.8 hm^3 in domestic uses, 10 hm^3 in tourism, and in industry about 2.4 hm^3. The percentage distribution of water uses per sector can be seen in Figure 39, whereas the percentage of the total water use in Ribeiras do Algarve basin in proportion with the water use in Portugal Continental territory can be seen in Figure 40.

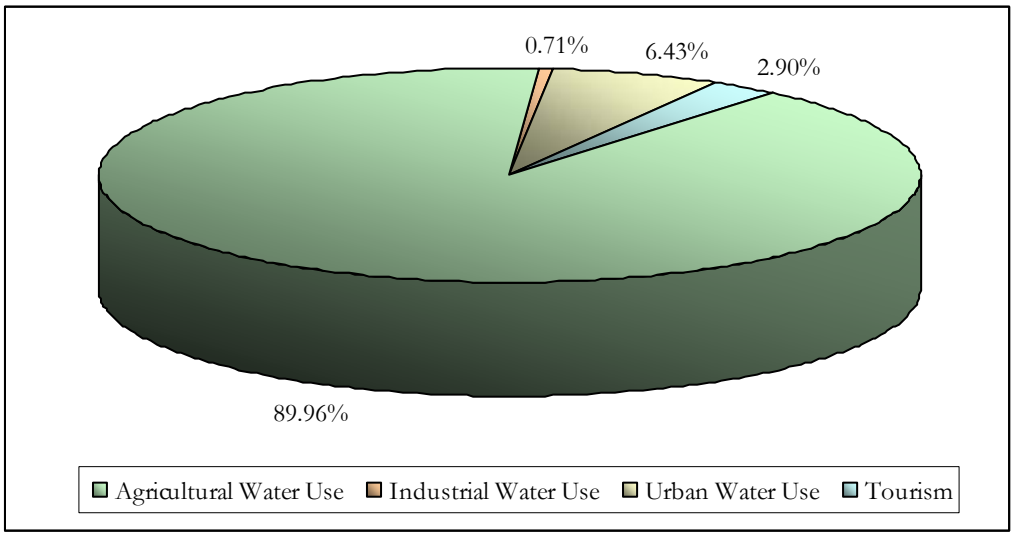

Figure 39. The Primary Water Supply System of the Águas do Algarve Company

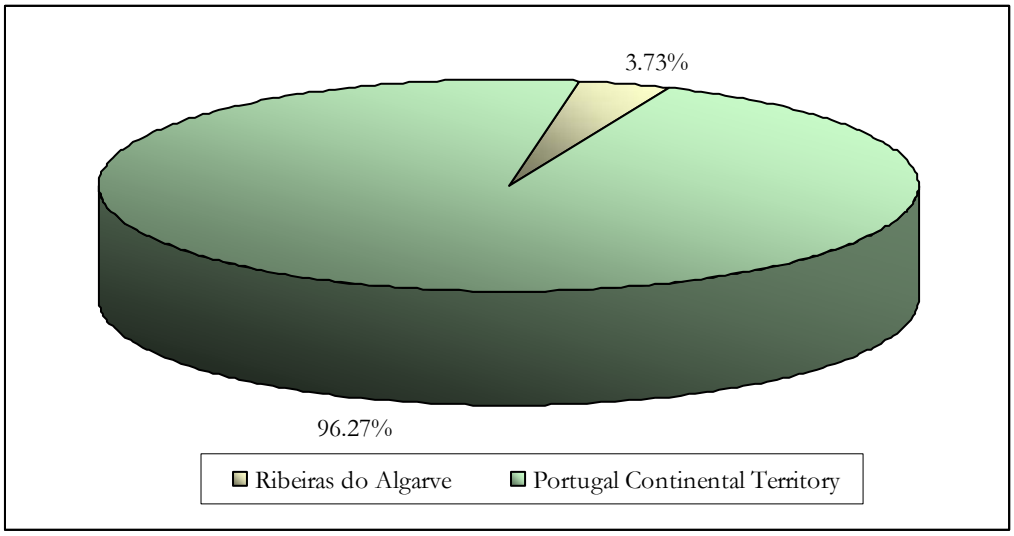

Figure 40. The Primary Water Supply System of the Águas do Algarve Company

8.3. Existing Water Management Plans

In a DPSIR analysis, one can resume the situation in the river basin as follows:

