Water Supply in Aegina Island: A search for innovation

Aikaterini Kalamara

MSc thesis

Water Supply in Aegina Island:
A search for innovation

Aikaterini Kalamara

MSc thesis

“People want to change but not to be changed”

Peter Senge

Student Registration number: 801128416010

Master: Applied Communication Science

Chair group: Communication and Innovation studies

Thesis Supervisor: Dr. ir. L.W.A. Klerkx
Assistant professor at the Communication and Innovation Studies Group at Wageningen University

Thesis Co-Supervisor: Dr.ir. L Stroosnijder
Professor at Land Degradation & Development Group at Wageningen University

Location and date: Wageningen University May 2011

Table of contents

Preface and Acknowledgements

This MSc thesis has been written as part of my Master in Applied Communication Science at Wageningen University, The Netherlands. It focuses on the water supply and conservation in Aegina Island-Greece and investigates its function and actors relations from an innovation system perspective. The system failure framework is used to detect and analyse the bottlenecks that hinder innovation in the local system and identify opening points that could assist in the process of social learning and augment water conservation.

I am grateful to all the people who have contributed to my thesis process. First of all, I would like to thank my supervisor Dr. ir. L.W.A. Klerkx and co-supervisor Dr.ir. L Stroosnijder for their guidance and advice allowing me to critically improve my work. Furthermore, I would like to thank the people in Aegina Island that participated in the interviews and provided information and support which was fundamental for my thesis process.

Aikaterini Kalamara

Wageningen, 31st of May 2011

List of Figures

List of Tables

List of Abbreviations

AN.KA.	Development Agency of Karditsa
MERA	Ministry of Education and Religious Affaires
EYDAP	Athens Water Supply and Sewerage Company
GDP	Gross Domestic Product
GOLR	General Organisations of Land Reclamation
GSRT	General Secretariat for Research and Technology
ICM	Integrated Crop Management
LOLR	Local Organisations of Land Reclamation
MoD	Ministry of Development
MLP	Multi Level Perspective
NGOs	Non Governmental Organisations
NIDO	The Dutch Initiative for Sustainable Development
GERD	Gross Domestic Expenditure for Research and Technological Development
RTD	Research and Technological Development
RTDI	Research, Technological Development and Innovation
RWH	Rainwater Water Harvesting
SI	System Innovation
SMEs	Small Medium Enterprises
STI	Science, Technology and Innovation
SWOT	Strengths Weaknesses Opportunities Threats

Summary

Aegina Island, located near the capital city of Greece, faces a water supply and conservation problem for many decades. The water management is performed exclusively by the municipal authorities, characterised by a hierarchical approach and the absence of long-term conservation policies, common features in the entire Greek water sector. The promoted solution, for over twenty years, is the construction of an undersea pipeline connecting the island with the network of EYDAP (Athens Water Supply and Sewerage Company).

This thesis focuses on the water supply and conservation system in Aegina and investigates its function and actors relations from an innovation system perspective. Furthermore, it explores how a locally applicable water conservation innovation could be generated. The three core objectives as described in the first chapter are:

1. Identify how the water supply and conservation system in Aegina Island operates and which actors or parties are involved in this system.

2. Detect potential obstacles in the system that may block innovation in water conservation.

3. Identify potential windows of opportunity that could assist in generating social learning and augment water supply and conservation innovations.

The second chapter presents potential strategies used in response to the growing water demand, these are desalination, water harvesting, leakage control, and wastewater treatment but the suitability of such measures in a local setting is crucial in the strategic planning of water resources management. In the case of Aegina alternative options were considered through the years but were never seriously negotiated due to actors' disconnection and contradictory interests which is a common phenomenon in environmental issues.

In the third chapter it is elaborated that innovation can be used as a central strategy for tackling challenges and grasping opportunities and as a means of achieving economic, social and environmental goals (Klerkx, Hall & Leeuwis, 2009). Inhabitants could benefit in multiple ways by engaging in watering conservation methods, and from an innovation system perspective, a locally applicable water conservation innovation could be generated via social learning and assist in building mutual goals, interests, starting-points and also trust and feelings of dependence and responsibility. Unfortunately, impediments in the water supply and conservation system may block learning and innovation. Therefore, the system failure framework, presented in chapter five, was used as an ordering device to identify the impediments (failures) in the local system that hinders water conservation and the actors involved.

As it is elaborated in chapter six, it is quite difficult to endorse innovative solutions in Aegina as the municipal authorities, which are the key actor in the system and operate as the central node connecting all other actors, have not established any participatory or communication mechanism. Relationships among the rest of the actors are quite weak and most wait for the

municipality to initiate some kind of interaction. Most actors focus on their own social circles and do not have a continuous collaboration with the others.

The plethora of identified system failures blocks innovation, efforts should be made in diverse areas simultaneously but priorities were given to the most severe impediments in the system. As presented in the seventh chapter, the main infrastructural failures were the obsolete and malfunctioning water supply network and the lack of scientific knowledge and of an innovation support system. The main institutional failures are the individualistic and passive attitude and the unawareness of the problem's severity. The main interaction failure is the weak relations among actors due to impetuous and fragmented interaction. Finally, the main capabilities failure is the inflexibility towards participatory learning and change.

This node of failures leads also to the creation of another overarching problem, the lock-in phenomenon. Lock-in refers to a complex composition of causes, not only does it concern the shift to a new single technology but it also acknowledges the interconnectedness of that technology with its social and economic environment (Klein Woolthuis et al, 2005). The main causes in the case of Aegina are the lack of trust, lack of resources, absence of knowledge and support bodies, individualism, environmental unawareness, and fragmented communication among actors.

In order to alter this rigid environment, social learning processes can be used but these cannot be imposed and spaces for it to take place within the local system have to be shaped. An actor should step up and take charge of such a process. Municipal authorities could play this role if there is a change in their philosophy but an external actor might be more suitable as he will be able to perform this task neutrally (e.g. EYDAP or a University). Furthermore, local actors should be motivated to enter this process; the leader of this effort should make sure that actors will find an 'entrance', for some this could be e.g. 'sustainability' and for another 'water sufficiency'. Moreover, the creation of a trusting environment could be achieved via the creation of a mechanism where actors will freely express their opinions, concerns and experiences and be a starting point for increasing actors' interaction, for finding common ground, and understanding their interdependence.

To conclude, a shift in the modes of learning needs to be achieved and conservation should not be seen as just a 'problem-solving' situation but as 'problem-finding' one. Water management authorities at all levels of governance should reconceptualise their top-down and procedural approach and strive to find a jointly acceptable solution that will increase actors' connectivity and interaction and create a shared agenda. One potential solution that could be used as the starting point in the conservation dialogue process is the use of water tanks. The majority of the interviewees were in favour of such an option for collecting rain water. This was a traditional water conservation method of the island and as it used to be part of the local culture it could be more easily reapplied as a decentralised and low-cost technology. Furthermore, it will enable people at household and community level to manage their own water and shift towards more community-based approaches and technologies which emphasise participation, ownership and sustainability (Nijhof et al, 2010).

1 Introduction

This thesis focuses on the water supply and conservation system in Aegina Island and investigates its function and actors relations from an innovation system perspective. This introductory chapter aims at concisely describing case specific information, providing a reflection on the problem identification, and presenting the outline of the thesis.

1.1 Aegina's problematic water supply

Aegina is the second largest island of the Saronic Gulf, and is located near the capital city of Athens-Greece. It has a population of 13.552 inhabitants according to the census of 2001. The area is poor in water resources, due to geological factors in combination with the morphology of the island and the climate data, hence there are no significant groundwaters and the creation of surface reservoirs is not facilitated. Aegina consists of small hills which are covered by pine trees. In the island there are mainly cultivated tree plantations (pistachio and almond trees) and vineyards (Sompolos, 2008).

Figure 1: Location of Aegina Island

Today the most important problems of the island are the water supply, and preservation of the environment from the pollution and the preservation of the urban environment and the character of the island from the intense construction activity (Municipality of Aegina, 2011). The island's water supply is achieved by the simultaneous use of groundwater and drinking water from EYDAP transferred via tanker ships. During the summer months 4 or 5 tanker ships arrive daily at the island with a total capacity of 4000 m^3 of drinking water (Kapsalis, 2006).

EYDAP's new profile is more market oriented; as a result an expansion of services in other than Attica area has been scheduled. The water company, using the same limited resources,

offer already some services in the Saronic Gulf islands and Cyclades. The sustainability of such schemes has been questioned. Moreover, the expansions of the service area might cause conflicts between different users of water (Zikos & Bithas, 2006).

1.2 Problem identification

In Greece, given the Mediterranean climate, the problem of water shortage is mainly due to the rise of the living standards, to the urbanisation, to the irrational water use in agricultural and industrial activities, as well as to the lack of "proper" environmental policies (Mariolakos, 2007). In Aegina, water shortages mainly occur during the summer period, when tourism and irrigation demand reach their peak. The ever increasing need of water led local authorities and inhabitants to the overexploitation of local water resources. According to the local magazine The Aiginaia[1] (Melissaris, 2004, p. 70), the main environmental impacts are:

- The Degradation of the aquifers due to pumping and digging of new wells.
- Microbiological contamination of some aquifers because of the construction development and the construction of absorbent cesspit and/or conversion of old wells into cesspits.
- Contamination of soil and groundwater aquifers from excessive use of fertilisers and pesticides and by the free grazing of animals and uncontrolled slaughter locations.

The core problem in environmental issues is often the conflicting interests different actors have in a particular resource or natural context. The use of soil and water creates often such conflicting conditions (Bouwen & Taillieu, 2004). The water management in Aegina is exclusively performed by the municipal authorities and it is characterised by a hierarchical approach which is the common leadership style in Greece. For many years local authorities struggled to balance water supply and demand and in finding potential solutions for resolving this issue. Inhabitants of the island are the main water consumers, accustomed in utilising water resources disregarding the water insufficiency and the potential environmental impact.

The assessment of potential water conservation measures and their suitability in the local setting is crucial in the planning of water resources management. The promoted, for over twenty years, but not yet achieved water solution is the construction of an undersea pipeline connecting the island with the network of EYDAP. This pipeline will potentially guarantee a continuous supply of water but the island will be dependent on external water resources that might be insufficient in the future. Supporting or alternative water conservation initiatives in the local environment are not endorsed, and related educational or informational activities are limited.

Innovation is a central strategy in tackling challenges and grasping opportunities and as a means of achieving economic, social and environmental goals (Klerkx, Hall & Leeuwis, 2009). In the case of Aegina, on the one hand water insufficiency and disruption of the local

[1] The Aiginaia is a cultural magazine locally distributed in the area of Aegina. It is published twice a year and it covers a variety of subjects including environmental issues.

environment are challenges that need to be addressed. On the other hand alternative water supply and conservation options should be considered as opportunities. Literature has shown that inhabitants could benefit in multiple ways by engaging in watering conservation methods (financially, environmentally, socially), and from an innovation system perspective, a locally applicable water conservation innovation could be generated via social learning and assist in the development of overlapping -or at least complementary - goals, insights, interests and starting-points and also build mutual trust and feelings of dependence and responsibility. Furthermore, there is a growing policy emphasis on the involvement of stakeholders and the public in water resource planning and decision making (Global Water Partnership, 2000) claiming that participatory methods can deliver both procedural benefits (e.g. dialogue) and substantive outcomes (e.g. consensual decisions or action plans) (Kallis, 2006).

In view of the problem identification the main objectives of this research are:

1. Identify how the water supply and conservation system in Aegina Island operates and which actors or parties are involved in this system.

2. Detect potential obstacles in the system that may block innovation in water conservation.

3. Identify potential windows of opportunity that could assist in generating social learning and augment water supply and conservation innovations.

1.3 Outline of the thesis

Chapter 1 briefly presented some case specific information and the problem identification. Chapter 2 provides an overview of the water setting in Greece and potential options for increasing water supply. Chapter 3 is devoted to the theoretical framework; the innovation system perspective is introduced and elaborated as well as the system failures providing the basis of this research. In chapter 4 information and research cases in respect to innovation in Greece are presented in an effort to comprehend the generic innovation climate. In chapter 5 the research questions under investigation are introduced and the methodology used for conducting the research activities is explicated. Chapter 6 presents the research results, in the first part some generic information on the available and selected water solutions are mentioned and the second part is devoted to the identified system failures. Finally, in Chapter 7 the research results are analysed for answering the research questions, and the conclusions and suggestions for further research are presented.

2 Water system in Greece: water supply and conservation

2.1 The water setting in Greece

This part briefly presents the characteristics and problems of the Greek water sector, assisting in understanding the generic environment of the case under investigation.

2.1.1 Structure of the Greek water sector

The National Water Committee is responsible for the formulation of the government's policy and also for the submission of an Annual Report to the European Parliament which includes the country's aquatic environment status, the implementation of legislation for the water protection and management and its conventionality with the European Framework.

The Regional Water Directorate specialises and applies long- and intermediate-term protection and management programs of rivers basins, evaluates Management Plans and Measure Programs for the water basins. Also is in charge of formatting register of protected areas and cares for the substantial participation of the public. It implements Monitoring programmes of the qualitative and quantitative parameters of the water and applies programmes of measures on protection from pollution and restoration of water and specialises in the national pricing policy and political costing of the water usages.

The Regional Water Council gives consultative response before the approval of the Management Plan and expresses its opinion on every water protection and management topic that is submitted by the General Secretary of the Region and finally Publishes Management Plans, in order the public to be informed on its content and participate in the public consultation.

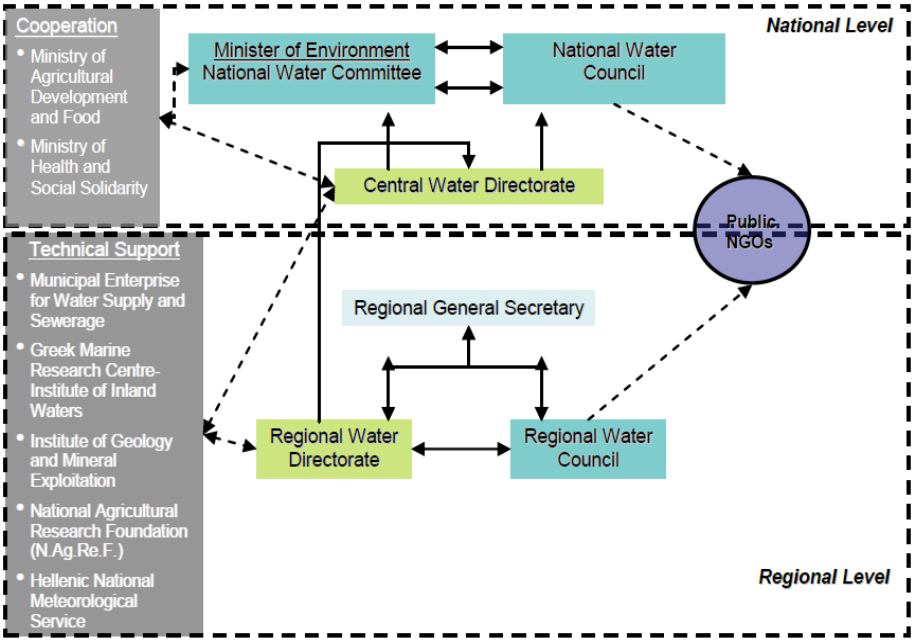


Figure 2: Structure of administrative schemes and bodies (Source: WATERinCORE, 2009)

At local level the Prefectures have an Authorisation, Inspection and Surveillance role. Municipal Enterprise for Water Supply and Sewerage is the competent authority responsible for the control, pricing and management of water supply, sewerage and waste water treatment (MED Programme 2007-2013/WATERinCORE, 2009). There is no move towards private sector involvement, except for some small wastewater treatment works (OECD, 1999a, 1999c) (Getimis, Bithas, & Zikos, 2001).

Irrigation management in Greece is a state responsibility (Latinopoulos, 2005). The Responsible Bodies for the irrigation network management are the General Organisations of Land Reclamation (GOLR) which operate under the inspection and surveillance of the government, Ministry of Rural Development and Food. GOLR inspects, coordinates and gives guidance to Local Organisations of Land Reclamation (LOLR), which are responsible for local irrigation networks management (MED Programme 2007-2013/WATERinCORE, 2009).

2.1.2 Hierarchical water governance in Greece

The major users of water in Greece are mainly located in the Eastern and Southern regions of the country. Greece does not present a balanced water usage scheme, as the rural usage takes the lion's share of 86%. More specifically, 96% of the rural consumption is allocated to irrigation (Mimikou, 2005).

The water sector in Greece, one of the most centralised countries in Europe, is characterised by the absolute dominance of hierarchy (Zikos & Bithas 2006; Getimis & Dimadama 2003; Getimis et al. 2001). The links between water management practices at different levels of governance are often disjointed, conflicting and strictly top-down. Top-down policy creation and implementation combined with the absence of integrated long-term policies, sums up the Greek water sector as a whole (Dimadama & Zikos, 2010).

The lack of well-structured state water authorities to supervise the irrigation activities of private users and an apparent gap in the regulation of the access to water resources has led to improper water resources management (Latinopoulos, 2005). Local and regional social actors are completely excluded from the problem solving process, a situation that, according to Mayntz (1993), reflects a clear lack of dialogue or negotiation. Traditional forms of command and control approaches and hierarchical structures are still dominant at all levels of governance (Dimadama, 2008). Public information is very often inadequate. In any given scenario there is usually one powerful principal actor, or a set of closely linked actors. This actor in turn usually becomes powerless at any higher level of governance (Dimadama, & Zikos, 2010). An indicative division of actors' involvement is given below (Getimis et al, 2001). The main actors are the public/state authorities, the public/municipal authorities, the private sector, associations (e.g. Technical Chamber, Federation of Greek Industries), and the civil society (e.g. NGOs). The areas of involvement are ownership (e.g. in a local setting the ownership of the water supply network and of the irrigation network can differ), management (e.g. in local settings usually the water supply management is performed by the municipal authorities), economic and environmental regulation (e.g. in the local level municipal authorities are responsible for the local water regulation).

Table 1: Actors involvement in the Greek water sector (Source: Getimis et al, 2001)

	Ownership	Management	Economic Regulation	Environmental Regulation
Public/State	+	+	+	+
Public/Municipal	+	+	+	-
Private	+	-	-	-
Associations	-	-	-	-
Civil	-	-	-	-

2.2 Water supply and conservation

This part will briefly present water resources management information and alternative options for increasing water supply and conservation. The literature review focused on the Mediterranean area and on Greek cases in order to find information approaching the research case and its environment and does not aim at presenting every available option.

2.2.1 Water resources management

Nowadays, many pressures applied on water resources, including those arising from agriculture, industry, urban areas, household and tourism. These driving forces are linked with national and international social and economic policies. Additional driving forces arise from the natural variability in water availability and climatic changes. Recent history has demonstrated that extreme hydrological events (floods and droughts) can create additional stress on water supplies, essential for human and ecosystem health (EEA, 1999). The problem of water shortage is particularly remarkable in the Southern European regions, where some semi-arid zones are located (ETC/IW, 1996). Greece is a country with a tourist sector accounting for about 4% of total GDP. Tourism has a tendency to have distinct seasonal

variations and to be in good weather areas, which are often associated with limited availability of water resources particularly in peak holiday seasons (Getimis et al, 2001).

