WATER MANAGEMENT IN SIGRI: CHALLENGES AND OPPORTUNITIES

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Introduction

Sigri is a village in the south-western part of the island of Lesvos, in the North Aegean Sea (fig.1). The village is less touristy when compared with other areas like Eressos or Molyvos. However like other areas, it certainly has some water management concerns. Generally water is plentiful accordingly to locals and can be characterised by the “quantity of water that is available or can be used in a sufficient way, the appropriate quality and the duration for the satisfaction” of present and future demands (Sofios et al. 2008).

In the face of increasing demand for water, Sigri seasonally suffers from water shortages. The common water resource management and water use efficiency issues in Sigri includes an increasing demand for water (potable and irrigation), inadequate and inefficient capture, storage and distribution of water resources, reduction in water quality and future climatic threats to water supplies. This is also of concern given the seasonal flux of tourists during the drier months.

The management of water in Sigri both within the context of domestic and sustainable tourism has to be managed at the household level. This is due to a number of tourist based activities in Sigri being operated out of private homes and managed at the domestic scale. If any incremental efficiency in water management is to take place, efforts should be made at the household level. It is within this framework that this paper aims to analyse the current situation of water supply in Sigri and propose measures and actions for the management of water resources. The report is divided into four sections. Section 1 provides a brief account of methodology and tools used to analyse water resources and management. The general baseline situation is then presented in section 2 of the report. Section 3 builds up on this, and details the major threats and root causes for water resource supply and management. It also looks at water security issues resulting from the increased threats. The last section of the report proposes a management strategy that combines water use efficiency (WUE), local capacity building and economic and policy instruments. The paper concludes by suggesting enhanced community awareness and investment for sustainable management of water.
1. Methodological framework

In assessing the existing water supply and management in Sigri, this paper takes an analytic approach. This approach involved explaining the context of water resources management and uses within the social, environmental and economic considerations of the community in the analysis. As such local community and stakeholder views formed a vital part of the report to understand different perceptions of water use. A semi-structured questionnaire (Annex 1) was designed and executed over five days. In total 7 people were consulted between 18th and 22nd June, 2009. To understand tourist behaviour of water use, general tourists and students from MESpOM were interviewed. Additionally, information from printed and online sources was consulted to provide background on the status of water use, demand and degradation, as well as the policy framework for water management in the entire island. A large proportion of material consulted was from published sources, with online technical reports providing more current news from the field.

2. Background & situation analysis

2.1. Water supply and use

Sigri, with a population of 300 people, has in place a water supply system built more than 200 years ago during the Turkish period (Lawrance 2001). Water is supplied by three springs known locally as 'Mana' (main source) and by one public well 10 meters deep, which is used as an additional source of water during the dry season (Athanasiadis pers.comm.). The 'Mana' is located in the rocky hills, 3-4 km from Sigri, in an old settlement called Palaeohorio where the inhabitants of Sigri originally resided. In 1770, Mustapha Sultan constructed ceramic pipes from the 'Mana' to Sigri resulting in people relocating here (Lawrance 2001; Chiotis pers.comm.). Currently, it is cemented and protected by two fences to avoid pollution of the underground water (fig 2,3).

Water from the 'Mana' and from the public well is delivered to two tanks for domestic purposes: first, to the old tank (180 m³) and then to the new tank (200 m³) (fig.4), which was built 15-20 years ago to create the required pressure for water supply (Athanasiadis pers.comm.; Chiotis 2000; Lawrance 2001). From these tanks, water is distributed to households and several public fountains in Sigri (Lawrance 2001) (fig.5).

The main load of water supply is covered by springs of the ‘Mana’. However, during the summer season, demand of water is increasing significantly. When the level of water in the tank is less than half, water is pumped from the public well to cover the demand (Athanasiadis pers.comm.).

Water consumption by households in Sigri varies from 180 m³/day in winter, to 400 m³/day in summer when the population of Sigri, including the tourists, increases up to 5 times (Athanasiadis pers.comm.). Besides direct domestic use, people utilise water for maintaining the streets and gardens.

Agriculture is the major water consumer in Sigri as well as in the entire island (74% of total in Lesvos) (Allen et al. 2009). There is a special tank for irrigation
purposes supplied by water from another well. A majority of the farmers are connected to the tank, while the rest pump underground water from private wells (Loannides pers.comm.).