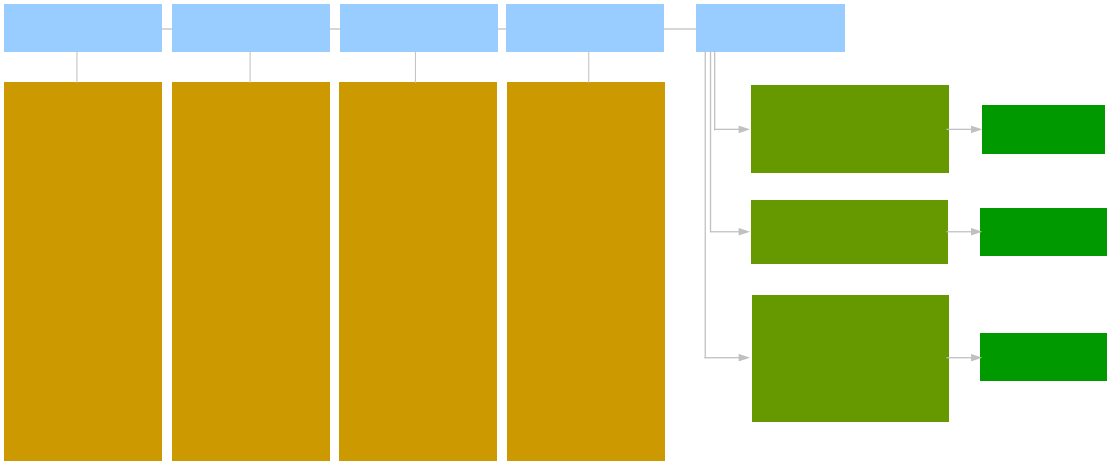

Figure 41. A DPSIR analysis and the dominant water management practices in the Ribeiras do Algarve River Basin

The current situation and foreseen measures are framed on national and regional planned water resources policy.

Portugal has, since 2001, a national wide planning policy and characterization in compliance with the WFD. This way, data availability is recent and complete, although eventually not homogeneous and accurate.

In fact, the Portuguese National Water Plan (NWP), approved at the end of 2001, is aimed to co-relate and co-ordinate the River Basin Plans measures and actions, decide eventual inter-basin water transfers and coordinate planning actions with Spain. At the River Basin level, the River Basin Water Management Plan (RBP) (approved in 2001) and

Driving Forces Pressures State

present data on: biophysics and socio-economic characteristics of the territory; legal framework and institutional organization; Portuguese-Spanish relationships; uses, demands and water needs; water resources; quality and water uses; Nature conservation, ecosystems and biological quality; aquatic domain and territory management; risk situations and civil protection; qualitative and quantitative monitoring of water resources; water's economy; and information, participation and co-responsibility. The fundamental articulation between those Plans is made through general and specific measures, in order to achieve short-, mean- and long-term (from 2006 to 2020) quantitative and qualitative goals on water resources different domains and issues.

However, in those plans, data is sometimes insufficient, eventually not homogeneous and accurate. In order to solve that problem, some recent plans and actions were developed at national and regional levels:

- The PNUEA ("Plan for efficient use of water"), made public in September 2001, before the NWP official approval, is framed not only by the RBP's and the NWP, but also by the PEAASAR ("Plan on efficient use of water on urban water systems"), presented in April 2000, during the phase of elaboration of those Plans. It aims to promote the sustainability of water demand, one of the (seven) "axes of action" established by the NWP, by means of the efficient use of water on urban, agricultural and industrial sectors, aiming to contribute to minimise water stress situations. A set of actions was established in order to achieve the established efficiency goals for those three sectors over a ten-year period.

- The INSAAR ("National assessment of urban water systems") was launched in 2002 and will be finished by the first trimester of 2004, in order to solve the detected insufficiency of basic data and also of physical and economic information needed to assess, periodically, urban water systems. It will also help to assess the PEAASAR implementation and to support the characterisation of all water uses and utilisation due to be produced by the USAP ("National assessment of urban water systems"), expected to be finished during 2004.

- The USAP will first analyse, update and correct the information furnished by the RBPs and by the NWP and the one existent on National and Regional Water Administrations (namely DRAOTs), and then complete it based on field work. This will enable to produce, namely, accurate:
  - Indicators of state, pressures and responses on water resources;
  - Quantification of water uses by sector of economic activity and costs associated to water services.