The assessment of the applicability and suitability of potential measures and instruments is crucial in the strategic planning of water resources management (Manoli, Katsiardi, Arampatzis, & Assimacopoulos, 2005). Efforts should focus on water conservation, which includes reducing losses, enhancing saving and promoting management of this resource as an economic commodity and less as a political asset or as a national privilege. Education and training (and in general capacity building) should fulfil the needs of specific sectors, and be adapted to water reform programmes, the process of decentralisation, or other large- or small scale water development and management projects. For example, in many countries water management is handled at local or community level; however, local governments and communities often do not have the capacity (either the knowledge or the financing) to manage this resource efficiently. Finally, data management is essential for reliable predictions of water supply on which to formulate allocation strategies (Araus, 2004).

Mismanagement of water resources can derive from a variety of sources. Lack of user awareness and participation, incomplete knowledge of resources and their value, and lack of shared overview of sector can lead to the lack of integrated strategies, policies, and legislation. Furthermore, inadequate coordination, and separate organisations can lead to weak sector organisations. Also, inadequate training, staff development and technology transfer can lead to weak management and technical skills (Araus, 2004). Thus, mismanagement can potentially affect or even block water supply and conservation innovation and relating initiatives.

2.2.2 Options for increasing water supply

Various strategies have been developed over the years in response to the growing water demand, such as building infrastructures to transport water to deficient areas. Since such projects require much time and money, alternative solutions are being proposed, such as desalinating seawater or brackish water, water reuse and water conservation measures using water-efficient technologies such as drip irrigation. In discussing alternatives, it is important to examine not only technical solutions but also socio-economic issues such as willingness to pay, public perceptions, risk analysis, assessment of monetary and non-monetary benefits, as well as the environmental impacts. The water reuse option is often not only the most cost-effective solution, but it has the advantage of valorising the social and environmental value of water, enhancing a region's resource availability and minimising wastewater outflow with additional environmental benefits (Lazarova, Levine, Sack, Cirelli, Jeffrey, Muntau, Salgot, & Brissaud, 2001).

Desalination

Desalination, a process that converts seawater or highly brackish groundwater into good-quality freshwater, has been practiced for over 50 years. Among the main desalination techniques, distillation is the oldest form of seawater treatment (Semiat, 2000). In general, the process uses heat energy to evaporate water and thus separate it from salts and impurities.

The evaporated water is then captured and condensed as freshwater. The process therefore recreates the cycle of evaporation and condensation of water that occurs naturally. However, distillation is an energy-intensive process.

In order to reduce energy costs, the seawater reverse osmosis process was developed in the 1970s. This is a more energy-efficient process, which makes use of tightly bound semi-permeable membranes, through which seawater is forced at very high pressures. Only the water molecules are able to pass through these membranes, as they are smaller than almost all the impurities (including salts) contained in seawater. The separated impurities and some residual water are then discharged as brine, usually into the ocean. Advances in membrane technologies have also led to the emergence of membrane configurations with different performance parameters. This method of desalination became popular during the 1990s, as it has a lower operating cost than thermal desalination processes (Qadir, Sharma, Bruggeman, Choukr-Allah, & Karajeh, 2007).

In the case of Dodecanese Islands, an illustrative case of isolated or decentralised Greek areas, two different types of desalination plants for seawater were considered. The solar distillation plants for the very small deserted and semi-deserted islands where the existence of electricity power is in doubt, and the reverse osmosis plants. The operation of these plants was considered not simple as the management scheme of the project had to face several difficulties, such as (Avlonitis, Poulios, Vlachakis, Tsitmidelis, Kouroumbas, Avlonitis, & Pavlou, 2002):

1. Limited or inexistence of technical personnel in many islands for the operation and maintenance of the plants.
2. Difficulties of spare parts transport.
3. Frequent electricity power shut-downs
4. Low water demand for the non-touristic period.
5. Production of water at low cost.
6. A reasonable price for the consumers and a reasonable profit for the investors.

Water Harvesting

A common straight-forward definition of water harvesting is the collection of runoff for productive use (Siegert, 1994). Runoff can be collected from roofs or ground surfaces (rainwater harvesting) as well as from seasonal streams (flood water harvesting) (Agromisa, 1997). The harvested runoff can involve different forms of surface runoff (sheet, rill, gully and stream flow) and the storage is either done above ground, in different systems of tanks, reservoirs or dams, or below ground in the soil (Rockström, 2000).

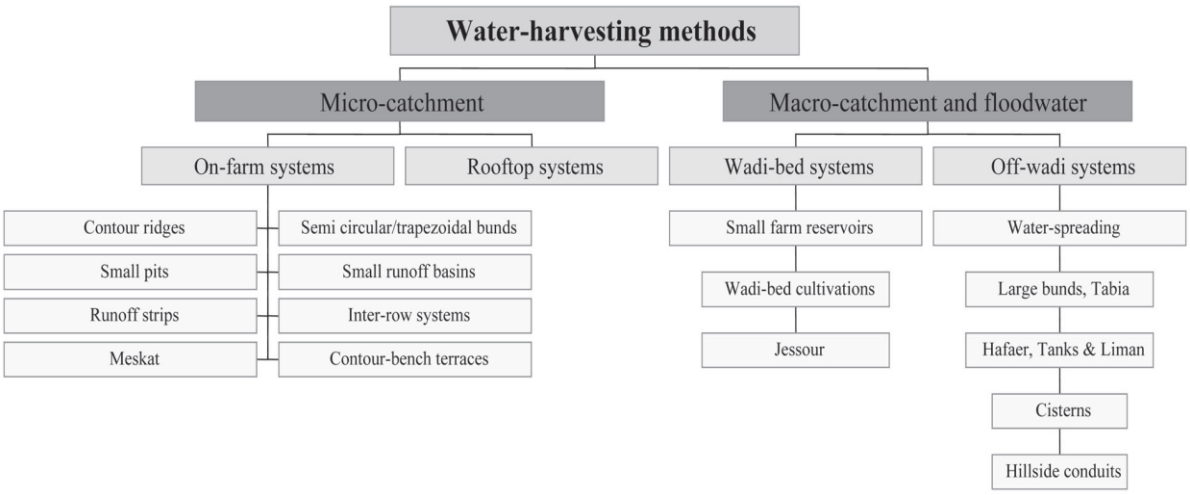


Figure 3: Classification of water-harvesting methods (Source: Araus, 2004)

Water harvesting systems operate at different scales (household, field, catchment), and can affect water availability at downstream locations (Rockström, 2000). In general, water harvesting may be broadly classified into: (1) macro-catchment and floodwater harvesting and diversion methods, and (2) micro-catchments methods, where the catchment area and the cropped area are distinct but adjacent to each other. Boers and Ben-Asher (1982) define micro-catchment systems as systems where the catchment area is less than 100 m in length. (Qadir et al, 2007).

Traditionally, water storage has been achieved with dams and surface reservoirs. However, good dam sites are getting scarce and dams have a number of disadvantages like interfering with the stream ecology, adverse environmental effects, displacement of people for new dam reservoirs, loss of scenic aspects and recreational uses of the river, increased waterborne diseases and other public health problems, evaporation losses, high costs, potential for structural problems and failure, and no sustainability since all dams eventually lose their capacity as they fill up with sediments (Bouwer, 2003).

Rainwater harvesting (RWH) has proved to be a viable alternative water source in challenging environments where other means of water supply have no or very little potential. As a decentralised and low-cost technology, RWH enables people at household and community level to manage their own water. Storage in above-ground ferro-cement tanks is another option, usually cheaper than (imported) polyethylene tanks. Besides above-ground tanks, several other options exist for water storage, such as (partially) below-ground tanks, plastic ponds and sand dams.

Smet (2003) and Ariyabandu (2003) list a number of external factors that facilitated increased interest in RWH, including (Nijhof, Jantowski, Meerman, & Schoemaker, 2010):

- The shift towards more community-based approaches and technologies which emphasise participation, ownership and sustainability;
- The increased use of small-scale water supply for productive and economic purposes (livelihoods approach);
- The decrease in the quality and quantity of ground- and surface water;

- The failure of many piped water supply systems due to poor operation and maintenance; the flexibility and adaptability of RWH technology;
- The replacement of traditional roofing with impervious materials (e.g. tiles and corrugated iron);
- The increased availability of low-cost tanks (e.g. made of ferro-cement or plastics).

Leakage control

Leakage control is more than just locating and repairing leaking pipes. On a low management level it can be seen as the tactical implementation of a choice leakage control methodology, whilst on a high level it is the management of a corporate strategy. Reducing leakage will often defer major capital expenditure by reducing the need to build new water production plant. It will result in substantial savings for every cubic meter of water that is not lost. It will significantly impact upon the environment through reduced energy consumption, resulting in less burning of fossil fuels. It will allow for better pressure management, leading to an enhanced level of service for the consumer. Finally, a well-managed leakage control initiative will result in less futile excavations for suspected leakages and less disruptions in the repair of existing leakages (Rizzo, 2002).

Wastewater treatment

According to Greek legislation, recycled wastewater can be reused for irrigation except for the irrigation of plants used for human consumption. As non potable reuse will long remain the goal of the large majority of reuse projects, the proposed criteria for municipal wastewater recycling and reuse for Greece are focused on microbiological hazards. Treated wastewater quality criteria should reflect the potential for regional variations in climate, water flow, and wastewater effluent characteristics and should be planned to protect individuals against realistic maximum exposures. In addition proposed criteria should be: (a) realistic in relation to local conditions (epidemiological, social-cultural, and environmental factors), (b) affordable, (c) practical, (d) simple, (e) flexible, and (f) enforceable (Tsagarakis, Dialynas, & Angelakis, 2004).

In the case of Dodecanese Islands wastewater treatment plants with photo catalysis and wetlands were considered as options. This combination gives a method for treating municipal wastewaters that has a low investment cost and has the possibility of treating different volumes while it makes possible the reuse of the treated wastewater. The main advantage of the photo catalytic process is its mild operating conditions and the fact that it can be powered by sunlight, thus reducing significantly the electric power required and therefore the operating costs. The treatment in the second stage of the effluent by constructed wetlands gives a perfect, low cost and effective wastewater treatment system (Avlonitis et al, 2002).

Different options for increasing water supply and conservation exist but their suitability in the local setting is crucial. Furthermore, actors with different standpoints are usually involved making change difficult, blocking innovation. By using the systems perspective of innovation, co-operation and connectivity between different types of actors is seen as key to successful innovation which can assist in the creation of a jointly acceptable solution.

3 Theoretical framework

3.1 Introduction to innovation

The water sector is currently undergoing major processes of transformation at local, regional and global scales. Today's situation is challenged by uncertainties, e.g., in water demand, by worsening water quality, by pressure for cost-efficient solutions, and by fast changing socio-economic boundary conditions. One expects additional uncertainties, due to climate change, such as a shift in the pattern of extreme events. Hence, new strategies and institutional arrangements are required to cope with risk and change in general (Pahl-Wostl, 2002).

Nowadays there is a necessity to shape innovation processes and it can be demonstrated by the fact that apart from the advantage of creating economic growth and societal benefits, current use of technologies often have severe negative side effects. Quite often these negative side effects are related to the impact of technology on the natural environment. The relation between technology and the environment is complex and paradoxical. On the other hand, technologies can also lead to a more efficient use of resources, less stress on the environment and even cleaning of the environment (Hekkert, Suurs, Negro, Kuhlmann and Smits, 2007).

Hence, exploring what innovation stands for and how it has developed can be quite elucidative. An older and simplified definition of innovation is that it regards new ways of performing tasks, new products and new procedures (Sunding & Zilberman, 1999). The category of innovation is extremely complex and heterogeneous. It includes process as well as product innovations. Product innovations may be goods or services. It is a matter of what is being produced. Process innovations may be technological or organisational. It concerns how goods and services are produced (Edquist, 2001).

According to the system of innovation approach (SI approach), innovation is an interactive, non-linear process in which actors, e.g. firms, interact with a manifold of other organisations (e.g. research institutes, customers, authorities, financial organisations) and institutions (e.g. regulations, culture). This complex process, characterised by reciprocity and feedback mechanisms, determines the success of innovation (e.g. Freeman, 1987, 1988; Lundvall, 1992; Nelson, 1993; Edquist, 1997) (Klein Woolthuis, Lankhuizen & Gilsing, 2005). Many authors have stressed the role of multiple actors in innovation processes (e.g. Akrich et al., 1988 & Chauveau et al., 1999). Given the heterogeneity of actors and networks, the emphasis is on improving the connectivity of the different groups (Spielman et al., 2008 & Klerkx and Leeuwis, 2008) (Poncet, Kuper, & Chiche, 2010). In the systems perspective of innovation, co-operation between several different types of actors is seen as key to successful innovation. Augmenting alignment and learning in a multi-stakeholder setting is a crucial process as the existence of gaps among involved parties may block innovation. Gaps may be formed for a variety of sources and levels, for example an information gap may exist when actors are not sufficiently informed about the other parties involved, their role in the system, and what they offer.

As regards the organisation of innovation, systems thinkers in innovation have re-conceptualised innovation as a successful combination of hardware, software and orgware (adapted from Smits, 2002) (Klerkx & Leeuwis, 2009). Hardware relates to equipment, infrastructure and technical practices, software relates to actors' knowledge and mindset, and orgware relates to the organisational and institutional setting.

3.2 Innovation as systemic and co-evolutionary affair

In recent years, there is increasing interest in transitions and system innovation, because of their promise to achieve jumps in environmental efficiency. An important insight from the systems of innovation approach(es) is the emphasis on inter-linkages between elements and co-evolutionary processes (Geels, 2005b).

To understand major changes and transitions, the multi-level perspective (MLP) provides a useful framework. The MLP distinguishes three analytical and heuristic levels. There are co-evolution dynamics at each of the three levels, but these usually remain relatively independent. Transitions take place when dynamics between the different levels become linked (Geels, 2005a).

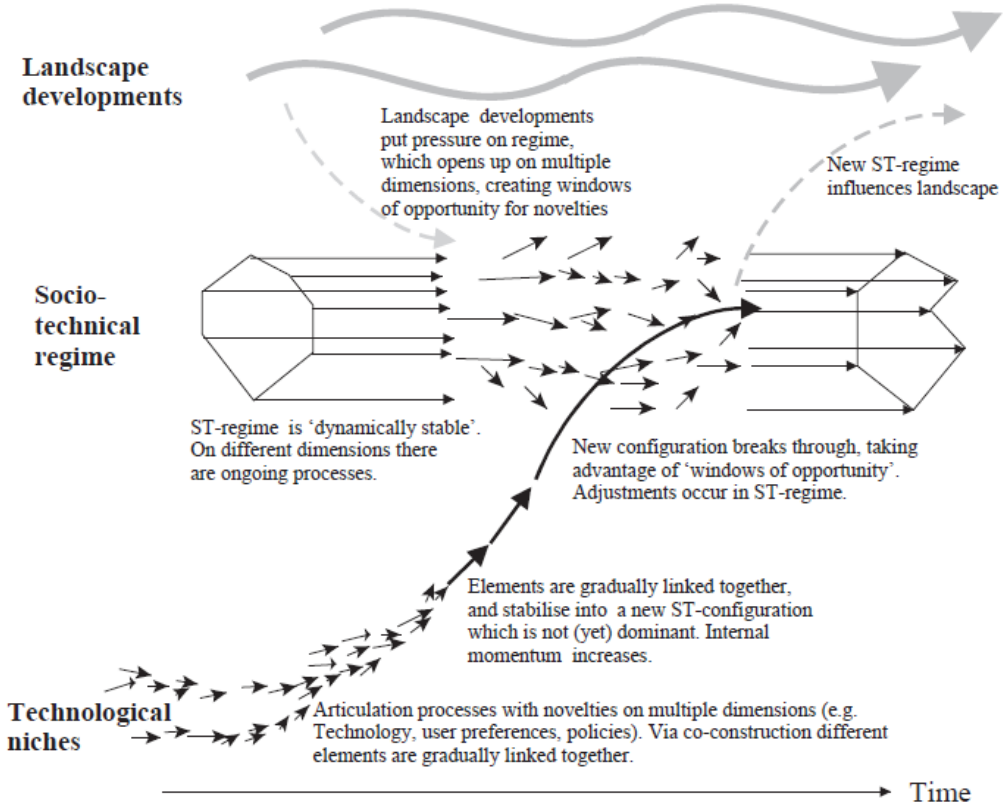


Figure 4: A dynamic multi-level perspective on system innovations (Source: Geels, 2005b)

The Multi Level Perspective has elaborated the concepts of socio-technical regimes, niches and landscapes, which form its basis as presented in figure 4. Geels (2002) proposed to use the term socio-technical regime in order to emphasise that not just engineers or scientists but all kinds of people constitute a regime (Markard & Truffer, 2008). By providing orientation and coordination to the activities of relevant actor groups, socio-technical regimes account for

the stability of socio-technical systems. This stability is dynamic; meaning that innovation still occurs but is of an incremental nature, leading to technical trajectories and path dependencies (Geels, 2005b).

Path dependence, leading to 'lock-in' of existing technologies, arises because of system or network externalities, combined with the fact that technologies are closely linked to their social and economic environment. Hence, new technologies must compete not only with components of an existing technology, but also with the overall system in which it is embedded. Similarly, industries and socio-economic systems can get 'locked-in' to a particular technological paradigm (Foxon, & Pearson, 2008). Lock-in can be the result of e.g. very few weak ties to bridge structural holes (strong network failure), lack of complementary cooperative relationships (weak network failure) or a simple lack of technological and organisational capabilities within the firms themselves (capability failure). Lock-in thereby refers to a complex composition of causes: not only does it concern the shift to a new single technology but it also acknowledges the interconnectedness of that technology with its social and economic environment (Klein Woolthuis et al, 2005).

Niches and the landscape are the complementary elements of regimes in the multi-level concept. The landscape represents the external environment of processes and factors. Landscapes are beyond the direct influence of actors, and cannot be changed at will. Changes at the landscape level usually take place slowly, in the order of decades (Geels, 2005a).

Niches are commonly referred to as protected spaces or incubation rooms, in which new technologies or socio-technical practices emerge and develop isolated from the selection pressures of regimes (Geels, 2005b; Kemp et al., 1998) (Markard & Truffer, 2008). The point of protection is that it creates some kind of shelter in which various individuals and groups can become engaged as participants in the innovation process. In this way they have opportunities to interact and learn about the innovation, and about their own preferences and attitudes in relation to the innovation. For this experimentation and learning to be successful, it has to be an interactive process. Niche creation is widely seen to require a broad and diverse co-operating actor network (Caniëls & Romijn, 2008).

Niches represent the local level of the innovation process (Markard & Truffer, 2008). Local innovations encompass both endogenous (home-grown) initiatives, and local adaptations of exogenous ideas, i.e. of 'interventions' introduced from outside. Local innovations include practices that outsiders coming newly into the area might initially regard as 'traditional'. Giving recognition to local innovativeness is an entry point to building partnerships between different actors in an innovation system (Waters-Bayer & Bayer, 2009).

The logic of the three levels is that they provide different kinds of coordination and structuration of activities in local practices. The relationship between the three concepts can be understood as a nested hierarchy, meaning that regimes are embedded within landscapes and niches within regimes (Geels, 2005b).

3.3 Innovation systems

The innovation systems approach emerged in the mid-1980s as a neo-Schumpeterian perspective that drew significantly from the literature on evolutionary economics and systems theory. From systems theory, the innovation systems approach drew its emphasis on the study of the attributes and interactions among diverse elements of a set, how the properties and behaviours of each element influence other elements and the set as a whole, and how interdependence among the elements renders the set indivisible and thus analysis of a single element irrelevant (Caarlson, Jacobsson, Holménb & Rickne, 2002). A World Bank report defines an innovation system as "a network of organisations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organisation into social and economic use, together with the institutions and policies that affect their behaviour and performance. The innovation systems concept embraces not only the science suppliers but also the totality and interaction of actors involved in innovation. It extends beyond the creation of knowledge to encompass the factors affecting demand for and use of knowledge in novel and useful ways" (Ballantyne, 2009).