Public awareness on water issues is quite low and people believe that water supply is generally not a problem (Chiotis pers.comm.). Some of those interviewed mentioned that a majority of residents try to reduce their consumption (Chatriandreou pers.comm.). The municipality undertakes a number of activities to ensure water saving, for instance, the president of Sigri actively communicate the need for water saving to the residents through public letters (Athanasiadis pers.comm.).

2.2. Water quality

The quality of water is considered to be good and is regularly checked by the municipality at a laboratory (Chiotis pers.comm.; Athanasiadis pers.comm.). Majority of interviewed residents stated that they are ‘very satisfied’ with the water quality and have never had water related health problems. However, the local doctor and some other people prefer drinking bottled water since the tap water does not undergo any disinfection and the pipes in Sigri are relatively old (Panagiotis pers.comm.). Local people also mentioned that they prefer to drink water supplied from the water spring, as the water from the new tank is considered generally too hard to drink (Chatriandreou pers.comm.).

2.3. Pricing system

Sigri, like the rest of Lesvos, has water prices set by the local municipality. Currently it includes operational and economic costs to some extent and excludes costs for natural resources and environmental degradation (Safarikas et al. 2006). The pricing system is generally aimed to sustain a socially acceptable price level that now presents a situation of underpriced water, consequent unsustainable behaviour and significant waste of water. It lacks any incentive to introduce water saving methods (Zikos and Bithas 2006). Pricing is based on volumetric rates which increase with the level of consumption.

In Sigri, households, hotels and farmers all pay the same rate for water. Households connected to the water supply network pay 20 euro for 6 months (if consumption does not exceed 50 m³). Farmers who have private wells do not have to pay at all. According to the current Lesvos policy, wells should be built and operated in accordance with a special permit given by the Prefecture. However, it is estimated that around half of all Lesvos drilling boreholes are illegal. In Sigri, many boreholes and wells were built much before the current policy was implemented (Loannides pers.comm.).

2.4. Policy context for water management

Concerning the current policy situation, despite the clarity and well-established legal framework in accordance with Water Framework Directive (WFD), its implementation and regulation are still being developed in Lesvos and Greece in general. Systems for abstraction, licensing and discharge control, as well as general procurement rules and water quality criteria adopted by the EU, are available and ready to be used (Tsagarakis et al. 2003). However, there is a lack of a single and overarching system for price and service regulation (Tsagarakis et al. 2003). The water management plan with programme of measures for Aegean islands (Lesvos belongs to this Water Region) has not been developed yet (in accordance with
the draft should be presented in 2008, and finalized up to 2009). A new pricing system under the EU WFD should be introduced by 2010 which results in higher prices of water for the locals.

### 3. Main threats and challenges

#### 3.1. Water supply and use

As mentioned in the introduction, water is one of the main concerns for Sigri. Till now people have not experienced water scarcity as there has been a permanent supply to households from the springs and well located close to the settlement. Generally the impression amongst the villagers is that water is plentiful and water shortage is a seasonal problem, and not imminent any time in future. At the same time, being a groundwater source, it can be depleted quite easily and is subject to negative impacts by different factors as described below.

**Seasonal variations.** On the island, groundwater is replenished only by precipitation which does not coincide with the demand peak. In Sigri, rains occur from October till April, and the dry season is from June till September. June and September are also the months with the highest demand for water. This demand is both due to the use of water by farmers for agricultural purposes and by increasing number of tourists that come to Sigri (Athanasiadis pers.comm.). Variations in demand and supply lead to excessive water in the storage tank during the winter season, which cannot be stored and is lost due to the limited capacity of the tank (Athanasiadis pers.comm.; Chiotis pers.comm.). Intensive pumping of water from the well during the summer season is an additional burden (Athanasiadis pers.comm.). The latter could cause intrusion of seawater into the well, which has already been observed in Sigri (Chatriandreou pers.comm.). In the future, by taking into account the increase in water demand and in need of water abstraction, this problem might pose a real danger for Sigri.

**Climate change.** Ground water is very sensitive to climate change (Winter et al. 1998) as it depends on precipitation. According to the latest IPCC report on Climate Change and Water (IPCC 2008) and precipitation scenario for the Mediterranean region, significant decrease in precipitation (up to 35-40%) is expected in Greece by the middle of 21st century and could cause severe water scarcity. Anecdotal evidence from the village elders suggest that rain is infrequent and has decreased in the last twenty years.