Both the INSAAR and the USAP follow the "programmes of measures" established by the NWP and aim: to validate and update the information of the RBPs and of the NWP; to produce reliable electronically available databases and correspondent GIS; to produce indicators on the use and utilisation of water; to produce statistical information, adequate to the efficient management of different water uses; and, to support the application and

implementation of the WFD. In fact, currently the aims of the WFD are always taken into account in all scheduled plans of actions and measures to implement the RBPs and NWP.

8.4. Description of the local stakeholders and the selection of stakeholders approached

- Ministry of Cities, of Land-use Planning and Environment (MCOTA): This Ministry disposes of two consulting councils to support it in policies definitions: The national Council for Environment and Sustainable Development (CNADS) and the National Water Council (CNA). The CNA has particular competences in the elaboration of the National Water Plan (PNA) and the River Basin Water Management Plans. This Ministry has the responsibility to define, co-ordinate and execute environmental policy and territory ruling, namely:
  - To manage national water resources on a global and integrated form in order to achieve a temporal balance between water availability and demand and to control pollution, safeguarding the aquatic environment and
  - To guarantee integrated and sustained coastal management, namely based on different institutions, as INAG, DRAOT (now CCDR), DGA and ICN.
- National Water Institute (INAG): It is the organism from the MCOTA responsible for the national policies on water resources and water supply and drainage, namely:
  - To develop information systems on national water availability and needs,
  - To promote an integrated planning on a river basin basis as also of the littoral,
  - To promote conservation of national water resources on quantity and quality, etc.
- Commission for Regional Coordination and Development of Algarve (CCDR Algarve): The Commission for Regional Coordination and Development of Algarve is one of the five CCDR's recently created (end of 2003), and integrates DRAOT Algarve. CCDR Algarve is an official body of the Ministry of Cities, of Land-use Planning and Environment (MCOTA) responsible for the prosecution of regional policies on environment, land-use, economical and social planning, having in view the integrated regional development of the Algarve Region. It is responsible for the elaboration of studies and programmes and coordination of public investments in the region. CCDR Algarve is also responsible for the elaboration and accompanying of the regional river basins management plans, regional and municipal land-use plans, regional development plans and coastal zones plans. CCDR Algarve is further responsible for the macroeconomic and social impact evaluation process of the multiple programmes, interventions and large regional development projects. DRAOT Algarve, integrated in CCDR

Algarve, has as main action the implementation of the national policy and objectives in the area and of the environmental and land-use planning policy, aiming to ensure the qualification of the environment, the adequate organization and utilization of the territory and conservation of nature, and executing the necessary measures for a correct utilization and exploitation of resources. It has also to assure:

- The elaboration of the Regional River Basin Plans,
- The articulation, in strict collaboration with the services of other ministries, between environmental, land-use and urbanism policies and the sectoral policies,
- The coordination and supervision of the execution of the environmental policy,
- The collaboration in the preparation of integrated programs for regional development.

- National Institute of Rural and Hydraulics Development (IDRHa): This Institute is a central service of the Ministry of Agriculture, of Rural Development and Fishing (MADRP). Its main responsibilities are:
  - To develop information systems on water needs and current utilisation of water resources in agriculture,
  - To support water resources conservation and use and hydro-infrastructure development on agriculture.
  - It has also a very important role in the administration of the four Public (State) Irrigation Sites and develops joint work with the existing farmers associations in the region (see below, Farmers Associations).
- Águas do Algarve, S.A.: This Company is integrated in the "Águas de Portugal" Group, a holding company (with major public capital, under private right statutory rules). Águas do Algarve is shared between the Águas de Portugal Group (51%) and the Municipalities of Algarve (49%). Created in 2000, resulting from the fusion between "Águas do Barlavento Algarvio" and "Águas do Sotavento Algarvio", Águas do Algarve Company has the concession for the Multimunicipal primary water (already operational) and wastewater drainage (expected to be operational by 2006) systems. It is responsible for the primary water system, supplying fifteen of the eighteen municipalities in the river basin.
- Association of Municipalities of Algarve (AMAL): The river basin is divided in eighteen municipalities, and fifteen of those integrate the Association of Municipalities of Algarve. Each of the municipalities is responsible for the secondary (domestic) networks of urban water supply as well as of wastewater drainage and treatment. The main purpose of this association is economic, social and cultural development. The AMAL is involved in the elaboration of common development programs for the municipalities and in the management, planning,

promotion and financing of their execution. The Commission for Regional Coordination and Development of Algarve, recently created, also has an important role in the decentralization process dynamics. In fact, the CCDR Algarve supports the municipalities in the juridical, economical, financial and technical fields, paving the way for endowing them with better operational and technical capacities.