An innovation system 'comprises all the actors and their interactions involved in the generation and use of knowledge, as well as the institutional and policy context that shapes the processes of interacting, knowledge sharing and learning' (Dijkman & Otte, 2006). In innovations systems agents-comprising individuals and firms as well as public institutions and non-state actors-constitute the principle operating components of the system. The primary focal agent in the literature is often the public sector research system; private firms are also increasingly important focal agents. Civil society organisations are also important focal agents and include producer/farmer associations, nongovernmental organisations, consumer groups, and other types of community or solidarity groups (Spielman, 2005). The various actors in innovation systems concerned with crop–livestock–water management can include farmers, pastoralists, other resource users, extension agents, research scientists, nongovernmental organisations, local authorities and higher-level policymakers in agriculture, rural development, water development, environment, transport and other sectors. The constellation of actors and their different roles and influences will vary according to each local situation (Waters-Bayer et al, 2009).

Next, an innovation system includes those institutions that affect the process by which innovations are developed and delivered-the laws, regulations, conventions, traditions, routines, and norms of society that determine how different agents interact with and learn from each other, and how they produce, disseminate, and utilise knowledge. These are the factors that determine the efficiency and stability of cooperation and competition, and whether agents in an innovation system are able to interact so as to generate, diffuse, and utilise knowledge.

Knowledge in an innovation system can be categorised in many different ways. Knowledge may be classified according to form-for example, as scientific/technical knowledge or organisational/managerial knowledge, as well as codified/explicit and tacit/implicit knowledge (Hall et al., 2002). Knowledge may also be embodied in some good, service, or

technology; or it may be distinct, disembodied, and complementary. Knowledge may be further characterised by its degree of accessibility and accumulation over time or among agents, depending on an agent's capacity to exchange, learn, and absorb. The sources of knowledge in an innovation system may be external -for example, a scientific journal article. Alternatively, the knowledge source may be some internal process—for example, the reorganisation of human and scientific resources within a firm to improve efficiency (Malerba, 2002). Knowledge may also derive from the conventional providers of advanced research: public research organisations, private laboratories, and universities. Yet it may also emerge from the practices and behaviours of individuals, households, and civil society organisations (Clark, 2002) (Spielman, 2005).

The innovation process is closely linked with interdependencies and multiple forms of interaction between the different elements related to that process, thus forming an innovation system. Such elements or factors of an innovation system are mainly human capital, research institutes and universities, technology transfer organisations, consultants, development agencies, financing organisations, business organisations and associations, services and innovation support infrastructures, markets and consumers, and firms producing and commercializing new ideas (Lundvall, 1992; Cooke et al., 1997) (Kyrgiafini & Sefertzi, 2003). Equally important are those interactions among individuals and organisations that are characterised by learning and feedback processes. The study of how individual agents structure their strategic interactions is what gives the approach its definitive systems perspective (Spielman, 2005).

Recent work in innovation systems has added new analytical dimensions, including the study of systems at different spatial (i.e., geographically determined) levels (Saxenian, 1994; Braczyk, Cooke, & Heidenreich, 1998; Fritsch, 2004), at different sectoral levels (Breschi & Malerba, 1997; Malerba, 2002), in different time periods (Anderson & Teubal, 1999; Andersen, 2000, 2004), and in relation to a given technology set (Carlsson & Jacobsson, 1993; Carlsson, 1995, 1997) (Spielman, 2005).

Functions of innovation systems

A framework used for studying technological change is the 'functions of innovation systems'. It focuses on the most important processes (functions) that need to take place in innovation systems to lead successfully to technology development and diffusion. Functions influence each other. Therefore, a non-linear model is expected with multiple interactions between functions, which will either positively or negatively affect the overall performance of the system. By mapping these processes (functions) over time, insight in the dynamics of innovation systems is created. Based on literature reviews and empirical studies the core functions that can be applied when mapping the key activities in innovation systems are (Hekkert et al, 2007):

- Function 1: entrepreneurial activities
- Function 2: knowledge development
- Function 3: Knowledge Diffusion through Networks
- Function 4: guidance of the search

- Function 5: Market Formation
- Function 6: resources mobilisation
- Function 7: Creation of legitimacy/counteract resistance to change

3.4 Innovation system failures

System imperfections can occur; these system imperfections may block learning and innovation by actors (Mierlo, Leeuwis, Smits & Klein Woolthuis, 2010). The 'failures' of the system do not refer to the deviation from the 'optimal situation' but rather to dysfunctions, gaps or traps in the system (Bach and Matt, 2005). Misallocation of efforts to one or few activities, technologies, practices and firms early eliminated or maintained too long, lack of coordination and absence of appropriate institutions, constraints in knowledge processing and diffusion are all possible failures that lead to lock-in or bad trajectories and difficulties in shifting to new paradigms. Hence, the policy-maker's role is to facilitate the progress of the innovation system through supporting, increase and/or change of the available knowledge base, reinforcing cooperation and diffusion of knowledge and facilitating transition and change to new paradigms (Bach and Matt, 2005; Metcalfe, 2002) (Komninos & Tsamis, 2008).

The four core categories of system failures are:

Infrastructural failures
It refers to Issues regarding the physical infrastructure in the relation with innovation. For companies to succeed, they need a reliable infrastructure to enable their everyday operations and support their long-term developments. Especially, the knowledge infrastructure and a high-quality ICT infrastructure are emphasised in the field of innovation. Emphasis should be put on the importance of the additional infrastructure; accommodation and transport (e.g. smooth roads, reliable railroads, adequate offices, laboratory space, science parks).

Institutional failures
Although differently named, there is a clear consensus that there are 'hard' institutions, being the formal, written, consciously created institutions, and the 'soft' institutions which are informal, have often evolved spontaneously and may be the implicit 'rules of the game' (North, 1991). Taken together, these institutions are conceptualised as the selection environment in which firms, knowledge institutes as well as the government itself are embedded.

Interaction failure
These interactions not only involve relationships with firms, but also the interaction with e.g. the government, public knowledge institutes, and third parties such as specialised consultants. Interaction failures can evolve in two ways: there can either be too much or too little interaction, strangely enough leading to the same sort of systemic failure. Carlsson and Jacobsson (1997) distinguish between weak and strong network failures, that arise in situations in which interaction is too weak (little or no interaction) or too strong (too much interaction).

On the one hand, too much interaction can make individual actors depend on network actors in such a degree that may block external knowledge renewal. Furthermore, long and trusting relations in the network among actors can make them inactive and internally oriented, not willing to exit the group or let others enter. Also, actors may be 'locked into' their relationships due to asset specificity, switching costs or due to a lack of alternative partners in e.g. high-tech or highly monopolised markets (Williamson, 1985). On the other, as a result of weak network failures, possibilities for interactive learning and innovation are under-utilised and firms may fail to adapt to new technological developments. Moreover, if organisations in a system interact poorly, this may lead to a lack of shared vision of future technology developments, which in turn might hinder the coordination of research efforts and investment (Carlsson and Jacobsson, 1997).

Capabilities' failure

Whereas strong and weak network failures can lead to e.g. lock-in, the lack of effective and efficient interaction is certainly not the only cause for this. Companies can also simply lack the competences, capacity, or e.g. resources. We refer to this failure as capabilities' failure. Central to the argument is that firms are unable to make the leap from an old to a new technology or paradigm. Therefore, the individual strength and development potential of a firm are of crucial importance (Klein Woolthuis et al, 2005).

3.5 Stimulating innovation system interaction

In order to overcome such obstacles or system failures, it is argued that actors involved in innovation processes not only need instruments that focus on individual organisations (e.g. financial and managerial instruments) or on the relation between two organisations (e.g. diffusion and mobility oriented instruments), but also on instruments that focus on the system level (Mierlo et al, 2010).

In the literature on innovation systems, it is argued that systemic instruments are needed to fulfil systemic functions beneficial to supporting system innovation as a collective endeavour. Several of the proposed systemic instruments centre around the idea of enhancing dialogue, vision building, strategic intelligence, demand articulation and experimentation, and hence have affinity with learning (Mierlo et al, 2010). Nowadays, innovation studies increasingly focus on learning itself, with emphasis on facilitation and the processes of human interaction from which learning emerges (LEARN@Paris, 2000; Roling & Wagemakers, 1988). The epistemological point of departure is that 'learning is an active knowledge construction process' instead of learning as 'the (passive) absorption and reception of knowledge' (Roling & de Jong, 1998: 144). Learning is seen as a social process in which participants in interaction and negotiation determine what is socially known (Koutsouris & Papadopoulos, 2003) (Koutsouris, 2008).

According to Social learning, the parties involved slowly develop overlapping -or at least complementary - goals, insights, interests and starting-points (Röling, 2002), and also build mutual trust and feelings of dependence and responsibility. This is not 'learning' in the sense of 'knowledge transfer' or 'teaching'; rather it is about the development of different

perspectives on reality through interaction with others. It is not just a question of cognitions about the natural and physical world but also of perceptions regarding one's own aspirations, abilities, responsibilities and space for manoeuvre, and of other people's views of reality. Exploration of different perspectives is vital in such a learning process because it is a very important route to 'reframing' (Gray, 1997): learning to look at a situation and one's role in it in a different way (Leeuwis, 2004). Social learning with respect to sustainable development is based on the participatory processes of social change and societal transformations (Pahl-Wostl, 1995; Minsch et al. 1998) with the aim of making clear the goals and stakes that are involved in transformation processes, achieve better (because democratic) solutions to environmental problems, thus fostering the implementation of measures that have been agreed upon, and better manage conflicts.

Social learning is based on the idea that social change requires:

- Critical self-reflection,
- The development of participatory, multi-scale, democratic processes,
- Reflexive capabilities of individuals and societies,
- The capacity of social movements to shape the political and economic boundary conditions towards improvement of the current situation (Pahl-Wostl, 2002).

Key ingredients for social learning in resource management

For a collection of actors to build up the capacity to engage in social learning for resource management processes, several capacities need to be created amongst the actors (Pahl-Wostl & Hare, 2004):

- Awareness of each other's sometimes different goals and perspectives;
- Shared problem identification;
- Understanding of the actors' interdependence;
- Understanding of the complexity of the management system;
- Learning to work together;
- Trust;
- The creation of informal as well as formal relationships.

Example of a communicative strategy for enhancing the basic processes relevant to innovation support in the case of social learning [sources: Pretty et al, 1995, Loorbach, 2007; Smits & Kuhlmann, 2004; Weisbord & Janoff ,1995; Aarts, 1998; Pruitt & Carnevale, 1993; Leeuwis, 2004] (Leeuwis, & Aarts, 2010):

- demonstrate and visualise interdependencies among stakeholder practices;
- explore and exchange stakeholder perspectives (values, problems, aspirations, context, etc) through discussion, role playing, dramatisation, visits, filmed interviews, informality, humour, fun etc.

- visualise invisible biophysical processes with the help of discovery learning tools or simulation;
- explore past and current trends and likely futures if nothing changes;
- use visioning tools and scenario analysis to imagine (and find common ground on) possible futures;
- discuss institutional and other influences that reinforce existing patterns/problems;
- organise contact with others who have encountered and managed similar problems;
- elicit uncertainties that hinder change, and design collaborative investigation and experimentation to develop common starting points;
- use practical actions and experiments as source of reflection and learning, rather than organising discussion and reflection only;
- organise regular reflection on process dynamics and satisfaction with outcomes.

4 The Greek Innovation System

4.1 The Greek innovation setting

Greece's entrepreneurship is characterised by the small or medium-size of businesses. Despite the crucial role that the business sector has to play in the knowledge – based economies, the Greek Innovation System is characterised by a low mobilisation of enterprises. The low contribution of the enterprises in the research activity may be attributed to the general structural weaknesses of the Greek productive base.

Knowledge creation in Greece is predominantly a public sector venture, which in great part remains under-utilised (or un-utilised) inside its boundaries instead of being diffused to the broader system. Under-investment in knowledge capacity from the private sector reduces the demand for technology and the capacity for interactions and knowledge flows inside the system. The sectoral and regional asymmetries show that innovation related activity concerns a small number of business entities and spaces inside the country, which means that a big part of the economy does not participate in the knowledge economy and cannot offer much in the operation and development of the system.

The overall policy for the promotion of Research (science), Technology and Innovation (STI) in Greece is formulated mainly at the national level. The ultimate objective of the STI policy has been to improve the competitiveness of Greek enterprises and the national economy as a whole, through innovation and exploitation of research results. In this context, most of the measures taken, aimed at providing incentives to firms in order to undertake RTD activities, preferably in cooperation with PROs, and to adopt new technologies (Ministry of Development General Secretariat for Research and Technology, 2007). An important weakness of the innovation policy process in Greece is the absence of proper ex-post evaluation of the measures implemented that would serve a policy-learning process. The R&D support programmes were never analysed to assess their effectiveness in leveraging private R&D (Komninos & Tsamis, 2008).

The main source of funding of RTD in Greece is the public sector and mainly the Ministry of Development (MoD) /GSRT and the Ministry of Education and Religious Affaires (MERA). Approximately, 70 % of the total RTD expenditures is provided by public sources. In 2003, industry (IFGERD) funded only the 28 % of the GERD. Funding from abroad is high, provided mainly by EU sources, both from structural funds and the EU - Framework Programme for RTD (Ministry of Development General Secretariat for Research and Technology, 2007).

4.2 SWOT analysis of the Greek innovation system

Greece is generally lacking in most aspects of innovation, with significantly lower ratings of the leading small countries. This makes very difficult the effort for improvement because changes must be made simultaneously in many sectors and levels. In most indicators Greece's ranking is below the EU average (Lioukas, 2009).

According to the SWOT[2] analysis of the Greek Innovation System contacted by the Hellenic Ministry of Development General Secretariat for Research and Technology (2007) the main points are:

Weaknesses

- The low R&D investments from the private and public sector,
- The weak production base, comprising of small sized enterprises, in traditional sectors, addicted to the mature technology transfer from abroad,
- The weak intermediate technology transfer mechanisms, the qualitative and quantitative deficiency of liaison offices,
- The incompatibility between the supply and demand of employment in the research – technology - innovation sector.
- The lack of entrepreneurial spirit in the Greek research community, the domination of risk avoidance attitude, even in young people,
- The low recognition level on behalf of the broader public and the enterprises of the technological importance and the possibilities it offers for the reconstruction of the economy and the society. The society is suspicious to technological change.
- The bureaucratic and time-consuming management system.
- Lack of innovation component in policy making in education, training and other areas.

Strengths

- The encouraging trends of the enterprises' participation in the research effort – there is an increase of employed researchers in industry.
- Strong and talented human capital and especially solid graduate and postgraduate education at scientific and engineering disciplines related to technology sectors.
- The good performances in funding from abroad, especially from the EU Framework Programme.
- The good innovative performances in the services sector
- The cooperation in innovation between small and medium sized enterprises.
- The non-technological innovation.

[2] This is a generic SWOT analysis of the Greek innovation system and not all points necessarily apply to the case of water conservation innovation.

- Emerging awareness of the importance for global competitiveness and innovativeness.

Opportunities

- Improving understanding of programme management and long term policy making in S&T and innovation
- The fact that Greece lies at a strategic intersection and constitutes an excellent business vehicle for expansion into the South-eastern European and Central Asian markets
- Establishment of a national Competitiveness Council that could promote innovation if adequately supported and led.
- The newly adopted law on Education reform and the pending legal governmental interventions on RTDI governance and post-graduate studies.
- Expected substantial increase of the Structural Funds' budget allocated to RTDI activities, along the line with an integrated RTDI strategy within ESFR 2007 – 13.
- The fact that the promotion of innovation and in particular in the backdrop of globalisation and the need to reap the benefits of globalisation are nowadays at the top of political agenda.
- Outsourcing is becoming very attractive to international corporations, especially in the technology sector, as they try to cut down their operational costs.

Threats

- Slow adaptation of the educational and training system to the requirements of knowledge intensive entrepreneurship and global competition
- Lack of experienced scientists- entrepreneurs to start new high-tech ventures, as well as a lack of experienced managers willing to undertake the control of high-tech SMEs.
- Slow replacement of the traditional stagnant firms by new dynamic technology intensive business
- Inability of both the government and civil service to assume the new role, as catalyst for economic and social development. Hiring, rewarding, sanctioning procedures and criteria, as well as lack of knowledge management procedures, lead to governmental failures.
- Techno phobic behaviour of the general public, extremely sensitive to environmental and health problems. Lack of broadly shared consistent vision of the country for the future
- Substantial motivation for attracting investors in neighbouring countries. Relocation of RTD activities of Greek firms to countries with more innovation friendly conditions.

4.3 Greek research cases on innovation stimulation

In this section two Greek innovation research projects are briefly presented. The following information highlights some of the weaknesses in innovation processes and interventions intended to stimulate these in Greece.

ICM project in Melissa village

The ICM (Integrated Crop Management) project in Melissa village-Greece based on the local Development Agency's (AN.KA.) vision for the plain areas in Karditsa Prefecture (i.e. the establishment of 'community' farms along with the introduction of more sustainable forms of Agriculture-with ICM conceived as an intermediate stage towards organic farming) involved agronomists-experts that had pre-determined (technical) objectives in mind and understood the situation as a classical 'problem-solving' (to introduce knowledge to solve the problem) instead of a 'problem-finding' one (interactive learning to rebuild questions). Therefore, the cultural and socioeconomic parameters of innovation were ignored. Shared agenda for action were by-passed; poor connectivity among actors, in turn, resulted in communication gaps and divergent understandings as far as targets and roles were concerned, thus in the loss of farmers' interest to transform or renew relations and, finally, failure. Thus, despite the 'triple bottom line' and 'interactive innovation' rhetoric, the top-down and agro-scientific approach that was taken in practice, which resulted in bypassing the multifaceted nature of such projects and in misunderstandings among the parties involved, emerged as crucial.

Contrary to the Melissa project, the evaluation researchers moved from external process observers or experts to active participants, positioned within the processes unfolding, while also process managers. Researchers thus engaged in action as learning agents; based on a number of tools (diaries, stakeholder review groups, external peers) they facilitated both the reconstruction of the project puzzle and, through dialogue, fostering reflexivity and interactive learning, the digging out of the reasons for the project's failure. As a result, evaluation made clear among participants the misunderstandings and deficiencies that led to the project's discontinuance as well as the prospects for future cooperation. Such designs involve an interactive (or participatory) process which aids the identification of both innovative and relevant initiatives, including both technically sound solutions and alternative social-organisational arrangements, with farmers 'owning' the agenda. Such an approach, in turn, relegates scientists, extension workers and other experts to the role of co-learners, as well as focuses on learning, innovation and other desirable outcomes as emergent properties of interactive systems. Therefore, power is redistributed and processes of planning and decision-making are negotiated (Koutsouris, 2008).

The Regional System of Innovation in Central Macedonia, Western Macedonia and Thessaly during the 1990s

This article investigated the factors which impede innovation activities and the possibilities to overcome these constraints in peripheral regions in Greece. The analysis was based on observations made in three objective 1 regions in Greece, those of Central Macedonia, Western Macedonia and Thessaly.