**Increased demand.** Not only are seasonal variations in water use has been noted, but long-term demand changes as well. Some of the interviewees mentioned that people today use much more water in comparison with previous decades. This can be explained by the increasing use of household and agricultural (modern) technology (Chiotis pers.comm.). Combined with the seasonal fluctuations, increasing demand is also contributing to the water scarcity in the region.

**Inefficient use.** Inefficient water use is one of the main reasons for water shortages in Greece (Tsagarakis et al. 2003). The same can be said about Sigri. The current pricing system does not provide any incentives for residents to save water. Most of them perceive the water source as a never-ending, common pool resource. Such perception leads to irrational use of water, e.g. use of drinking water for streets and garden sprinkling, etc.

At the public level, water leakages are commonly observed in and around the village (fig.6). For instance, there are persistent leakages from pipes and watering of grass is usually done at mid day instead of in the morning or late evening when soil moisture retention is better.

At the private level, toilet leakages (1.5 litres every 30 minutes based on an experiment that the group conducted), constant dripping of tap water, washing of paths and driveways using a hosepipe and the lack of water saving home appliances such as low-flow shower heads, half-flush designed toilet, non-switch taps and water saving washing machine are some problem areas that were identified.

Other general issues with water use efficiency at the private level depend on the habits of the householders in the kitchen, bathroom, garden varying based on day to day consumption.

During the summer season, tourists contribute to irrational use of water. Similar to local people they do not have any incentives to use it wisely, especially for the short duration of their stay in Sigri. The locals pay a fixed amount for their accommodation and can use as much water as they want.
Use for water for agricultural purposes is another source of irrational use. Water for irrigation is pumped from a separate well (see section 2) and is used without any control, as there are no water meters installed on the farms. It was also noticed during the study that water-consuming crops, like clover, were being cultivated by farmers, which contributes to the water depletion. Field observations indicate that water is wasted via practices such as watering plants and irrigation during the hottest time of the day resulting in huge losses by evaporation (fig 7).

3.2 Water quality

Water quality and possible threats to human health is another important issue to be considered. As mentioned in the section 2.2, the majority of the respondents mentioned that the water in Sigri is safe and can be used for drinking purposes. Quality of the groundwater is ensured by Municipality which undertakes several measures for it, including concrete isolation of spring and well and water sampling four times per year (Athanasiadis pers.comm.). At the same time there is no disinfection of water, which poses a risk of water contamination in the distribution system (Panagiotis pers.comm.) and spread of water-born diseases. It should be mentioned that municipality already started the program to replace old pipes by the new plastic ones that correspond to the EU legislation requirements (Athanasiadis pers.comm.). However this alone will not ensure 100% safety of water for drinking purposes.

Another threat to water quality is that posing from the landfill located near Sigri, as well as illegal dumping sites. As no required protection (lining) is ensured for the landfill, there is a risk for leachate intrusion and contamination of groundwater, which in turn is a risk for the village water supply and public health. Currently the impact of the landfill on water contamination has not been analysed.

4. Proposed Management Strategy

4.1. Water use efficiency

Water use efficiency contributes significantly to water conservation. Based on observations in Sigri, issues related to water use inefficiency can be divided into the public and private levels. Achieving this in Sigri means that measures such as water re-use and recycling, changing local/tourist behaviors and upgrading water infrastructure functions efficiently are applied (GWP 2005).

As identified later, the establishment of the EU Water Framework Directive with higher prices for water in all of Europe can act as a price signal for water saving, increase environmental awareness and reduce sewage discharge to lakes and seas (DEPA 2002).

But before its introduction in Sigri, water conservation programs and new technologies can be implemented so that the locals are not impacted heavily by the increase in water prices.

Some recommendations for water efficiency are outlined below:

Recommendation 1. Designing and implementing Water Conservation Programmes as described below:

1. Systematically identifying current and future problems like climate change and growing uncertainty of rainfall, unsure groundwater...
supply, differences in water consumption during the tourist season, sewage discharge, sea water pollution, marine system contamination, impacts on food chain and human health

2. Educating and demonstrating water saving via a practical guide to assist households in reducing water consumption. For instance, programs on how to identify and fix leakages, do’s and don’ts like not to run water while brushing, running washing machines on full load, reusing grey water, using a broom to clean instead of water and other such basic, ‘easy to implement’ measures (TCDC 2009).

3. Educating children on the need for water use efficiency so that they can influence their elders. This can be done through environmental education at school or by the Museum.

4. Providing incentives to install water saving appliances (a grey water system for newly constructed houses) and giving out awards for the best performance in water saving activities or for reporting water issues. This is important to encourage people to take the lead in water use efficiency.