- Farmers Associations: They represent the farmers that integrate the Public Irrigation Sites existing in the River Basin. They manage water resources and plan their utilisation in the area of the irrigation site. One can identify three major farmers associations:
  - Farmers Association of the Mira Public Irrigation Site;
  - Farmers Associations of the Alvor Public irrigation Site;
  - Farmers Association of the Silves, Lagoa and Portimão Public Irrigation Site.
- Tourism:
  - Algarve Tourism Office; The Algarve Tourism Office has administrative, financial autonomy and its own patrimony. It is responsible for defining the tourism policy of the region and for planning and executing of all the actions that can promote Algarve. It has also the mission of doing the tourism characterisation of Algarve, elaborating regional plans of actions and collaborating with the local administrative entities.
  - Hotel Industry Association. The Hotel Industry Association ("Associação dos Industriais Hoteleiros e Similares do Algarve – AIHSA") represents the major undertakers of tourism sector in the region.

These different stakeholders have responsibilities at different levels but are connected through support actions from the national level to the regional level and to the local level.

8.5. Consultation procedure

The stakeholder consultation was made beginning with the national responsible for water management, the National Water Institute (INAG), through the direct involvement of the Vice-President and the Director of Planning Division and direct work with the technicians of this Division. INAG was responsible for the elaboration of the National Water Plan and the coordination of the River Basins Water Management Plans. Its collaboration is essential to gather all the information available on a national basis and fundamental to identify the local stakeholders.

IDRHa was also consulted, on a national basis, through direct work with its planning director. This Institution is responsible for agriculture water use and policy. In fact, the State administrates the public irrigation sites, in collaboration with the local farmers associations. Thus IDRHa is also a local stakeholder.

These two main Stakeholders (INAG and IDRHa) introduced the regional entities to be contacted, more in contact and aware of the river basin reality:

Firstly, DRAOT Algarve, now under of the recently formed CCDR Algarve, was approached through its president at the time. Besides the complementary work that was done concerning the Water Management Plans, this active collaboration allowed a more specific study of the different areas of the project and specific of the region as the importance of groundwater resources. The Vice-President also participated in the Paris Meeting of the WaterStrategyMan Project, enhancing the collaboration of this Office and its involvement with the Project.

The Primary Water Supply Company, the Águas do Algarve was also consulted. It is the result of the fusion of the two previous companies, "Águas do Barlavento Algarvio" and "Águas do Sotavento Algarvio", respectively former responsible of the correspondent Primary water systems of the western and of the eastern part of the river basin. The cooperation of the President and his main collaborators was crucial in the definition of the water consumption in the river basin and the identification of the existing infrastructures for urban supply and drainage.

In a more specific approach, the stakeholder consultation proceeded with the Farmers Associations, the Tourism responsibles and the Association of Municipalities. For each one of these, the opinions and expectations were collected, leading to the identification of different approaches to water management.

In the case of the Farmers Associations, it is important to note that the contact was made via IDRHa since it is also a local stakeholder.

For the Association of Municipalities, this procedure was made through the CCDR Algarve since it is the regional entity that directly supports the Municipalities, mostly improving the responsibilities of the local administration. In fact, it was possible to collect the opinion of one of the Municipalities' responsible during a work session with CCDR.

Besides the several meetings organized with the identified stakeholders, it has been necessary to contact also the Meteorological Institute (IM), not as a stakeholder but as a source of necessary data that could not be obtained through the other entities involved.

8.6. Consultation results

From the stakeholders consultation emerged different perspectives and expectations. However, a better management of the existing resources seems to be an aspect referred by all.