The main obstacles to the development of links between research and production are the lack of interest on the part of enterprises, the lack of skilled personnel, inadequate laboratory equipment, the lack of appropriate premises and the existence of institutional problems. The most serious factors, which impede the development of links between research and production are qualitative in character and are related to culture (individual and institutional), while technical barriers (adequacy of infrastructure and premises) are considered less significant. The problem of the latent integration observed in the three regions, is translated to lack of communication, stimulation and coordination between the regional actors. The low levels of systematic collaboration, and the limited knowledge transfer activities, render interaction between the demand and the supply side in Central Macedonia, Western Macedonia and Thessaly irregular and weak. Taking into account the systems-oriented theory of the innovation process, which considers interaction and 'system' identical, non-functioning innovation systems were recorded in the three regions during the 1990s (Kyrgiafini & Sefertzi, 2003).

5 Research Approach

5.1 Research questions and objectives

As already mentioned, the main objectives of this research are:

1. Identify how the water supply and conservation system in Aegina Island operates and which actors or parties are involved in this system.

2. Detect potential obstacles in the system that may block innovation in water conservation.

3. Identify potential windows of opportunity that could assist in generating social learning and augment water supply and conservation innovations.

In respect to these objectives and in consideration with the theoretical framework and the presented research cases the main research questions are:

(a) How is the water supply and conservation system organised in Aegina?

(b) How do actors in the system interact and what are the characteristics of their relationships?

(c) What impediments are there in the system that prevents innovation in water supply and water conservation?

(d) What are possible entry points for a process of social learning?

5.2 Methodology

5.2.1 Research methods

In order to scrutinise the problem under investigation and answer the research questions, corresponding to the theoretical framework that was presented in a previous chapter, the main focus will be on agents (individuals, businessmen, public actors and non-state actors), which constitute the principle operating components of the local system. Furthermore, on local knowledge and on how it is exchanged in the system. Finally, on institutions (laws, regulations, conventions, traditions, routines, and norms) that determine how different agents interact with and learn from each other, and how they produce, disseminate, and utilise knowledge. Interactions among actors will be explored and the characteristics of their relationships will be identified.

In this research qualitative methods are employed. Qualitative research provides the opportunity to the researcher to see the pluralisation of the observed topic (Mason, 2002). The four analytical strengths of qualitative methods are: complexity, depth, context and dynamics (Milburn, 1995). Qualitative researchers study things in their natural setting and interpret the everyday social world (Denzin and Lincoln, 1998). On the other hand,

quantitative methods limit responses and are not flexible to follow information in every direction owing to the use of standardised questions (Patton, 2002) (Papadopoulou, Papalexiou, Hasanagas & Ventouri, 2010).

5.2.2 Semi-structured interviews

A semi-structured interview is a verbal interchange where one person, the interviewer, attempts to elicit information from another person by asking questions. Although the interviewer prepares a list of predetermined questions, semi-structured interviews unfold in a conversational manner offering participants the chance to explore issues they feel are important (Longhurst, 2003).

In this research, the method of semi-structured interview was employed for the collection of qualitative primary data. Questions were separated into 4 sections. More specifically, the first section included questions about water policies, the second one focused on water practices in the area. The third section was devoted on identifying and analysing how different actors in the system communicate and interact, as well as the characteristics of their relationships. In the fourth section, interviewees were asked to state their opinions about the water issue and the potential innovations in water supply and conservation. A pre-test was conducted before the execution of the semi-structured interviews, two local inhabitants participated, in order to make sure that all the questions were clearly stated and that there were not biased. No significant inconsistencies were found and only small changes were done in some of the statements facilitating understanding.

The semi-interviews were audio based and note based, this way the researcher made sure that everything was recorded. A transcript of each interviews was made, and then all the transcripts were rechecked and an overview document was created with the main arguments and striking opinions of the interviewees. The process of coding was a continuous dialogue between literature and empirical material (interviews) (Verbij, 2008). The interviews were also crosschecked with the study of all related documentation (e.g. local newspaper articles, library material). Overall, these sources assisted in developing a solid understanding of the topic under investigation and in answering the research questions.

Sampling

The purposive sampling method and specifically the snowball sample were employed in this research. Purposive sampling is one technique often employed in qualitative investigation (Wilmot, 2005). The researcher actively selects the most productive sample to answer the research question (Marshall, 1996). With a purposive non-random sample the number of people interviewed is less important than the criteria used to select them. The characteristics of individuals are used as the basis of selection, most often chosen to reflect the diversity and breadth of the sample population. However, there are different approaches to purposive sampling (Wilmot, 2005). When the snowball sample is used, subjects may be able to recommend useful potential candidates for study (snowball sample) (Marshall, 1996).

In this case the researcher initially approached some key actors holding different positions or representing different groups in the water supply and conservation system in Aegina Island

(e.g. representative of the municipality-local authorities, representative of the agricultural association-farmers, Citizens-general public) and asked them to recommend other potential candidates for participating in this research, for example people that have knowledge of the water supply problem or are directly/indirectly involved in the water supply problem resolution or are involved in water conservation. The list of Actors in the public and private sector that participated in the semi-structured interviews is presented below:

-Local authorities: One representative of the local authorities and one representative of the municipal opposition.

-Environmental associations: A representative of Active Citizens of Aegina and a representative of FERIAS.

-Local media: A representative of newspaper Nea Epoxi and a representative of the newspaper Kalimera Aegina.

- An agriculturalist experienced in irrigation.

-Inhabitants: Five local people with or without farming activities.

-Businessmen: A private water supplier and driller, a representative of the pistachio producer cooperatives, a representative of the professional agricultural association, a representative of the professional association of hotel owners, and a coligos[3].

Seventeen interviews were conducted from 102/2011 till 1/03/2011 with prescheduled meetings; the time and place of the interviews was selected from the interviewees. The majority of the interviews lasted around 45 minutes and only the interviews with local citizens lasted around 25 minutes as they were not very informed about the water supply history, developments and alternative options that were part of the first section of the interview. An interview with EYDAP was not contacted as there was no representative or bureau in the island.

All actors were informed that the interviews were contacted as part of an MSc thesis, and accepted to be recorded. Furthermore, they were aware that this material was going to be integrated and used in the final report.

5.2.3 System Failure framework as analytical framework

To analyse the results, the system failure framework is used as an ordering device. In this framework that has the form of a table, in the vertical axis system imperfections are discerned (Mierlo et al, 2010). That is the conditions that are either specifically created by the actors, or have spontaneously evolved, that influence not only the functioning of individual actors, but also the system as a whole (Klein Woolthuis et al, 2005). On the horizontal axis actors are identified that cause, are impacted by or try to resolve system imperfections (Mierlo et al, 2010).

[3] Coligos: A Coligos cultivates land owned by others and receives as a reward for his work a part of the production (usually 40-50%).

Table 2: The SI-policy framework (Source: Klein Woolthuis et al, 2005)

Actors (missing actors) / *Rules (system failures)*	**Demand** •Consumers •Large buyers	**Companies** •Large firms •MNCs •SMEs •Start-ups	**Knowledge institutes** •Universities •Technology institutes	**'Third parties'** •Banks, VCs •Intermediaries, consultants •Sector organisations, employers
Infrastructural failure: ICT, roads, railroads, telecom, ..				
Institutional failure: • Hard: laws, regulations, …				
• Soft: norms, values, …				
Interaction failure • Weak network failure				
• Strong network failure				
Capabilities failure				

By using this framework, priorities are given to the most stringent obstacles for innovation. The circles represent the areas in which system failures are observed and the actors that are related to causing and/or potentially solving these failures (Klein Woolthuis et al, 2005). An example illustrating the use of this framework is the NIDO project (The Dutch Initiative for Sustainable Development) presented in table 3. In this project the main system imperfections were the unclear definition of sustainable product, the unwillingness of customers to pay more for sustainable products and the lack of knowledge about potential customers in the long term. The actors that cause, were impacted by or could try to resolve the last two problems were the consumers and producers and in the first case also the regulators.

Table 3: NIDO project-Market Chances for Sustainable Products (Source: Mierlo et al, 2010).

System imperfections\ Actors	Consumers	Producers	Regulators	Knowledge institutes	Organisations of interests
Infrastructure					
Institutions hard					
Institutions Soft	Definition of sustainable product is unclear				
Interaction too strong					
Interaction too weak					
Capacities					
Market	Customers not willing to pay more for sustainable products	Lack of knowledge about potential customers in the long term			

In Aegina's research case, the SI framework is mainly used in order to identify and analyse the impediments in the water supply and conservation system. The framework will be adjusted to the Aegina case, following the example of the NIDO research project. By using this framework potential entry points for social learning and innovation could be identified assisting in directing and planning intervention and action.

6 Research Results

This chapter presents the results of the contacted research, in the first part some generic information on the history, involved actors and the available and selected water solutions are illustrated and the second part is devoted to the identified system failures.

6.1 Historical outline

The main incidents throughout the history of Aegina are briefly presented in order to assist in comprehending how the current situation was formed and how the water supply and conservation problem climaxed.

According to the local magazine The Aiginaia (Poulopoulos, 2004, p. 33), in ancient times, when Aegina had a very large population, the city was water supplied from a very large aqueduct with a few rudimentary pipes.

At the first 30-40 years of the 20th century the island covered its needs with each own resources, no water was imported. All the agricultural houses used to have water tanks and collected the rain water or had wells. There was a self-efficiency, autonomy in agricultural houses, in cultivations, and in cattle-breeding. There were the ‘souvales’, which were natural cavities in the ground, but they were also shaped by the inhabitants by placing rocks around them in order to collect the water and use it for their animals through the year (Interview representative of environmental association Energoi Polites Aiginas, 2011).

In the early 20th century the town of Aegina was watered from the area of Meristos, The well of Gouroukou and Fantado. Later watermen walked around with barrels or jugs and sold water from the area of Livadi, this lasted until about 1946 (Poulopoulos, The Aiginaia, 2004, p. 32). In 1947 studies were made and artesian wells opened in the area of Perivola and elsewhere. The water was provided in 1948 for two hours per day (Poulopoulos, The Aiginaia, 2004, p. 33).

Since the mid-20th century (there are no reliable figures for past seasons), Aegina begins to rely mainly on external sources of water, importing the larger amount of water by tanker ships, (originally from Galata in Troizinia area and most recently from the network of EYDAP) to cover its needs (Sarantakos, The Aiginaia, 2003, p. 48). In the early '60s pumps working by hand appeared. The large wells with diesel engines were very few. The development of the cultivation of pistachio coincided with the rapid growth of tourism and holiday making. The local government of the island asked to construct their own wells to meet the needs of the summer, while large wells were constrained in Troizinia to cover Aegina’s needs and a water ship began to come and go from there to the port of Aegina (Moutsatsos, The Aiginaia, 2003, p. 79).

The construction of an underground water distribution system was done during the dictatorship period (1967-1974). It did not solve the problem, since it increased consumption.

The network, however, brought other problems, there was extensive network botchery. From the dictatorship era, the water ship was the main way of water supply of the city (Moutsatsos, The Aiginaia, 2004, p. 60).

In 1996 a small-scale operation using small bags was used to supply water to the islands of Aegina and Angistri, transporting it from a freshwater source across the sea, at half the cost of previous supplies by tanker (Qadir et al, 2007). This method was used only for a limited period of time as local interests did not allow its well functioning. Regarding this issue it was characteristically mentioned 'when they brought these bags after a couple of times they were torn' (Interview representative of agricultural association of Aegina, 2011).

In 2000, the needs are maximised and the swimming pools are another element that burdens the water supply issue (Interview representative of environmental association Energoi Polites Aiginas, 2011). New buildings (new building permits) prior to 1998 was about 50-60 a year, reached 376 in 2001, 524 in 2002, and 1400 were planned for 2003 (Vrixea, 2004, p. 111) indicating the intensification of construction in the island.

6.2 Current water supply setting

Aegina has a population of 13.552 inhabitants (Sompolos, 2008) but in reality the number of inhabitants is much higher, as to the permanent residents need to be added the seasonal ones, i.e. regular weekend visitors, summer vacationers and tourists of all kinds. The main water users in Aegina Island are:

-The permanent inhabitants

-The seasonal residents and tourists

-Small scale businesses (cafes, restaurants, hotels etc), there is no industry

-Farmers

From secondary data it was derived that the current needs of Aegina in water are covered:

A) With water purchased from the network of EYDAP and transferred via tanker ship (Sarantakos, The Aiginaia, 2003, p. 53). According to EYDAP Aegina is outside its jurisdiction, but it is water supplied from EYDAP through major supplies allocated to its O.T.A. (local government), without the participation of EYDAP at the operation of its local network (EYDAP, 2011).

B) With water from municipal wells that is dropped into the municipal network.

C) With water from private wells that drop into the municipal network (Sarantakos, The Aiginaia, 2003, p. 53). According to the newspaper Eleutherotipia[4] (2004), the water from wells is not sufficient to meet the ever increasing needs of the island. In summer the daily quantities are estimated at 15,000 cubic meters, while in winter the permanent population needs about 9,000 cubic meters. EYDAP in recent years carries via tanker ships about 4,000

[4] Eleutherotipia is one of the biggest nationally distributed Greek newspapers.

cubic meters to the island, blended with locally available, so the water in the taps is not drinkable and residents resort to bottled water.

D) With bottled water, available via trade (Sarantakos, The Aiginaia, 2003, p. 53). According to the national newspaper Eleutherotipia (2004), EYDAP in recent years carries via ships to the island about 4,000 cubic, blended with locally available water, so the water in the taps is not drinkable and residents resort to bottled water.

6.2.1 Water networks in Aegina

Municipal water network

Tanker ships take water from EYDAP at Salamina Island and transport it to Aegina. The water comes at 4 locations in Aegina, the first is at Perdika, the second is at NOA (Nautical Club of Aegina at the main port of the island), the third is at Agia Marina, the forth is at the port of Leonti. The municipality manages the 4 former communities and the municipality of Aegina (town), each part has a separate water network (Interview representative of newspaper Kalimera Aegina, 2011). The municipality is responsible and manages the entire water system, handles the water bills and the technological infrastructure.

Private irrigation network

The municipality does not have an irrigation network (Interview coligos, 2011); farmers buy water from 4-5 private owners that have their own drillings. These private water sellers have their own private superficial pipe networks in the island and distribute the water to the farmer's fields. These networks are installed and operate between July-September and then are uninstalled again. The majority of the water is used for pistachio and olive trees, only these two trees can tolerate the brackishness[5] of the water (Interview coligos, 2011). Furthermore, the water supply of the municipality is limited; it provides 1.5-2 m^3 of water per hour, while the well-owners offer a water supply of 15-20 m^3 per hour. Also, the private water sellers sell the water from 15 to 17 € per hour, depending on the requested hours of irrigation. If the farmers bought EYDAP's water from the Municipality they would have to pay per cubic meter with a scalar charge and the price for large quantities is very high (e.g. from 40 to 60 m^3 the price is 2 €, from 80 m^3 and above the price is 8 €). Thus it is beneficial to irrigate with the per hour system, and farmers prefer to buy water from private sellers as they can save time and some money (Interview representative of agricultural association of Aegina, 2011).

6.2.2 Current actors involved in the water supply system

The main actors of the water supply and conservation system identified by the majority of the interviewees are:

Municipal authorities

The municipality is the authority regarding the water supply and conservation system in the

[5] Brackish water: Contains soluble salts at a rate of between 800 mg / l and 2000 mg / l (The Aiginaia, 2003).

island and is responsible for its management, monitoring, and for fixing all damages. It was identified by the majority of the interviews as the key actor in the system and this is proven also by the fact that all interviewees recognised the municipality as the responsible actor for making decisions.

Citizens/Inhabitants

Another actor mentioned by many interviewees is the citizens of Aegina. It is identified as an actor with a big stake in the issue, as said for example by citizen2 'The consumers are those that complain. Those mainly concerned are the citizens, the rest…', meaning that local people are those that are truly involved and the rest of actors try to promote their own interests. Some of the interviewees think that local people are not really aware of the water issue, 'Not all of the inhabitants have realised the problem' (Interview representative of newspaper Kalimera Aegina, 2011), and from the interviews it was derived that they are not very informed and active, taking collective action.

Water transporters

The water from EYDAP comes to Aegina Island via private water ships and the continuous water supply of the island depends on them, the prices they set and their collaboration with the municipality. In some occasions the island was left without water and most people are against this way of water supply. For example citizen5 said 'We depend on the water transporters for having water and it is more expensive this way, if we used our own water the municipal charge (incorporated in the water bill) would not be so high'.

Shaft/well owners

In Aegina there are 4-5 private well owners that have their own private superficial water network. They have a close relation with local farmers, as the majority of them are supplied by these private networks. Since there are only 4-5 private well owners, each one covering a specific area, there are limited options for the farmers and as said by the coligos 'There is a cartel among water sellers, deciding together on the water price'.

Farmers

The number of farmers has decreased in recent years due to the cost of water and cultivation. Moreover the vast construction of the island has decreased the cultivation areas. Farmers are collectively represented via the agricultural association and professionally have a close relation with the private well owners, e.g. 'My problems and proposals, as a farmer, I express them to the water sellers' (Interview coligos, 2011).

NGO'S (environmental associations)

In Aegina there is a plethora of associations but those directly involved with water conservation are the environmental associations that do not have a very long history. From the interviews it was identified that these bodies conduct some sporadic activities on various topics but they do not have a continuous agenda. Furthermore, most of the interviewed inhabitants did not mention any environmental bodies and seem to be unaware regarding their

existence, illustrating that these organisations have no continuous and water specific actions.

Businessmen

Aegina does not have factories or industries and is mainly dominated by small scale businesses and local shops. The most water demanding businesses are hotels, restaurants, and washing machines that use municipal water. Local businesses do not usually take collective action and are mainly profit oriented.

6.3 Current options for improving water supply

A field under investigation during the interviews was the water solutions that have already been considered for resolving the conflicting water problem of the island. The main selected options, promoted for many years, and recognised by the majority of the interviewees were:

Undersea Pipeline

The water supply of the island today is based on the existence of wells and the transport of drinking water from EYDAP via water vessels. There is an effort of linking the island with undersea pipelines to Salamina for the final resolution of this problem (Municipality of Aegina, 2011). The 2001 preliminary study prepared on behalf of EYDAP examined all the alternatives solutions and concluded that the construction of an undersea pipeline for the islands of Aegina and Agistri is advantageous, in both cost and based on qualitative criteria (Eleutherotipia, 2004). The undersea pipeline has a completed preliminary study and all the environmental permits (17 in number) (Nea Epoxi[6], Issue 102, 2011).

Terrestrial project

This is a locally executed project in Aegina Island and will assist in improving the water supply infrastructure and in changing the obsolete water supply network. This project is crucial because when it will be completed Aegina will be able to connect and receive the increased amount of incoming water from EYDAP. The current network cannot support such a connection. It is a vital project as a) the vast water reservoir created in the Leonti area, b) the replacement of the obsolete distribution network, c) the branching of all regions with the central network and d) new pumping stations and generators will ensure adequate water, steady flow to all areas and better water quality. The "terrestrial" project was studied by the municipality itself, the study and permits were completed in April 2009 and submitted to the Prefecture aiming at the funding from the NSRF (National Strategic Reference Framework). A period of government instability and changes significantly delayed integration. On 4/11/2010, however, the Attica Prefecture sent the formal document which gives the ‘green light’ (Nea Epoxi, issue 98, 2010). At the end of February 2011 the pre-contract agreement among Aegina and the prefecture was signed, that defines that the prefecture will be the authority that will supervise/check the terrestrial project (Interview representative of newspaper Nea Epoxi, 2011).

6 Nea Epoxi is a local newspaper distributed in Aegina island and has been published since 2007

Cost of the projects

The cost of the projects has created great conflict through the years. As municipal authorities change every 4 years so does the budget for contacting the projects, creating the suspicion that local interests interfere in the process. For example, according to a study of the pre-previous mayor (done by EYDAP) the cost of the pipeline was 53 million euro's; while the previous mayor estimated that the cost would be 13.8 million euro's (Interview representative of newspaper Nea Epoxi, 2011). The cost of the terrestrial project is somewhere about 7 million euro's (Nea Epoxi, issue 39, 2008).