INAG

Through the application of the existing Water Management Plan for the Ribeiras do Algarve, INAG identified and proposed as main strategic objectives in terms of urban

water supply to the population and economic activities, including water irrigation for agricultural use:

- Supply enhancement:
  - To solve existing lacks in water supply to guarantee the delivery of good water, in good conditions to all the existing population (resident and tourist),
  - To promote the quality of the water supply service,
  - To minimize the effects of water shortages, especially during the summer period.
- Demand management:
  - To deepen the knowledge on the current irrigation situation,
  - To promote a more efficient management of water irrigation in order to prevent water resources degradation,
  - To minimize scarcity of water resources in order to achieve irrigation guarantee percentage of 80%.
- Socio-Economic Measures:
  - To improve the taxes for the equipped areas in the public irrigation sites.

Other, more generic, objectives and applicable to other thematic areas have been identified:

- To guarantee the economic and financial sustainability of all water sectors,
- To promote the valorisation of the human resources associated to the management of the systems,
- To encourage the participation of the users in the management of the demand and of the systems.

As an actual measure to improve the supply enhancement, Odelouca dam (see Figure 43) is under construction and will be only used for urban supply. That will also enable the reinforcement of irrigation supply, because currently some irrigation water sources (Funcho dam) are mostly used for urban water supply Plan.

Águas do Algarve

As the Primary water supply system already exists, the emphasis is given to its improvement and development. That way, the major interventions the shifting strategy concentrates on supply enhancement.

The main foreseen interventions and improvements are:

- Development of the water supply system,

- Increase of the guarantee in the water supply system (from82% in 1998 to 95% in 2006),
- The integration, for emergency situations, of some wells considered adequate in quantity and quality and already existing in the different municipalities. If there is a problem in the primary water supply system, these wells should be able to substitute, at least partially, the water supply made by surface water,
- With the construction of the Odelouca Dam, it will be possible to improve urban water supply in the east side of Ribeiras do Algarve Basin to 95% of the population and will be the major supply node of the existing primary system. In addition, the sharp degradation of the aquifers water quality and its insufficient supply capacity in critical years makes their substitution by surface water into a real priority. The Odelouca Dam will assure the surface flow regularization, with a tunnel between Odelouca dam and the already existing Funcho dam allowing the transfer of water to the Alcantarilha Water Treatment Plant.
- As Águas do Algarve has the concession for the Primary drainage system and treatment facilities, it will be possible to improve the percentage of population served with treatment facilities and quality of return flows from urban uses.

IDRHa/Farmers Associations

As there are several farmers associations in the River Basin associated with Public irrigation sites, the contact with IDRHa was relevant, as national responsible of those irrigation sites but also as in direct contact with the local stakeholders. During the work sessions, a specific contact with a member of the Sotavento Farmers Association was made.

It may be referred that, until Odelouca dam is constructed, Funcho dam is used for water supply and for irrigation.

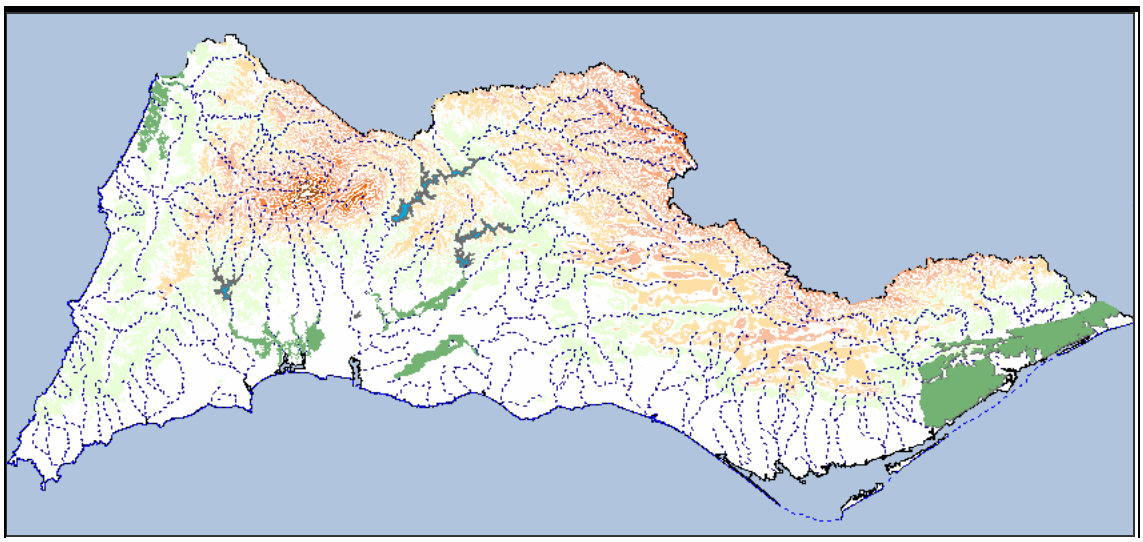

Figure 42. Agriculture Localization of the Public Irrigation Sites, the existing dams and the Odelouca dam