6.4 Alternative options for improving water supply and stimulating water conservation

A part of the interviews was devoted on exploring the alternative options that could have been selected in order to enhance the island's water supply and assist in water conservation. The basic identified alternatives were:

Desalination

Desalination was a potential option for improving the island's water supply mentioned by some of the interviews. It was not selected for various reasons but mainly because it is an energy demanding option. Desalination was not only recently discussed, the interviewed agriculturalist mentioned a desalination proposal that happened in the 90's by an international corporation but it did not materialise due to local interests. It was specifically said 'a British-Greek came that was the representative of a colossal English desalination company, and came to propose to the municipality to build a desalination factory in Aegina. He did a pre-study and said that the huge energy that needs a desalination factory would be done by the construction of a thermal plant. The contract would say that with the current price of the water (at1996) we will offer as much potable water as you want for 15-20 years and then the factory will be conceded to you (the municipality). The mayor at the time refused to bring it for discussion to the municipal council; it was a financial issue as the relation of the mayor at this period with the owner of the water-ships was well known'.

The representative of hotel association of Aegina also suggested desalination as a supporting option and proposed the use of solar power for finding the necessary power for the desalination but again this option was not put forward. He characteristically said 'The first step of desalination has already been done naturally; this would be a much progressed project. Financially it is possible as there are motives for green tourism in the current legislation that include desalination and photovoltaic', 'Aegina has ideal locations for this, given it is considered among the places with the highest sunshine in Greece according to studies, and this project could be done in Tourlos area a huge state land that is flat'

According to the representative of local authorities desalination could have been used as a supplementary option and it did not materialise due to 'the communication among the state's government and the local authorities, the municipality could not reach at least a medium term

solution as a replacement for the drillings and have one or two desalination units'. The representative of the municipal opposition said that it was not selected as there is not enough energy supply in the island to support it and there is also the waste management issue, specifically he said 'To have 20.000 m^3 of water would need 80% of the energy of the island, so is something that cannot be done. There is also the great waste problem and the monitoring of all this.'

The representative from the newspaper Nea Epoxi also mentioned desalination as another option but with two negative aspects, specifically 'the first is that it demands a lot of energy that we do not have, which is obvious to everybody from the blackouts we have and secondly it has some solid waste which were can you take them when you are in a closed golf?, regarding the photovoltaic a huge area is needed. Photovoltaic demands also a big investment but there are companies now that can do it lets say for free and then beneficiate from the surplus of the energy but they also demand a huge space that is also something difficult to find and do'.

The representative of Ferias, a local environmental association, was also against desalination saying 'There was also that irrational suggestion', 'desalination is an expensive method, energy demanding, and for small areas. Aegina is a big island; it is a city not just an island.'

Finally, according to the local newspaper, Nea Epoxi, 'the case of desalination has been studied in the past and was judged as not viable for several reasons: a) the energy needs of a desalination plant are enormous. What is lightly written on the wind generators and photovoltaics are funny. It would take all the hillsides of the island to support this, b) environmentally there is a problem in the management of solid waste in an enclosed bay such as the Saronic Gulf, c) it will take at least another 3 to 4 years to restart new studies and licensing with a questionable result and d) water from desalination is not drinkable, further treatment is needed for this (Nea Epoxi, Issue 102, 2011).

Water tanks

A few decades ago many houses and farms in Aegina especially those in rural areas used to have water tanks. With the vast construction in the island and the increase of tourism this method was abandoned. Many of the interviewees mentioned the necessity of having water tanks incorporated in new houses, especially those outside the city centre. This would be a supplementary option in order to collect rain water and have at least partial water autonomy in households. Water tanks used to be a traditional way of collecting water in Aegina and many interviewees suggested that it should be made obligatory for those with new construction permits, the representative of Ferias said 'in all new buildings tanks should be obligatory with an urban regulation'. The cost of building such a tank was mentioned but, the representative of the hotel association, offered a different option saying 'Another way is, we do not have to build water tanks, you can buy a plastic water tank and place it in the ground and collect rainwater with low cost'. This option, although it is strongly supported, has not progressed probably because it also demands alteration of the current construction regulation and a bigger investment from those that want to build in the inland.

Lake-dam

The creation of a lake-dam was suggested as a potential solution a few decades ago, before the vast construction in the island, in order to collect all local water. However it stayed in paperwork phase and no progress in this direction was made. The interviewed agriculturalist said regarding this option 'Since the 80's it was decided that Aegina is an island that needs water, and there were 10 islands in Greece including Mykonos in which it could be tried as a solution the creation of lake-dumps, and the location was found, in the area after Agios Nektarios there is a big basin, this is the biggest basin and it is 11.2 square acres. In the era of Andreas Papandreou (former Prime Minister of Greece) that we connected with the EU and IMPs (integrated Mediterranean programmes) were made, the programme of the lake-dams was put forward and representatives from the Ministry of Agriculture came in Aegina to see what could be done, what happened we learnt it a few years later, it did not progress as the local authorities, not only the municipality that had the major word but also there where others that geographically were involved, showed total indifference. After 3 years the lake-dam of Mykonos was constructed, all these are not current politics it is history'.

Different water flows according to its use or location

Another potential solution would be the distinction of water according to its use, for drinking or agriculture. This option could assist in the creation of an integrated water management, as the current framework is considered unjust for some groups and especially local farmers. The representative of the agricultural association specifically said 'We as an association made some proposals, those areas that will be characterised as agricultural to have the precondition of irrigation, if there is no water the capacity of the land to perform is minimised. It will be forbidden in these areas to build or sell building properties. We proposed that at the ends of torrents to have the ability of water intake, and without major construction projects you can place pipes and it will branch out to the fields.' The representative of the agricultural pistachio producer cooperatives of Aegina, also supported the distinction of water but according to the location saying that 'if you look at Aegina the areas that are densely populated should have their own water tank and have clean water from EYDAP and the houses that are outside this area, as my own, we could have the mixed water, as most of it is used in gardens'.

Biological Treatment

Another option would be to have biological treatment units in houses, supplementary or not. According to the representative of Ferias 'regarding the biological treatment in unzoned areas (outside the city), a new house in order to be connected with DEI (Public Power Corporation SA) should have its own biological treatment, whose investment capital is reasonable nowadays. For building a house of 150.00-200.000, the biological treatment costs 7.000-10.000. The municipalities should ask except from all the other documentations, one indicating that you are connected to the sewer or have a biological treatment unit.' This option was only mentioned by the representative of environmental association Ferias.

What was identified during the interviews was that inhabitants are not very involved in the water supply and conservation system and the decision making process. A point illustrated by the fact that they did not know any of the alternative options, and were only informed about

what has already been selected.

6.5 Water conservation measures currently employed

One of the issues that were explored during the interviews was the water conservation measures that have already been taken in the island. The representative of the municipal opposition said that with the consultation of EYDAP, which is considered the expert in Greece on this issue, the municipality tried to engage in water conservation by invoicing water at a very high price after more consumption than 40 m^3, which is considered the normal consumption of a family of four people. He specifically said 'we, as EYDAP did, increased the price and in very large quantities we charged a price that was 'prohibiting' to pay'. This measure was also analysed by the representative of newspaper Nea Epoxi, saying that 'One measure taken in the past 4 years is that the water regulation says that the water bill is scalar as EYDAP does. After some point the water price reaches the 8 euro's per m^3 and this price is prohibiting. A special water invoice was created for those that de facto need water to run their business, this invoice indicated that they will pay for water exactly its cost, without going up to 8 euro's starting from the first m^3'. Furthermore, the municipality tried to enlighten the people via leaflets. The representative of the municipal opposition was satisfied with the results saying that 'We came from 2.800.000 m^3 in 2006 to 2.520.00m^3 and in 2009 to 2.300.00 m^3 and the population and waste increased during this time. The difference of approximately 500.000 m^3 is a big amount'. The following table also supports the claims of the representative of the municipal opposition and indicates that in 2006 there was 43% of water loss while in 2007 it dropped to 32%, showing the efforts of the new municipal authority in this direction.

Table 4: Reduction in water losses (Nea Epoxi, issue 19, 2007)

Year	Inflow (purchases)	Consumption	Invoiced quantity	Losses
2006	1.185.225	674.804	729.195	43%
2007	1.078.615	735.926	787.438	32%

A recent development, showing the discontinuance regarding the water conservation policies, is that the new municipal authorities changed the water invoicing approximately 3 months after they took over. The new management suggested abolishing the special water invoice for businesses and changed the water consuming scales, from which the price per cubic was defined, from 4 to 3 (Nea Epoxi, Issue 103, 2011).

Regarding the irrigation network, farmers in Aegina have stopped using the traditional pits or dikes to irrigate their cultivations and use drip irrigation systems and according to the representative of the agricultural association of Aegina 'Farmers mainly use drip irrigation, with drip irrigation you can manage better the water with a decreased water supply and this helps in water retention'. Farmers seem to be more careful regarding water usage than inhabitants as water plays a vital role in their profession, and have understood the necessity of not wasting it. Furthermore, farmers are more in contact with nature and the local resources and have learnt to respect water based mainly on their own experiences. For instance the representative of the agricultural pistachio producer cooperatives said 'they are careful with

water, fixing leaks, in order not to waste it. This is not the case for the consumers-households that leave the tap open' and the representative of local authorities said 'in Aegina the last 15 years the irrigation system that has been applied was drip irrigation that seems to save water. On the one hand the farmer himself is not a water waster. The farmer generally is cautious with the water'.

Another point illustrating that inhabitants are not very involved and are not very concerned in saving water is that they did not know any water conservation measures taken in the island.

6.6 The decision making process on water supply and conservation measures

One of the issue that was explored during the interviews was the decision making process regarding the water supply and conservation in Aegina. The majority of the interviewees recognised the authority of the municipality in making decisions as it was elected by local people in order to represent them, but most feel that there is a distance among the municipality and the surrounding environment. An example statement is 'The decisions are made by the municipality but the municipality should listen at the voices of the sensitised people and bodies. When something is done, it happens on its own, it is not like the municipality comes and ask you if you have to say something on the water issue' said by the representative of environmental association Energoi Polites Aiginas. Many think that other people could be involved in the decision making process by offering their opinion, knowledge or expertise, for instance 'In the past I made a suggestion that the 7 members of parliament that represent us in the Greek parliament now, should sit at the same table with technicians from EYDAP and with all the mayors of the last 15-20 years and create a common committee with the goal the connection with EYDAP, in this fight no one surpluses' said by the representative of newspaper Kalimera Aegina. This statement also indicates that there is no continuance in the municipal efforts and as the municipal authorities' change every 4 years, the water issue is dealt each time from the beginning and previous experiences are lost. Moreover, the need of involvement of scientists in the water field was identified by some, for example 'Some professionals, University, EYDAP consultants, representatives from the ministry of environment. To be honest they (municipality) do not have the scientific capacity to cover these. They are elected people that should have the will but the scientific capacity they do not have' said by the representative of environmental association Ferias.

The new Kallikratis[7] programme includes in its policies the performing of social meetings, meaning that in some decisions consultation from the people can be derived. According to the representative of local authorities 'From 1/1/11 started the obligation of public participation,

[7] With the Kallikratis Programme the total redesign of the levels of governing is attempted. The municipalities are being reinforced with new duties in the fields of education, welfare, health, employment, issuing building permits. With Kallikratis significant steps are made for the deepening of the institutions of direct citizen participation in local government, democratic accountability and control of its functions (Ministry of Interior Decentralisation and E-government, 2011).

the bodies are those that can participate, which are the associations, the commercial association, that have their representatives and participate'. The representative of newspaper Nea Epoxi is pessimistic on the functionality of this development and explained that 'According to Kallikratis there should be a consultation committee, but I think it will not function, the way it was institutionalised it presupposes that bodies will participate, in Aegina from the 30 names that were suggested 12 were citizens. Many bodies were left out e.g. the agricultural association, the pistachio producer cooperatives, the women's association, all these are not represented. Secondly, the municipal management does not say to the bodies to send a representative but the management says who it wants from each body. The bodies do not decide who to send'. If the municipal management makes the choices regarding participation in the committees then there is the danger that all opinions will not be expressed and past experiences and knowledge will not be accumulated.

6.7 Innovation system failures in the case of water supply and water conservation in Aegina

In order to scrutinise the problem under investigation and answer the research questions, the main focus will be on agents (individuals, businessmen, public actors and non-state actors), local knowledge and how it is diffused in the system, institutions (laws, regulations, conventions, traditions, routines, and norms) and interactions among actors.

6.7.1 Interaction failures

<u>Impetuous and fragmented interaction among actors</u>

The interviews demonstrated that there is a communication gap among actors and that their interaction is in most cases spontaneous and fragmented. The municipality is the responsible authority regarding the water supply in Aegina; it manages the system, deals with the damages and complaints and pursues the resolution of the water issue. Thus, it can be said that it operates as the central node connecting all other actors in the water system, a point also mentioned form the representative of newspaper Nea Epoxi that said 'I think that the linking point among all actors is the municipality that has the headquarter role of coordinating. There is no point for me to go and say to the well owner why he put more of his water in and that now it is salty' and the representative of newspaper Kalimera Aegina said 'How communication with actors will be done is the responsibility of the deputy mayor of water' and the representative of the hotel association said 'This is a matter of effectiveness of the one doing the management, if it does it effectively it brings results'. Therefore, the way the municipality perform its management and the philosophy it embraces affects the communication and collaboration of the rest of the parties involved. What is indicative of the municipal philosophy is that they consider the act of sending fliers with the water bills a water conservation method, an educational activity toward the public, and a communication activity.

The only direct communication with citizens is done when they have something to compliant or ask about; the representative of the municipal opposition specifically said 'We communicate with the inhabitants when they express their complaints, on daily bases' and

citizen1, said regarding her communication with other actors ‘Mainly by paying the bills. This is my communication with the municipality, to pay and receive the bill and if a problem with my bill occurs, to express my complaints. Beyond that I do not have a direct contact with the municipality or others involved’. Also the environmental association Ferias does not have a direct communication with the municipality and the representative said ‘Communication is done at local cafés in daily interaction. There is no organised system collecting suggestions’. It can also be indicated from the above statements that the limited interaction among actors is usually done informally and randomly.

Throughout the research activities it was identified that there are no established participatory processes leaving room for open flow of information and exchange of opinions. For example the representative of local authorities said regarding actors interaction ‘The base is the regulation and then the application of the regulation is done by the municipality and specifically by the technical water department’ giving a very strict and closed definition to the process. Furthermore, form the side of the public they are not accustomed in open participation and interaction as it was never part of their local culture, the representative of the agricultural pistachio producer cooperatives specifically said ‘If you do a gathering and make a speech, it does not say a lot. As how many will come? Many will come and ‘sleep’ and come only just to come’, citizen2 said ‘You cannot gather everyone in order to inform them, the only way is to write the information in the newspapers and get informed from there’ and the representative of newspaper Nea Epoxi said ‘we are not very willing to participate in seminars or other things done, there is no response’.

There seems to be no set communication mechanism from the municipality, providing feedback to those expressing their suggestions and concerns, this is illustrated by what the representative of agricultural association said ‘We made our proposals but we met once and did not talk again, we gave our proposals to the deputy mayor at the time and he never said anything back, I do not know what happened from there, we were not informed’. There is a distance among the municipality and the rest of the actors and according to the representative of newspaper Kalimera Aegina ‘The distance is not created by the inhabitants that are considered equal; the municipality creates it’ and also the of the representative of the agricultural pistachio producer cooperatives said ‘There is a distance among those responsible and the rest of the people’.

By looking at the other actors in the system, it was made apparent that though it is recognised that communication is problematic, no effort is made for acting collectively. For example the coligos said regarding actor’s interaction ‘I do not think it is done in an organised way, and this is why there is no pressure towards the state. One waits for the other to do something’ and citizen4 said ‘Inhabitants of Aegina are not organised in order to express their complaints to the mayor’ and citizen5 said ‘If I have a problem I will call and someone will come to fix the problem. There is no permanent communication among citizens–municipality’ and the representative of newspaper Nea Epoxi said ‘The consumers should have had some power but only a few times they do, the society in Aegina does not unite in order to demand things. Inhabitants are not organised although there is a plethora of bodies and associations. Maybe this is why there is a plethora of them, as none of them has proven to be effective’.

The main sources for information regarding the local and general water developments are the local newspapers, and the internet. The informational channels used, also support the fact that there is a gap between actors and direct communication is limited, characteristically citizen5 said regarding the way she gets informed 'From the newspapers, I do not have contacts with others'. Inhabitants also use their daily informal communication with their fellow citizens in order to get informed, for example citizen4 said 'I get informed by local newspapers and from whatever I hear from people I know'.

Although it was identified that actors in the system interact poorly, it does not seem to be a lack of shared vision regarding the optimal water solution, as the majority recognises the connection with EYDAP via an undersea pipeline in combination with the terrestrial projects as the ones that will resolve the problem. The other options (e.g. desalination, water tanks) are mainly considered as supplementary ones. Answers regarding the optimal water solution are 'The connection with EYDAP' said by the representative of the municipal opposition, 'The connection with EYDAP, there is no other solution anymore' said by the agriculturalist, 'fix the current water supply network and we should connect with EYDAP' said by citizen4 and 'What is already been told from the past, to connect undersea via a pipeline and take water from Athens in order to have a stable quality and not have any more the ships coming' said by citizen3. It is important to highlight that the water issue and its resolution via a pipeline has been promoted for many decades and passed from generation to generation. Thus, it has become a fixed standpoint for local people not leaving much room for alternative considerations though it does not include any environmental or conservation aspects.

Dependence on dominant partners

Dependence of the local authorities on dominant partners appears to be twofold. On the one hand, the water from EYDAP comes to Aegina Island via private water transporters and the continuous water supply of the island depends on them, the prices they set and their collaboration with the municipality. It can be said that the municipality is 'locked into' this relationship due to the lack of alternative options. For example citizen5 said 'We depend on the water transporters for having water and it is more expensive this way' and the representative of newspaper Nea Epoxi said 'The water transportation is a monopoly in Greece; the companies that transport water are supposed to be two but in reality is one. International competitions are made and only one comes and submits an offer. What negotiation can you do? What price can you maintain? There is no room for that, you are a hostage' and 'water transporters in times can leave Aegina without water, there is a balance of terror, but we cannot do otherwise we need them, we are obligated to go along with their ways otherwise we will not have water'.

On the other, the malfunctioning water supply system (leakages, non-payment of water bills, dependency on the water transporters etc) in Aegina has created a financial dept that each municipal authority tries to manage. Specifically the representative of newspaper Nea Epoxi said 'every now and then, each mayor tries to escape the municipality from sequestrations, as water is something that we carry as a debt for at least three municipal services. The financials of the municipality are going to hell and will be going as there is nothing to do, the state subsidies were cut. Form the water starts the entire bad situation, this is gangrene'. Private

local funds for resolving this situation and for launching innovative solutions are difficult to find as in Aegina there are no large scale companies, industries or other bodies that could support the process. The representative of newspaper Kalimera Aegina said on the issue 'the money we leave it at the central state and if they do not help, no matter how much willing we are as inhabitants or as the municipality of Aegina, nothing will be done. The municipality cannot support the project financially, alone' and the representative of the agricultural pistachio producer cooperatives said 'The goals they have set (municipality) are difficult to achieve due to the financial aspect'. Finally, the representative of local authorities identified as a water conservation bottleneck 'The financial aspect, the investment'.

6.7.2 Infrastructural failures

Obsolete and malfunctioning water supply network

One of the issues that were explored during the interviews was the condition and operation of the current water supply network. The majority of the interviewees recognised as one of the major issues the bad condition of the local infrastructure; malfunctions, and damages is a common phenomenon as well as water leakages. The representative of the municipal opposition said 'Some water is lost and there should not be. Some amount of water is not recorded and the water consumption is bigger than it appears. We did an experiment and we changed some water meters in the centre of Aegina, in some businesses. We compared the previous consumption with the one with the new meters at the same period of the year and it was double' and the agriculturalist said 'The major bad thing was that during the dictatorship era the central pipeline system was build under the roads, there was botchery, and we pay for it till today with constant damages'.

The municipal pipe network is also affecting negatively the quality of the water as it is obsolete and some parts are made from asbestos. For instance citizen4 said 'Infrastructure is a big problem as the original water form EYDAP is of good quality and citizens in the basin of Attica drink it without a problem. How then becomes inappropriate for drinking?' and the agriculturalist said 'the pipes are made from asbestos, of course when something breaks it is replaced by pvc, but most part is still asbestos. No epidemiological study has been made showing the cancer rates'.

Water insufficiency, especially during the summer period, is another major problem identified by most of the interviewees. The representative of local authorities said 'In response to the technology, we take the water via tanker ships, a 'Palaeolithic' system of getting the water and not with a pipeline or any other medium that will provide a continuous flow'. The agriculturalist said regarding the local water pipes 'insufficient because they were designed in a different epoch for 1/3 of the current houses and then expansions were constantly made which were not made according to a plan or programme or a study. If there is a pipe for a specific house and 10 more are built, then from this pipe the water cannot pass to go to the 10 houses and crazy things happen, adding-cutting pipes, and like this is all Aegina'.

According to the magazine The Aiginaia (Sarantakos, 2003, p. 56) the problem lies in the failure of the municipal network providers to meet the needs of the island during the peak

months, and the unsatisfactory quality of water supplied, especially in terms of hardness and sensory properties.

Lack of Scientific and applied knowledge

Regarding the availability of scientific, applied knowledge, and skills the answers of the representative of local authorities and the representative of the municipal opposition are indicative of the general attitude, the first one said **'**All of us need education for the water management, all of us' and the second 'We are amateurs, I did not know about the water and I learned, then I left and someone else will learn about it but our amateurism stays there, this is bad, it is better to be done by someone professionally continuously and consistently'. Although it is recognised by representatives of local authorities that there is a general lack in experience and water related knowledge, the municipal authorities in Aegina remain isolated from the public not allowing the inflow of local knowledge and scientific enrichment. This point was also illustrated by the representative of the agricultural pistachio producer cooperatives that said 'Ancient Greeks said 'I know only one thing, that I do not know anything'. If the one responsible starts with this principle then he can learn a lot from people, from the mass. There are many wise people in the society, scientists or not, local knowledge could be used. They (municipal authorities) should have their eyes and ears open to be able to listen and to create the right opinion'.

On the other hand some interviewees considered that there is a more specialised knowledge insufficiency e.g. citizen1 said 'Regarding the technical knowledge, I think there is knowledge for example changing some parts of the infrastructure. The area that there might be a lack of knowledge is scientific knowledge, someone that has studied water management and modernisation to go the situation one step further' and the representative of the hotel association said 'I think that specialised knowledge does not exist and it would be an utopia and wrong if any of us in the island wanted to believe that we have this ability. The water management is clearly a matter of a specific study that will have economic and technological data. There are no specialised technicians-managers; it is overweening to say that I can manage it when today even for the last part of the production activity there is specialisation'.

Actors identified by some of the interviewees that could assist in resolving the water problem and in generating innovation and are currently missing from the local water supply and conservation system are:

Knowledge Institutes (Universities-Research centres)

Aegina is a small island with no Higher Educational Institutes or Research Centres. Furthermore, collaboration and knowledge exchange with institutes located in other areas is limited or nonexistent. Many of the interviewees recognised the lack of specialised or scientific knowledge in the local setting and its importance for finding innovative solutions. A contributing factor to the lack of specialised knowledge is that only a few young educated people return home after their studies as it is quite difficult to find a job related to their field of expertise, and have to struggle to use this knowledge in the local setting.

EYDAP

EYDAP is the main supplier of water with a long experience in water management and is considered by some the expert that could assist in the resolution of the water issue. A characteristic example is what it was said by the representative of newspaper Nea Epoxi 'EYDAP is the 'university' for all that want to get involved with water as this is what EYDAP does endlessly'. EYDAP does not have a representative or a bureau in Aegina, its headquarters are in Athens, creating a gap among local actors and the company.

Prefecture/State authorities

State authorities can assist or block the water problem resolution. Municipalities usually depend on the central authorities for resources (e.g. funding, scientific knowledge). State's authorities are centralised in Athens and communication and collaboration with municipal authorities can be problematic. Bureaucracy, a characteristic of the Greek public sector, can hinder even more communication and innovation processes. A few interviewees mentioned the state, as for the application phase of the terrestrial and undersea pipeline projects the state's authorities play a vital role. For instance the representative of newspaper Kalimera Aegina said 'The most important actor for making decisions of course is the mayor but for the materialisation of the project it is not enough, a state intervening is needed. You need the funding from the government at that time'.

Consultant or advisory agents

Another missing actor that could be involved in the water system and assist in innovation stimulation, not mentioned by the interviewees, are consultant or advisory agents. These could provide support and advice on water supply management and conservation measures and potential conservation interventions. Such agencies do not exist in Aegina and generally this sector is underdeveloped in Greece.

<u>Lack of an Innovation Support System</u>

As it was identified there are some missing actors in the local setting but another part contributing in the malfunctioning and rigid water and conservation suystem is the lack of linkages with such actors outside Aegina. These could assist in creating room for change and provide support and advice on water management and conservation measures and potential interventions. Negatively, no effort in approaching such organisations or bodies and in establishing a continuous relation was ever launched by local actors. This may be attributed also to the fact that Aegina is still a quite closed and traditional society and people are not very accustomed in participating in research activities or participatory processes. Furthermore, the individualistic perspective that will be analysed in a following section may restrict local actors from asking for external help.

Generally, in the Greek setting the public research organisations are characterised by introversion with limited response to economic and societal needs. The public sector still constitutes the main driving force of innovation. Furthermore, there is weak intermediate technology transfer mechanisms, and qualitative and quantitative deficiency of liaison offices (Ministry of Development General Secretariat for Research and Technology, 2007).

6.7.3 Institutional failures

Actor's detachment from the system

The interviewed actors perceive their role in the water and conservation system according to their own standpoint but a common characteristic was that a number of them do not perceive themselves as an integral part of the system and consider having just a procedural role. This attitude enhances the stability of the current problematic situation and does not allow the beginning of a collective change process. For example, the representative of the agricultural pistachio producer cooperatives identifies the cooperatives as water consumers, not very active in the water issue and specifically said 'We are not involved in the water issue, we just sell hoses'. Furthermore, citizens and farmers of Aegina also see themselves mainly as consumers, having a more passive role in the water system. For example citizen5 said 'The municipality manages the water. I am just a consumer; I pay my bills and not owe anything to the municipality'. Citizens and farmers complain when they face an immediate problem but do not have a collective and continuous activity regarding the water issue. This is also illustrated by what it was said by the coligos 'We as farmers put pressure for 1-2 months that we need the water, the municipality is the responsible, is has the motive power as we pay to them'.

This characteristic can also be identified in the answer of the representative of local authorities, who analysed the role of the main actors in the water system as it follows 'EYDAP is the supplier, the municipality is the customer of EYDAP and the water manager in Aegina, the inhabitants consume and pay-financiers', defining the relations and roles of actors in a business terminology and confronting water as any other commercial product and not as a social good demanding a different type of management.

Regulation disobedience

Noncompliance to the regulation is a common phenomenon in the Greek society. State and local authorities enhance the situation as they are characterised by bureaucracy and lack of a monitoring system and in some cases corruption. Regarding the fulfilment of the legal obligations by people citizen5 characteristically said 'Regarding the depts. There are people that owe money for years and they have not straightened these issues, they are pending, and it is a very important issue for the island, they (municipality) are very flexible regarding this issue' and the representative of the municipal opposition said 'Regarding the inhabitants, 47% do not pay the water bill, which was improved in 2009 as 82% of the inhabitants paid by our efforts' and the representative of newspaper Nea Epoxi said 'there is also another phenomenon they do not pay, they are accustomed in not paying and whoever makes them pay is considered very bad'. Furthermore, many times people and even politicians manage to bypass the rules by finding gaps or misinterpreting the current framework, this attitude was expressed by the representative of environmental association Ferias that said 'There are regulations but they do not want to apply them. It is like everywhere in Greece, they want to create 'windows' in the laws. This is proven by their law breaking'.

Another fact supporting the regulation violation is the customer relations among politicians and the public. Regarding this the representative of agricultural association said 'Some, as they have social, economic power may escape and not pay. There was a coastal villa that water leaked outside and reached the sea and this person probably never paid'. In some cases local authorities also disobey the law to promote their own interests or to cover up their 'mistakes'. According to the magazine The Aiginaia (Damorakis, 2004, p. 43), in Aegina, with the exception of the area of Perdika, the water is not drinkable. The responsible (Municipality of Aegina) and co-responsible authorities (Public Health Directorate of the Region, the Prefecture and the Ministry of Health) have never indicated a problem as presupposed by the law. On the contrary, those in charge declare for years that the water is appropriate but without drinking it themselves.

Passiveness

The passive attitude of actors in the system contributes in the lock-in and blocks innovation processes. From the research activities it was identified that inhabitants of Aegina are not very active regarding the water problem and are not very united in order to struggle and change the situation. Local businessmen are also inactive and are mainly concerned for their own interests (e.g. not pay the water bill), not searching for water conservation solutions. As it was said for example from the coligos 'they are not very interested in the issue; they wait from the municipality to find solutions', and 'I do not think that businesses contribute in changing the situation' said by citizen1. Finally, local politicians also engage in this attitude, in a bigger or smaller degree. Although the water issue is the longest problem in Aegina, no real progress and change was ever achieved from the various political authorities; something causing the disappointment of the inhabitants. For example citizen2 said 'They always say that something will be done but nothing happens'. A characteristic statement demonstrating this passiveness of the system is 'One waits for the other to do something' said by the coligos. The situation will change as citizen5 said 'If there are some very active people at the municipality with a lot of free time to devote on this issue. We did not have this until now, 4 year municipal services pass by and we are at the same point'.

Another aspect demonstrating the passive attitude of the actors is the water regulation unfamiliarity. The local water regulation is the responsibility of the municipality, it is being processed and then approved by the municipal board but the processing of the regulation is done by the technical department of the municipality (Interview representative of local authorities, 2011). The former outdated regulation was renewed and improved with the consultation of EYDAP, as an expert in the field (Interview representative of the municipal opposition, 2011).

Many of the interviewees and especially the citizens did not express their opinion regarding the current regulation framework. What is noteworthy is what the representative of newspaper Kalimera Aegina said 'those that manage the regulation, they manage it for themselves, they do not open it for the people to know and this is wrong. The regulation is not even known to all the municipality aldermen, one municipal party knows it and the others do not have any information in order to express the correct opinion'. During the interviews significant problems regarding the water regulations were not identified but this may be

contributed to the lack of awareness of the legal framework in Aegina, the only ones that expressed some complaints were some professionals as they thought that in some occasions the regulation is not corresponding to their business activities and water demands.

Individualistic perspective

During the interviews with different type of actors it was identified that there is a lack of collective thinking, e.g. 'the society in Aegina does not unite in order to demand things' and 'we do not react as a society. It's one is in its own little circle' said by the representative of newspaper Nea Epoxi, which is probably connected with the previously identified passiveness. A characteristic that is common in many cases in the Greek setting is that people are mainly concerned about protecting their own interest and not very interested for the common good. It was characteristically said by citizen4 'there are many interests, in a local community, all want to benefit financially even regarding the water issue, if the water comes in Aegina (pipeline with EYDAP) the municipality will not have so many revenues and there are many people selling bottled water, as you can see the interests are big' and the representative of environmental association Ferias said 'there are so many small fragmented interests, a characteristic of the Greek society. These interests are not like a wall but more like a gel, when you have a wall you break it down, when you have a gel what do you do? You puss and your hand goes in, you pull back and the gel is in its original form'. For example, regarding businesses involvement in finding potential water solutions it was said by citizen2 'They could assist but they do not do it. What concerns them is to decrease their water bills and have cheaper water; they are interested in the cost'.

Local authorities also are considered having an individualistic perspective, promoting their political interests instead of those of the citizens. It was said by the representative of local authorities 'water is also used as a political trap for the voters in order for someone to be elected as a mayor, every potential mayor says that will bring the water in Aegina saying 'you will not have any problems with water', and the voters fall into the trap every time' and the coligos said 'There are many economic interests. The municipality has more revenues with the current system and with the new system there will be check, something we do not have now'. Furthermore, the representative of agricultural association said regarding the municipalities role in water conservation measures 'all this is a matter of political will, the municipality sells the water, they say that the municipal taxes are returnable, but the municipality manages money, approximately 2 million euro a few years ago. It is not beneficial for the municipality to do anything like that, although it is the one that should pursue this'.

Unawareness of the problem's severity

During the research activities it was identified that although all actors know that there is a water issue in the island they do not really perceive fully the problem. There is the general belief that the problem will be solved externally via the undersea pipeline, although this has not happened and being promoted for many decades, and as the agriculturalist said 'When you give people the impression that a solution was found, then you enter a demonic cycle'. Furthermore, people do not seem really concerned, not engaging in water conservation individually or collectively. For example the coligos mentioned a very common expression in

Greece 'You do not have to fret about it, it is only water' to illustrate that people are not conscious of the degree of water's scarcity and environmental impact of their attitudes. Moreover, the representative of local authorities said 'It cannot be understood that water is an irreplaceable good and it is not respected. For example, Aegina cannot have houses with lawn; it cannot have houses with swimming pools, it cannot have cars washed by hose' and citizen2 said 'we think that we have a lot of it and we do not care'. Generally, the interviews illustrated that people are mainly concerned about the pricing system and in having a continuous flow of water to cover their needs and are not (especially the inhabitants) very concerned about the overexploitation of local recourses, contamination of the aquifer (e.g. by cesspits), and the decreasing water resources in the country level.

6.7.4 Capabilities failures

Learning by obligation

A general socially accepted norm identified during the research activities seems to be that people will only learn to obey the guidelines and engage in water conservation if they are forced to do it by prohibitions and not by rewards. For example some consider that a 'punishing' policy framework or the existing economic crisis will make people more careful on their consumption. Examples are 'The only think that Greeks here are the prohibitions. The water conservation is done via 'whipping', unfortunately' (Interview representative of the municipal opposition , 2011), and 'I think that problems in Greece are not solved, problems should be cut' (Interview representative of environmental association Ferias, 2011), and 'unfortunately the best education is the financial recession in Greece, when we do not have money we are couscous about the water and the electricity and everything' (Interview representative of local authorities, 2011) and 'I think that if we get punished for bad use of water there might be a result' (Interview representative of newspaper Nea Epoxi, 2011).

This attitude comes in contrast with the regulation disobedience identified in the soft institutional failure. Since it a common phenomenon in Aegina and Greece that people try to 'escape' the rules or find ways to bypass them, it is remarkable to try in the same time to make them learn about water conservation and engage in an environmentally friendly way of living by regulations and prohibitions. Furthermore, the economic crisis can make people more conscious about their water consumption and usage but the reason behind it will be strictly financial and not environmental. If people in Aegina learn to save water only to reduce the water bill cost, they will not become more aware of the water insufficiency problem or comprehend that their actions have an environmental impact. They will be locked-in a cost reduction attitude not able to identify the bigger picture. Finally, this learning perspective may have some positive results in the short term but it will not lead to a long term solution, assisting in the creation of an environmentally conscious culture.

Limited and discontinued educational activities

In Aegina educational and informational activities are limited and fragmented. The absence of knowledge institutes is one of the main determining factors. Furthermore, there is no other body or leading actor trying to endorse such activities and assist in collective learning. The majority of the interviewees think there are no or only occasional water related educational

activities, the representative of the municipal opposition said ‘There are no educational activities by anyone’ and the representative of environmental association Ferias said ‘There is nothing there. The water issue arises in August or Easter and then we start from the beginning’. Some professionals have participated in educational activities mainly organised by their associations which were partly related to water, e.g. the coligos said ‘some agriculturalists from the ministry of agriculture come every year and talk about water, sprayings, soil. This happens usually twice per year and is organised by the agricultural association and/or the pistachio cooperatives’ and the representative of the hotel association of Aegina said ‘We as an association have done many educational programmes for training the staff in the tourism sector, maybe more than 15 in the last 6 years. We have done 2 HACCP programmes that include topics for energy saving and water. HACCP has some parts that refer to water’.

The main educational activity of the municipality is considered to be the incorporated leaflet in the water bill, and it is considered by many as a good informational activity, e.g. ‘We tried to inform them many times via leaflets’ (Interview representative of the municipal opposition, 2011), and ‘the municipality puts in the water bill an informational brochure. If this information reaches every house, this is the best thing to do.’ (Interview representative of the agricultural pistachio producer cooperatives, 2011). This impersonal activity supports also the lack of participatory processes leaving room for open flow of information and exchange of opinions analysed earlier. It also supports the mismanagement that will be analysed later on, the representative of the hotel association of Aegina characteristically said ‘Unfortunately the political staff that manages the municipalities and generally Greece is outside the needs and timing of our era, do not understand the educational needs’, the representative of the agricultural pistachio producer cooperatives said ‘this kind of messages should be done from someone with knowledge and will, and not care only if they are going to be elected’ and the representative of environmental association Energoi Polites Aiginas said ‘There is no continuous education as one cannot deal with all the issues of the island’.

Inflexibility

the society of Aegina is still quite traditional and not very open to change, this aspect was identified by the representative of environmental association Ferias who said ‘The society of Aegina is very backward thinking in relation to the distance with Athens’ and ‘There is no edge that you should start there is a node that as you turn it around you cannot find the start’ and citizen1 said ‘We are in an island, a closed community, so from generation to generation some traditions are passed on and it will be difficult to change as they are accustomed in using their experiences, they trust what they know’. Also the municipality shows inflexibility, as it was mentioned in a previous part, municipal authorities are isolated not open to the inflow of ideas. An example of this rigidity was illustrated by citizen2 who said ‘I believe that the citizens will say their opinion but the municipality will do what it thinks’. The municipal inflexibility was shown also when the representative of local authorities was asked by the researcher who else she could contact regarding the water issue in order to get an overall picture of the issue and he said ‘I think you are done’ despite the fact that this was the first conducted interview.

In general, local customs and traditions were not considered as blocking factors. Traditional water methods, for example water tanks incorporated in households that were used some decades ago, are not considered an obstacle to change and in many cases they were considered positive and supportive to innovation. For example, the private water seller said 'I do not think tradition creates any problems; sometimes it can serve us more', the representative of agricultural association said 'Tradition was positive' and the representative of environmental association Energoi Polites Aiginas said 'traditions were positive and should have been maintained, and change only where it should, meaning the use of new technologies'.