- For Supply Enhancement:
  - The need to improve the existing irrigation networks and the related infrastructures.
  - The Construction of Odelouca dam that will allow Funcho dam to maintain his initial purpose: irrigation water supply.
- For Environmental Interventions:
  - In accordance with the recovery of the aquifers characteristics plan (that pretends to invert the salinisation process of the aquifers), it is necessary to substitute groundwater by surface water.

More specifically, the Sotavento Irrigation site is a main objective in the river basin since it will represent approximately 35,000 ha. This public irrigation site, located in an area with good climatic conditions and availability of soils with ability for irrigated cultures is still under construction, with only a first phase of 8,600 ha being already active. The farmers expect that the new infrastructure will provide water in sufficient quantity and good quality.

AMAL

The association of municipalities was consulted through the Coordinating Commission of the Algarve Region (CCDR Algarve), which is the official body of coordination. In fact, as there are 18 municipalities in the Ribeiras do Algarve river basin, it was not possible to contact each one of them. In general terms, their expectations are similar, since they benefit from the same primary water system. The existing differences are in the municipal networks. That way, the general consultation was completed with a work session with the presence of one of the municipalities' responsible.

As main expectations come the necessity of a better network coverage combined with an improvement of the supply namely on dry periods. Nevertheless that has to be accomplished with the achievement of cost recovery as requested by EU and, in national terms, pricing of water is (still) a political issue. Adding to that, the Municipalities add as main priority the reduction of the distribution losses existing in their secondary supply networks, representing more than 30% of the consumption volume.

The Municipalities want to maintain their drills operational for emergency situations. They want to be able to use them when needed and not only through the Primary supply system as emergency drills.

Tourism

Tourism is a major activity sector in the River Basin. In fact, the expectations of Tourism Institutions match the Municipalities expectations in what concerns supply and drainage systems improvement. The emphasis is given to water shortages during summer periods. The important increase in water consumption associated to tourist population implies pipelines with higher capacities and significant associated infrastructures.

8.7. Formulation of a new proposed Water Management Paradigm based on the results of the stakeholder consultation

The Regional Paradigms shall be framed on the current and foreseen national reality and policy options as well on its Dominant Paradigms, on the regional currently foreseen constraints and water policy strategic aims and on the requirements of the WFD (Water Framework Directive).

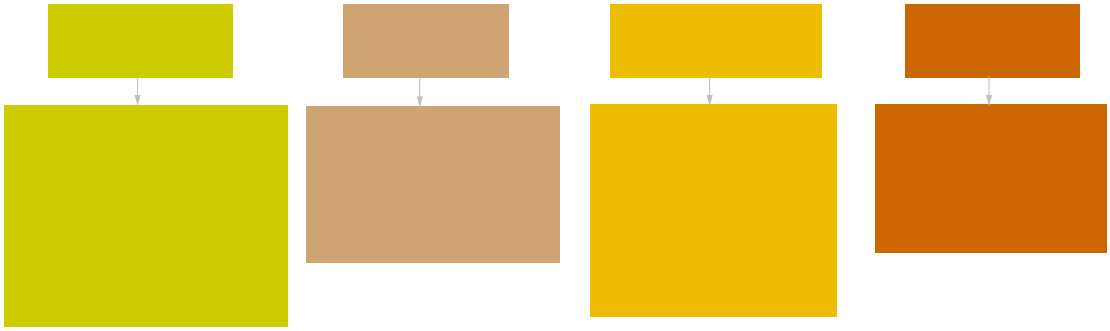

Figure 43. A Proposal for a New Strategy

From the Stakeholders consultation, one can define a new Strategy that will have to be evaluated (Figure 43). Most of the interventions referred are associated with supply enhancement.

Supply Enhancement	Demand Management
- Storage Reservoirs (Odelouca dam in construction) - Infrastructure Improvement - Water transfer from the Alqueva, new multipurpose hydraulic plant (Guadiana River Basin)	- Reduction of water losses - Public Education - Recycling and reuse especially for agriculture and golf courses