A good example illustrating the inflexibility of the society of Aegina was mentioned by the representative of the newspaper Kalimera Aegina. He said 'When I closed the Kourenti stream, as there was a command from the positioned district attorney because the water was inappropriate, they (citizens) nearly beat me, my car was damaged, as the citizens in this area had grew up with this water. The water had to be closed and people there could not accept it, 3 generations had grew up with this water and thought that this was the best water but this was not the case. We had to explain it to them, it is really difficult to say to an old person that was born there and took water from the stream that he should not drink this water as if he would die. We did 2-3 gatherings at the elementary school of Vathi and Agious and with the professional association of Souvala, there were many reactions but with the passing of time they all understood the problem and now no one drinks from this water. It was difficult to pass it to a local community, saying 'What are you trying to do? Why do you close the water?''.

Water resources mismanagement

The water management in Aegina is handled by the local political authorities which in this case is the municipality. One of the Deputy Mayors is appointed in charge of the water supply department. Often there is no continuance in the municipal efforts as the authorities change every 4 years with the elections, and the water issue is dealt each time from the beginning. Since a politician is responsible for the water management, it is highly possible that there is no experience in the field and as the representative of environmental association Energoi Polites Aiginas said 'Unfortunately, we do not always have the best people in decision positions'. Furthermore, a conflict of interests may occur as on the one hand municipal authorities are elected in order to represent Aegina's people and support their rights and on the other they operate the water business, and as the representative of newspaper Nea Epoxi said 'there is a lot of money circulating in this water situation, out in the light and hidden'. Some interviewees expressed their dissatisfaction regarding the management, the representative of the hotel association said 'there never was a rational water management, it was the medium for becoming rich for some people and that is why this situation was kept as it is', the representative of environmental association Energoi Polites Aiginas said 'I am not satisfied with the way that the municipal authorities deal with the water management, and citizen3 said 'there are many problems regarding water deriving from many sides and it should start internally from its management and organisation'.

The insufficiency of the water management that is performed by the local political authorities can be connected with the lack of scientific and applied knowledge in this field. In general, there is a lack of an organised water conservation plan or other offered conservation initiatives form the municipal authorities. The representative of local authorities said ‘each one must become aware of the fact that water is not something that has a cost-price, water is a good that starts lacking throughout the world and no matter how much money you have at some point it will not be enough to buy it ’. This statement suggesting that water should be separated by the cost factor comes in complete contract with the municipal policy that tries to promote water conservation via the water charges, there seems to be a differentiation among problem perception and action.

According to Mr. Sarantakos (2003, p. 56) the municipal authority cannot and must not manage the water. The various irregularities of the past (observed deficits in the shipped water quantity and inevitable judicial disputes with the supplier, delay or negligence in collecting water charges and many others) convince that municipal services are form insufficient till inappropriate in Aegina area.

7 Discussion and conclusion

In this chapter the research results are analysed and discussed for answering the research questions (7.1-7.4). Furthermore, the limitations of the research are presented and the final part is devoted to main conclusions and suggestions for further research.

7.1 Water supply and conservation system in Aegina Island

In Aegina Island there are two separate water networks. The municipal water network that mainly supplies water to the general public, and the private irrigation network that provides water to local farmers. Private water sellers have their own private superficial pipe network and are responsible for its operation and for forming the water prices.

Municipal authorities are responsible and manage the entire water supply system in the island. Furthermore, the municipal water supply department is responsible for the local water regulation, for the water pricing and the conservation policies. Furthermore, a Deputy Mayor is appointed at the head of the water supply department every 4 years after the local elections. Thus, it can be said that there is often discontinuance in the efforts of the department and a lack of expertise. What is salient is that despite the dissatisfaction of most of the interviewees about the constant water supply problem and the inability of the ever changing municipal authorities in resolving it, most local people did not question the Deputy Mayor's capacity in managing the water supply department.

The main actors in the water supply and conservation system are the municipal authorities, citizens, water transporters, private shaft/well owners, farmers, NGO's, and businessmen. Municipal authorities are in close collaboration for many decades with another actor, the water transporters that take water from EYDAP's network and bring to Aegina via tanker ships. The efficiency of this water transferring process has been questioned by most of the interviewees as it has created a big financial debt to the municipality and the constant dependence on the water transporters for guaranteeing continuous water supply in the island.

Municipal authorities are the key actor, and this was indicated also by the interviewees that recognised the municipality as the responsible actor for making decisions. This finding resembles with earlier findings indicating that local and regional social actors are completely excluded from the problem solving process and that hierarchical structures are still dominant at all levels of governance. Furthermore, also in the case of Aegina there is one powerful principal actor-the municipal authorities that at a higher level of governance are often powerless and depending on the central state.

7.2 Actors' relationships and interaction

During the interviews it was identified that actors' interaction is in most cases is limited, and spontaneous. Municipal authorities operate as the central node connecting all other actors in the water supply and conservation system. Negatively, they have not established any participatory or communication mechanism leaving room for open flow of information and exchange of opinions that could assist in retrieving local knowledge and in creating a shared agenda. A contributing factor can be that people are not accustomed in participatory processes as it was never part of their local or generic culture.

Relationships among the rest of the actors are quite weak and most wait for the municipality to initiate some kind of interaction. Local newspapers are the main informational channel, which also support the fact that there is a gap between actors and direct communication is limited. The only face to face communication with citizens is done when they visit the town hall for complaints and queries or when they meet accidentally a representative of the local authorities somewhere in the island. Finally, it was made apparent by the interviews that although it is recognised that communication is problematic, no effort is made for altering the situation or taking collective action.

Similar findings were identified in the CM project in Melissa village, where poor connectivity among actors resulted in communication gaps and divergent understandings as far as targets and roles were concerned. Furthermore, in the research case on the Regional System of Innovation in Central Macedonia, Western Macedonia and Thessaly the problem of the latent integration observed in the three regions, was translated to lack of communication, stimulation and coordination between the regional actors. Thus, it can be concluded that insufficient communication and collaboration is not just a local problem but probably a more generic phenomenon.

7.3 Impediments preventing water supply innovation and water conservation

7.3.1 Application of the system failure framework

After presenting the diverse failures derived from the research activities, priorities are given to the most severe impediments in the system. In table 5 key problems in the case of Aegina Island are presented. This table will assist in visualising where key systemic failures occur and which actors should be addressed to promote change, according to the semi-structured interviews and other crosschecking sources.

Table 5: Observed system failures

Actors / Rules (System Failures)	CONSUMERS -Inhabitants -Farmers -SMs -Tourists	SUPPLIERS -Municipal Authorities -Private water sellers -EYDAP	OTHER ACTORS OF INTEREST -Water transporters -NGOs -Prefecture/State Authorities	KNOWLEDGE & SUPPORT BODIES -Universities -Technological Institutes -Research Centres -Consultants/Advisors
INFRASTRUCTURAL FAILURE		Obsolete & Malfunctioning water supply network Lack of scientific knowledge and of an innovation support system		
INSTITUTIONAL FAILURE **-Hard** **-Soft**	Individualistic & passive attitude Unawareness of the problem's severity			
INTERACTION FAILURE **-Weak network failure** **-Strong network failure**	Weak relations among actors due to Impetuous & fragmented interaction			
CAPABILITIES FAILURE	Inflexibility towards participatory learning & change			

The identified failures of the local water supply and conservation system were analysed separately according to their type, however they have apparent linkages to each other. One failure can lead in some degree to the creation of the other or be partly the result of it. In the following section the links among key failures, presented in table 5, are explored.

<u>Infrastructural failure</u>

- Water resources mismanagement
- Individualistic perspective
- Regulation disobedience

⇨

- Obsolete & malfunctioning water supply network
- Lack of scientific knowledge and a support system

The main Infrastructural failures are the obsolete and malfunctioning water supply network, and the lack of scientific knowledge and of an innovation support system. The main actors that should be addressed in the first failure are mainly the local, prefecture and state authorities and in the second the local/state authorities, knowledge and research institutes and advisory agents.

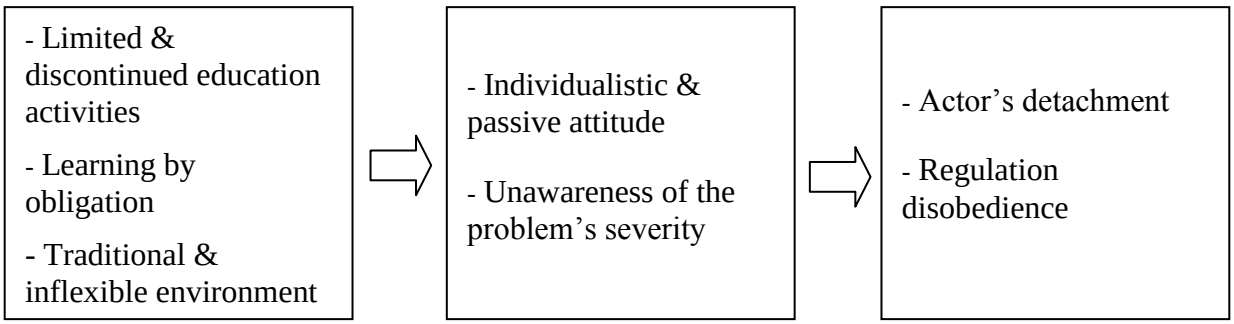
These failures are to some extent the result of the identified water resources mismanagement, as actors responsible for the water management in Aegina are local politicians that usually do not have the technical and specialised knowledge to monitor the water network, regulate and perform the water management. This finding is compatible with the hierarchical water

governance in Greece, where the lack of well-structured state water authorities to supervise the irrigation activities of private users and an apparent gap in the regulation of the access to water resources has led to improper water resources management.

Individualistic perspective is also contributing in the lack of scientific knowledge and of a support system, as local actors and especially local authorities focus on achieving their goals on their own and are not very open in asking for external support and in creating linkages with knowledge and research bodies located in other areas. Finally, regulation disobedience reinforces the bad condition of the local infrastructure (e.g. corruption).

This finding resembles with earlier findings in the second research case in section 4.3 where there was a lack of skilled personnel and limited knowledge transfer activities. It relates also to the generic environment, as knowledge creation in Greece in great part remains under-utilised inside its boundaries instead of being diffused to the broader system as it was presented in section 4.1.

<u>Institutional failure</u>



The main Institutional failures are the individualistic and passive attitude and the unawareness of the problem's severity. In this case the actors that should be addressed are all local actors and authorities as for this problem change should start at the local level.

One factor contributing in the creation of these attitudes are the limited and discontinued education activities, and learning by obligation. Aegina's traditional, closed and inflexible environment is a factor contributing in the problem unawareness as people are 'closed' in their own little circles. These failures result in actor's detachment from the system and regulation disobedience as actors are focusing on themselves and not on societal issues and are willing to act only to peruse their own goals. Furthermore, this individualistic attitude is demonstrated by the fact that local actors are mainly interested in the water prices and not very concerned about the environmental impact of the overexploitation of local resources.

This finding relate also to table 1 indicating that civil society is not involved in any fields of the Greek water sector. This exclusion consequently leads to an inactive attitude and enhances unawareness of the current setting and potential problems.

Interaction failure

- Impetuous & fragmented interaction among actors - Dependence on dominant partners - Passiveness & individualistic perspective	⇨	Weak relations among actors

The main identified interaction failure is the weak relations among actors. Interaction among different actors that hold different positions in the system is limited. Thus, most of the actors should be addressed to escape from this failure (e.g. local people, local/regional authorities, EYDAP, private water sellers etc).

This failure is the result of the impetuous and fragmented interaction among actors and the dependence on dominant partners, which make actors wait for external help instead of focusing in developing a strong internal coalition in order to collectively pursue their goals. Furthermore, inhabitants are excluded from the decision making process and cannot exchange opinions. Lack of negotiation and dialogue a typical example as it was identified in the hierarchical water governance in Greece section. Passiveness and individualistic perspective also make actors focus more on themselves and their proximate social surroundings than on society and other living in the island.

Capabilities failure

- Learning by obligation - Limited & discontinued educational activities - Water resources mismanagement - Individualistic perspective	⇨	Inflexibility towards participatory learning and change

The main capabilities failure is the inflexibility towards participatory learning and change. In order to overcome this failure all kinds of actors should be addresses, as this is a local and a generic problem. Participatory processes are not well established in the Greek setting and local people, local/state authorities, NGO's and knowledge and advisory bodies should be addressed for resolving this problem.

This failure derives from the learning by obligation, limited and discontinued educational activities, and water resources mismanagement. The Greek learning style has remained in old paradigms and people are used in compulsory learning and learning by threat. This mode of learning stands in contrast to the interactive learning process used by the extension team in the CM project in Melissa village. In that case evaluation made clear among participants the misunderstandings and deficiencies assisting in the identification of both innovative and relevant initiatives with actors 'owning' the agenda. Such approaches are not very common but their application is crucial for the emergence of innovation.

Educational activities in decentralised areas are mainly launched by the central state and other

initiatives are limited. Moreover, the actors performing the water resources management have not incorporated any educational programmes in coordination with other initiatives. This rigid knowledge climate is one of the factors generating the inflexibility of local actors. The identified inflexibility relates also to the fact that the Greek society is suspicious to technological change a point presented in the SWOT analysis. Finally, the individualistic perspective of actors restricts them from participating in collective actions and depending on others for changing the situation.

7.3.2 Lock-in effect

In the previous part the linkages of the identified failures of the local water supply and conservation system were analysed. This node of failures leads also to the creation of another overarching problem, the lock-in phenomenon which was presented in the theoretical framework.

Lock-in in the case of Aegina is caused form various areas in the system. For many decades the water supply and conservation system in Aegina has remained static, despite the sporadic efforts to create changes and find ideal solutions. The main causes are presented below, demonstrating the reasons that block innovation and water conservation initiatives.

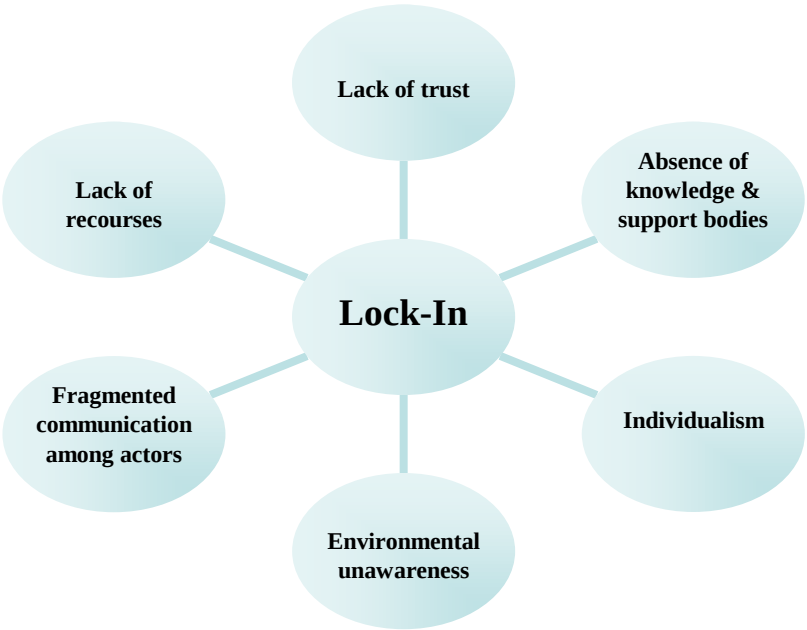


Figure 5: Causes of the Lock-in phenomenon

Lack of trust is the aftermath of the constant mismanagement of water resources through the years and the inability to improve the obsolete and malfunctioning water supply network. The lack of well structured water authorities, supervising water supply and irrigation activities with the support of an efficient regulation framework is a typical characteristic of the water governance in Greece as presented in the introductory chapter. Therefore, it can be said that although Aegina is still quite traditional and isolated, it is influenced by the external environment-landscape but the landscape is not directly influenced by local actors.

Lack of resources is the outcome of the dependence on dominant partners and the passiveness that characterises actors, not allowing them to search for alternative options and think out of the box. This characteristic is also the result of some of the weaknesses identified in the Greek Innovation landscape. For example, the low R&D investments from the private and public sector, and the bureaucratic and time-consuming management system.

Moreover, the absence of knowledge and support bodies in Aegina and also the lack of collaboration with those located in nearby areas assists in the stability of the problematic situation and do not allow the inflow of information and creation of new ideas that could help in innovation processes. The lack of innovation component in policy making in education, training, the weak intermediate technology transfer mechanisms and the qualitative and quantitative deficiency of liaison offices, which where some of the weaknesses of the Greek Innovation System, support the creation of this phenomenon in the local setting.

The lack of collective thinking is a characteristic of Aegina's isolated community that also relate to the lack of a broadly shared consistent vision for the future at the country level identified in section 4.3 in the SWOT analysis. Local people are not involved in communal procedures and cannot express and exchange opinions; as a consequence they try to protect their own interests with all means, even with regulation disobedience. The identified individualism in Aegina comes in contrast with older studies made in the Greek setting indicating that the culture of Greece tend to be collectivist (Triandis, Bontempo & Villareal, 1988).

Environmental unawareness is also a common phenomenon in Greece. People are more financially driven and have a short term way of thinking. This can be related to the used modes of learning as for example learning by obligation. Furthermore, environmental communication initiatives are erratic and usually without participants' active involvement, having only an information transfer role. Finally, communication among actors in Aegina is occasional and indirect. Most people get informed by newspapers and do not express their opinion openly. This process creates weak relations among actors and does not help in creating a shared agenda. In the second research case presented in section 4.3 similar problems were identified in the regional level. Specifically, lack of communication, stimulation and coordination between the regional actors and also that the low levels of systematic collaboration rendered interaction. This illustrates that despite the fact that Aegina is not in Macedonia or Thessaly, they have similar malfunctionalities connecting with the generic Greek environment.

To conclude, the lock-in phenomenon relies on a complex set of connected socio-technical issues. The relationship between niche-regime-landscape affects the potential of local innovation and change and can reinforce the creation of the lock-in phenomenon.

7.4 Entry points for a process of social learning

The water supply issue and its resolution via an undersea pipeline has been promoted for many decades, thus it has become a fixed standpoint for local people not leaving much room

for alternative considerations. In order to alter this rigid environment, social learning processes can be used but these cannot be imposed and spaces for it to take place within the local system have to be shaped.

One question that arises is who could step up and take charge of such a process. Selecting the most suitable leader that could manage the situation and inspire people is of vital importance. It could be an internal actor that is recognisable and respected in the local setting or an external actor that has the expertise and capacity to direct such processes. During the research activities a local actor that could engage in this role was not identified. Municipal authorities could play this role if there is a change in their philosophy, as currently they show no interest in learning and co-development initiatives. An external actor might be more suitable as he will be separated from local interests and groups and will be able to perform this task neutrally. An actor that was mentioned by many interviewees was EYDAP as it is the company that manages the water supply in the capital city. EYDAP is considered an expert in the issue, already organising learning activities in other areas. Finally, a University could also play this role as it has the knowledge and scientific staff to execute such a project but linkages with such an actor should firstly be created.

Another question is how local actors could be motivated to enter this process. The leader of this effort should understand actors' mutual interdependence and the system's complexity. He should make sure that actors will find an 'entrance' to the process, finding common interests and links will liven up the process but also create a new basis for collaboration. For some actors this entrance could be e.g. 'sustainability' and for another 'water sufficiency'.

An additional question is how a trusting environment among actors could be created as it was identified that actors are characterised by individualistic perspective and lack of trust. The creation of a mechanism where actors will freely express their opinions, concerns and experiences could be a starting point for increasing actors' interaction, for finding common ground and understanding their interdependence. Actively integrating actors with different perspectives and knowledge and allowing them to be part of the process will be an important element and will assist in the creation of shared problem identification. Finally, actors will learn to work together and function as a group and overcome their detachment but a long-term effort is needed in order to achieve this.

Recommendations for initiating social learning

A communicative strategy could assist in bringing actors together and create an appropriate environment for social learning. Such a strategy could include the following points:

- Use visual means for demonstrating how the local system is organised and for demonstrating actors' interdependencies;
- Incorporate intermediary persons who can build bridges between the diverse kinds of actors in order to increase the connectivity among different groups;
- Use tools for increasing actors' exchange of perspectives, e.g. role playing, visits, filmed interviews etc.

- Collectively explore the problems' history, current situation and alternative futures (e.g. with scenario analysis);
- Contact others who have come across and managed similar cases and learn from their experiences;
- Organise practical events and initiatives for generating collective learning, and not stay only in the theoretical and discussion part;
- Address local actors as 'experts' according to their role, this will help the participants to respect the competence and knowledge of the other (non-scientific) actors and, at the same time, to experience respect for their own knowledge.
- The organiser of the process will have to address groups of actors and not individuals to make changes in the innovation system possible.

7.5 Limitations of the research

- The interviewees might not represent fully the local population and some opinions might have not been heard (e.g. inhabitants living in different municipal departments).
- Official documentation and data assisting in the crosschecking of what was derived from the semi-structured interviews was not available. The main sources that were used for this purpose were a local newspaper and magazine.
- While the researcher made an effort to remain objective in her role as a researcher (e.g. avoid interviewing people in her inner social circle, not commenting on the interviewees responses), she might have been influenced in some degree as the location where the research took place is the place of her origin and she has experienced the water problem for many years. On the other hand, the fact that she has this background made it easier for her to approach the diverse actors and allowed them to openly express their opinions, as they are not accustomed in participating in such procedures.
- The system failure framework could further be tested in practice by using it as a tool for analysis as there are only a few research cases available in the existing literature.
- The application of theoretical frameworks such as the system innovation and social learning in the Greek setting can be proven to be quite difficult as such processes demand time and resources not available in many occasions.

7.6 Conclusions and suggestions for further research

7.6.1 Main conclusions

Promoting innovation in Aegina is quite difficult as changes must be made simultaneously in many areas. Consideration of the socio-cultural parameters of innovation is of equal importance as the technological ones, as most of the identified impediments are of qualitative nature. The long promoted solution of an undersea pipeline will not address all the diverse

system failures and will just guarantee a continuous water supply bypassing the multifaceted nature of the problem.

As it was identified also in the ICM project good intentions or the mechanistic attempt to transfer successful practices do not suffice. In Aegina, the municipality's attempt to promote conservation via fliers was quite deficient; the main measure that assisted in reducing water consumption was the increased pricing system. This comes as no surprise as the majority of the interviewees indicated that the motive for engaging in conservation should be financial. This monetary philosophy of both sides illustrates the short-term orientation and environmental unawareness of the local community. Negatively, though financial motives may seem effective initially, do not facilitate people in comprehending the true value of water conservation and do not guarantee it will become a way of living.

A shift in the modes of learning needs to be achieved and conservation should not be seen as just a 'problem-solving' situation but as 'problem-finding' one. Water management authorities at all levels of governance should reconceptualise their top-down and procedural approach and strive to find a jointly acceptable solution that will increase actors' connectivity and interaction and create a shared agenda. One potential solution that could be used as the starting point in the conservation dialogue process is the use of water tanks. The majority of the interviewees were in favour of such an option for collecting rain water. This was a traditional water conservation method of the island and as it used to be part of the local culture it could be more easily reapplied as a decentralised and low-cost technology. Furthermore, it will enable people at household and community level to manage their own water and shift towards more community-based approaches and technologies which emphasise participation, ownership and sustainability (Nijhof et al, 2010).

7.6.2 Policy implications and suggestions for further research

Research on innovation systems and social learning in the Greek setting is limited, despite the fact that Greece is generally lacking in most aspects of innovation. This research made the first step in identifying impediments in a local setting that block innovation generation. Further research on similar local cases will assist in gaining a broader perspective on factors blocking change and innovation creation and in crosschecking their similarities and differences. An area that demands special attention is the Greek innovation policy and how it affects local communities' ability to move forward, as the generic environment is of equal importance. Some water policy implications are:

- Water supply and conservation policies should place more emphasis on social processes, enhancing actors' connectivity, mutual understanding, and knowledge development.
- Water supply and conservation initiatives should focus on finding current or potential spaces where learning processes between local actors occur and finding ways of enriching them.
- The leader of the process (e.g. municipality, prefecture) should not see himself as a manager, top in the hierarchy, but as a facilitator in a dynamic process of knowledge emergence. In this perception all actors are part of the learning process with equal

participation.

- Water supply and conservation authorities' service should be separated from the election system in order to guarantee the continuance and application of launched initiatives.
- Water supply and conservation authorities should not be managed exclusively by politicians but from actors with the necessary theoretical and practical knowledge and qualifications.
- The local-regional water supply regulation should be transparent and publicly available to avoid misconceptions and mistrust.

References

Araus, J.L. (2004) 'The problems of sustainable water use in the Mediterranean and research requirements for agriculture', Ann. appl. Biol., vol. 144, pp. 259-272.

Avlonitis, S.A., Poulios, I., Vlachakis, N., Tsitmidelis, S., Kouroumbas, K., Avlonitis, D., Pavlou, M. (2002) 'Water resources management for the prefecture of Dodekanisa of Greece', Desalination, vol. 152, pp. 41–50.

Ballantyne, P. (2009) 'Accessing, sharing and communicating agricultural information for development: Emerging trends and issues', Information Development, vol. 25, no.260.

Bouwen, R., and Taillieu, T. (2004) 'Multi-party collaboration as social learning for interdependence: Developing relational knowing for sustainable natural resource management', Journal of Community & Applied Social Psychology, vol. 14, pp.137–153.

Bouwer, H. (2003) 'Environment Integrated water management for the 21st century: Problems and Solutions', Food, Agriculture & Environment, vol.1, no. 1, pp. 118-127.

Caniëls, M., and Romijn, H. (2008) 'Actor networks in Strategic Niche Management: Insights from Social Network Theory', Futures, vol. 40, no. 7, pp. 613-629.

Damorakis A. (2004), 'Quality of water and its checking, The Aiginaia, Issue 9, tribute Aegina and Water supply, January-June, p. 43.

Dimadama, Z., and Zikos, D. (2010) 'Social Networks as Trojan Horses to Challenge the Dominance of Existing Hierarchies: Knowledge and Learning in theWater Governance of Volos, Greece', Water Resour Manage, vol. 24, pp. 3853-3870.

Edquist, Ch. (2001) 'The Systems of Innovation Approach and Innovation Policy: An account of the state of the art', DRUID Conference, Aalborg, June 12-15, 2001, under theme F: 'National Systems of Innovation, Institutions and Public Policies'.

EYDAP (2011), viewed 1 March 2011, <http://www.eydap.gr/include/popup_company.asp>.

Foxon, T. and Pearson, P. (2008) 'Overcoming barriers to innovation and diffusion of cleaner technologies: some features of a sustainable innovation policy regime', Journal of Cleaner Production, vol. 16S1, pp. 148-61.

Geels, F. (2005a) 'Co-evolution of technology and society: The transition in water supply and personal hygiene in the Netherlands (1850–1930)-a case study in multi-level perspective', Technology in Society, vol. 27, pp. 363–397.

Geels, F.W., (2005b) ‘Processes and patterns in transitions and system innovations: Refining the co-evolutionary multi-level perspective’, Technological Forecasting & Social Change, vol. 72, pp. 681–696.

Getimis, P., Bithas, K., and Zikos, D. (2001) ‘Achieving sustainable and innovative policies through participatory governance in a multi-level context Final Report on water supply in Greece-Athens’, Panteion University of Athens, Institute for Urban Environment and Human Resources, Research project funded by the European Community under the 5th framework programme.

Hekkert, M.P., Suurs, R.A.A., Negro, S.O., Kuhlmann, S., and Smits, R.E.H.M. (2007) ‘Functions of innovation systems: A new approach for analysing technological change’, Technological Forecasting & Social Change, vol. 74, pp. 413-432.

Kallis, G. (2006) ‘Participatory methods for water resources planning, Environment and Planning’, Government and Policy, vol. 24, pp. 215-234.

Kapsalis, A. (2006) Research Project: ‘Research on Sustainable Development in Aegina’, Sustainable Development Network Islands Daphne, scientific support: National Technical University, Interdisciplinary Institute for Environmental Research.

Klein Woolthuis, R., Lankhuizen, M., and Gilsing, V. (2005) ‘A system failure framework for innovation policy design’, Technovation, vol. 25, pp. 609-619.

Klerkx, L., Hall, A., and Leeuwis, C. (2009) ‘Strengthening Agricultural Innovation Capacity: Are innovation brokers the answer?’, UNU-MERIT Working Papers, ISSN 1871-9872.

Klerkx, L., and Leeuwis, C (2009) ‘Establishment and embedding of innovation brokers at different innovation system levels: Insights from the Dutch agricultural sector’, Technological Forecasting & Social Change, vol. 76, pp. 849-860.

Komninos N., and Tsamis A. (2008), “The system of innovation in Greece: Structural asymmetries and policy failure”, International Journal of Innovation and Regional Development, vol. 1, no 1.

Koutsouris, A. (2008) 'Innovating Towards Sustainable Agriculture: A Greek Case Study', The Journal of Agricultural Education and Extension, vol. 14, no. 3, pp. 203-215.

Kyrgiafini, L. and Sefertzi, E. (2003) 'Changing regional systems of innovation in Greece: the impact of regional innovation strategy initiatives in peripheral areas of Europe', European Planning Studies, vol. 11, no. 8, pp. 885 -910

Latinopoulos, P. (2005) ‘Valuation and pricing of irrigation water: An analysis in Greek agricultural areas’, Global NEST Journal, vol. 7, no. 3, pp 323-335.

Lazarova, V., Levine, B., Sack, J., Cirelli, G., Jeffrey, P., Muntau, H., Salgot, M., and Brissaud, F. (2001) 'Role of water reuse for enhancing integrated water management in Europe and Mediterranean countries', Water Science and Technology, vol. 43, no.10, pp. 25-33.

Leeuwis, C. (2004) 'Innovation as a process of network building, social learning and negotiation-Implications for transdisciplinary research collaboration', Trans-KARST 2004-International Transdisciplinary Conference on Development and Conservation of Karst Regions, Hanoi.

Leeuwis, C. and Aarts, N. (2010) 'Rethinking communication in innovation processes: creating space for change in complex systems', Proceedings of the 9th European IFSA Symposium, 4-7 July, Vienna, Austria.

Lioukas, S. (2009) 'Innovation in Greece, Benchmarking with international indices, political, strategic recommendations', Kokkalis Foundation, Athens University of Economics.

Longhurst, R., (2003) 'Semi-structured interviews and focus groups' in: Clifford, N., J., and Valentine, J. 'Key methods in Geography', Sage publications ltd.

Manoli, E., Katsiardi, P., Arampatzis, G., Assimacopoulos, D. (2005) 'COMPREHENSIVE WATER MANAGEMENT SCENARIOS FOR STRATEGIC PLANNING', Global NEST Journal, vol. 7, no 3, pp. 369-37.

Mariolakos, I. (2007) 'Water resources management in the framework of sustainable development', Desalination, vol. 213, pp. 147–151.

Markard, J. and Truffer, B. (2008) 'Technological innovation systems and the multi-level perspective: Towards an integrated framework', Research Policy, vol. 37, pp. 596-615.

Marshall, M., N. (1996) 'Sampling for qualitative research', Family Practice, vol. 13, no. 6, pp. 522-525.

MED Programme 2007-2013/WATERinCORE, "Sustainable Water Management through Common Responsibility enhancement in Mediterranean River Basins", Water Management Analysis in "water district 10" of Region of Central Macedonia, Greece, 2009.

Melissaris P. (2004), 'A concise preposition for dealing with the water problem', The Aiginaia, Issue 9, January-June, tribute Aegina and Water supply, p. 70.

Mierlo, B., Van, Leeuwis, C., Smits, R., and Klein Woolthuis, R. (2010) 'Learning towards system innovation: Evaluating a systemic instrument', Technological Forecasting & Social Change, vol. 77, pp. 318–334.

Mimikou, M.A. (2005) 'Water resources in Greece: Present and future', Global NEST Journal, vol. 7, no. 3, pp 313-322.

Ministry of Development General Secretariat for Research and Technology, S&T Policy Planning Directorate, Programming Department (2007) 'THE GREEK INNOVATION SYSTEM Review of Greece's Innovation Policy by the OECD', Background Report, Hellenic Republic.

Moutsatsos, M. (2004), 'will the problem of water supply resolution mature?', The Aiginaia, Issue 9, tribute Aegina and Water supply, January-June, p. 59-60.

Moutsatsos, M. (2003), 'Water resources: the eco-crime', The Aiginaia, Issue 8, tribute Pistachio tree and Aegina, July-December, p. 79.

Municipality of Aegina, HUMAN ACTIVITIES ENVIRONMENTAL PROTECTION, viewed 2 March 2011, <http://www.dimosaiginas.com/show_images.php?imgID=8>.

Nea Epoxi (2011) 'Water supply taxes: Increases for the small and medium decreases for the big & prodigal ', Issue 103, March 19, p. 4, available at http://www.neaepohi.gr/images/newspapers/pdf/103.pdf.

Nea Epoxi (2011) 'One more step for the terrestrial projects With a turtle pace…. to the desired integration', Issue 102, March 3, p. 8, available at http://www.neaepohi.gr/images/newspapers/pdf/102.pdf.

Nea Epoxi (2010) 'Integrated water supply in the ESPA 6,435,000 Euros! The largest project of the last 20 years implemented within 2 years The Koukoulis leaves legacy to the citizens of Aegina', issue 98, November 19, p. 4, available at http://www.neaepohi.gr/images/newspapers/pdf/98.pdf.

Nea Epoxi (2008) 'N. Pteroudis: - tangible results before the end of the four years for the pipeline - Solution for the debris before the end of 2008', issue 39, July 11, p. 10-11, available at http://www.neaepohi.gr/images/newspapers/pdf/39.pdf

Nea Epoxi (2007) 'Mayor's Press Conference Arrangements for the beach and ... Water Alarm', issue 6, March 30, p. 4, available at http://www.neaepohi.gr/images/newspapers/pdf/98.pdf.

Nea Epoxi (2007) 'Water: New Revelations Over 50% of wells fell in the network in 2006 For shame propaganda speaks Mr. Mourtzis', issue 19, September 28, p. 10-11, available at http://www.neaepohi.gr/images/newspapers/pdf/19.pdf

Nijhof, S., Jantowski, B., Meerman, R., & Schoemaker, A. (2010) 'Rainwater harvesting in challenging environments: Towards institutional frameworks for sustainable domestic water supply', Waterlines, vol. 29, no. 3.

Pahl-Wostl, C. (2002) ‘Towards sustainability in the water sector – The importance of human actors and processes of social learning’, Aquat. Sci., vol. 64, pp. 394–411.

Pahl-Wostl, C., and Hare, M. (2004) ‘Processes of Social Learning in Integrated Resources Management, ’Journal of Community & Applied Social Psychology, vol. 14, pp. 193-206.

Papadopoulou, E., Papalexiou, Ch., Hasanagas, N., and Ventouri, E. (2010) ‘Rural Development Policy Delivery and Governance in Greece’, 118th seminar of the EAAE (European Association of Agricultural Economists), ‘Rural development: governance, policy design and delivery’, Ljubljana, Slovenia.

Poncet, J., Kuper, M., and Chiche, J. (2010) ‘Wandering off the paths of planned innovation: The role of formal and informal intermediaries in a large-scale irrigation scheme in Morocco’, Agricultural Systems, vol. 103, no 4, pp. 171-179.

Poulopoulos, J. (2004) ‘The declining course of the natural environment and water resources of Aegina through time’, The Aiginaia, Issue 9, tribute Aegina and Water supply, January-June, p. 29-35.

Qadir, M., Sharma, B.R., Bruggeman, A., Choukr-Allah, R., Karajeh, F. (2007) ‘Non-conventional water resources and opportunities for water augmentation to achieve food security in water scarce countries’, agricultural water management, vol. 8 7, pp. 2-22.

Rizzo, A. (2002) ‘Strategic Management of Water Leakage in the Maltese Islands’, Engineering Today, No. 17.

Rockström, J. (2000) ‘Water resources management in smallholder farms in Eastern and Southern Africa: An overview’, Phys. Chem. Earth (B), vol. 25, no. 3, pp. 275-283.

Sarantakos, D. (2003), ‘The water supply of Aegina. An attempt of an spherical approach to problem’, The Aiginaia, Issue 7, tribute Aegina and Environment, January-June, p. 48, 53, 56.

Sompolos, T. (2008) 'Analysis of the urban network of Aegina Problems and Prospects', Thesis, National Technical University, School of Surveying Engineering, Department of Geography and Regional Planning.

Spielman, D., J. (2005) ‘Innovation Systems Perspectives on Developing-Country Agriculture: A Critical Review’, ISNAR Discussion Paper 2.

Sunding, D., and Zilberman, D. (1999) ‘The Agricultural Innovation Process: Research and Technology Adoption in a Changing Agricultural Sector (For the Handbook of Agricultural Economics, Department of Agricultural and Resource Economics, Berkeley.

Tsagarakis, K.P., Dialynas, G.E., and Angelakis, A.N. (2004) ‘Water resources management in Crete (Greece) including water recycling and reuse and proposed quality criteria’, Agricultural Water Management, vol. 66, pp. 35–47.

Eleutherotipia, (2004), ‘WATER water Aegina yells, EYDAP does not listen’, 8 November, available at <http://archive.enet.gr/online/online_text/c=112,dt=08.11.2004,id=47274172>.

Verbij, E. (2008) ‘Inter-sectoral coordination in forest policy: a frame analysis of forest sectorisation processes in Austria and the Netherlands’, Wageningen University, Wageningen.

Vrixea, A. (2004), ‘The activation of citizens "for the habitation of Aegina", The Aiginaia, Issue 9, tribute Aegina and Water supply, January-June, p. 111.

Waters-Bayer, A., and Bayer, W. (2009) ‘Enhancing local innovation to improve water productivity in crop–livestock systems’, The Rangeland Journal, vol. 31, pp. 231–235.

Wilmot, A. (2005) ‘‘Designing sampling strategies for qualitative social research: with particular reference to the Office for National Statistics’ Qualitative Respondent Register’, Survey Methodology Bulletin -Office for National Statistics, No. 56, pp. 53-65.

Zikos, D., and Bithas, K. (2006) ‘The Case of a “Weak Water” Governance Model: Athens – Greece’, Proceedings of the IASME/WSEAS Int. Conf. on Water Resources, Hydraulics & Hydrology, Chalkida, Greece, pp.161-166.

Annex

Timetable of Actor's Interviews

Agriculturalist, 16/02/2011.

Citizen1, 02/02/2011.

Citizen2, 01/03/2011.

Citizen3, 28/02/2011.

Citizen4, 01/02/2011.

Citizen5, 28/02/2011.

Coligos-professional farmer, 23/02/2011.

Representative of local authorities, 12/02/2011.

Representative of the municipal opposition, 13/02/2011.

Representative of agricultural association of Aegina, 14/02/2011.

Representative of the agricultural pistachio producer cooperatives of Aegina, 17/02/2011.

Representative of the hotel association of Aegina, 28/02/2011.

Representative of environmental association Energoi Polites Aiginas, 19/02/2011.

Representative of environmental association Ferias, 12/02/2011.

Representative of newspaper Kalimera Aegina, 28/02/2011.

Representative of newspaper Nea Epoxi, 24/02/11.

Well owner-Private water seller, 24/02/2011.