5. Practicing sustainable land and agriculture management. The later relates to changing land and animal husbandry patterns of farming, such as use of drip irrigation and reducing grazing pressure.

Recommendation 2. Implementing and embracing new technologies for use and conservation.

In terms of construction costs, operational costs and reliability, rainwater harvesting and utilisation shows better performance than installing grey water systems and desalinisation of seawater (Han 2007). The later two systems are generally more expensive and costly for a small village like Sigri.

Rainwater harvesting can provide a good supplement to the existing water sources and utilization systems, thus relieving pressure on other water sources. The earliest practice has been used over 2000 years in northern Egypt, where tanks ranging from 200-2000m3. The small-scale collection of rainwater from the eaves of roofs or via simple gutters into traditional jars and pots were introduced thousands of years ago. Typically, a rainwater harvesting system contains three basic elements: the collection system, the conveyance system, and the storage system. The collection systems vary from simple types within a household as the sources of car or path washing uses to bigger systems where a large land surface catchment area for the agriculture purposes (GDRC 2007).

The successful experience of Japan can be reviewed and explored further to be applied in Sigri. Rainwater harvesting in Japan is aimed at securing good quality drinking water, conserving piped water by utilising rainwater for flushing toilets and watering plants. For a smooth introduction, five main sectors need to be integrated namely the administration, municipal guidelines, implementation policy, technology development and technician training, and network establishment (Murase 2004).

Observations note that some hotels use advance shower techniques such as having an additional plug to turn-off water when the taps for hot-cold are adjusted. Such devices prevent waste of water during showers, especially during the tourist season.

4.2. Capacity building

A majority of the residents of Sigri are supplied with water from the main pipeline that draws from an underground source as described before (see section 2). As it is heavily dependent on the rain, the long-term sustainability of this source is questionable in view of changing climatic conditions. However, not having had prolonged problems so far, the residents of Sigri do not seem too concerned by the possibility of shortage of supply in the future (Popudopulus pers.comm).

Interviews with various stakeholders of water resources show that water availability is not a concern or problem for them. Households, restaurants and farmers pay a minimum price for consumption over a six month period. Consumption is measured by water meters but there is some ambiguity about the existence of this meter based on the mixed responses of the stakeholders. This indicates that measurement is purely symbolic and of no consequence to the consumers and the municipality.

The issue that needs to be focussed on is the lack of efficiency in water use. Acknowledging this fact, some residents are interested in participating in initiatives to improve the current use practices (Popudopulus
pers.comm). Yet, there is a general lack of information on the ways in which water can be conserved.

**Recommendation 3: The Museum can organise educational programs on the need and implementation of water conservation measures for the residents of Sigri and for tourists. The incentive for residents to participate is savings on water bills while for tourists, the possibility of a discounted fee for exhibits.**

Any campaign for water efficiency will have to be sustained over a long period of time in order to be effective. A few informative tools that could be applied are public awareness campaigns through community consultations, posters depicting the benefits of proper use, workshops that involve and engage the local community so that they can identify themselves with the issue, environmental education for all ages so as not to isolate water issues from other environmental problems and pamphlets specifically targeted at tourists during the peak season, encouraging them to use water efficiently during their stay. Additionally, proper measurement and treatment of water use should be given priority by the municipality.

**Recommendation 4: Awareness and training workshops implemented by municipalities utilising resources from an established environment trust fund to upgrade community skills in water quality monitoring, animal husbandry, agriculture and managing water (reuse & recycling) in Sigri, in partnership with women’s cooperatives.**

Awareness can be raised through numerous activities but the key task is to identify an organising body to oversee these activities, such as a community environmental board explained further in section 4.3. The viability of this board is closely linked with the sustainability of the initiatives. The next cohorts of MESPOM can also assist and sustain these activities during their stay in Sigri.

Presently, all stakeholders are unwilling to pay higher prices for water although they admit that the current fee is minimal (Chiotis pers.comm). But with the impending EU Water Framework Directive, they will no longer have an option. They can, however, benefit by increasing the efficiency of their consumption and decreasing their water bills which in itself is incentive to act. Should time and resources be invested presently into capacity building measures, it will pay off monetarily when the price hike is introduced.

### 4.3 Economic and policy instruments

The questionnaire response shows that people are satisfied with the current prices of water and see no need to increase it. But with the enormous wastage as highlighted earlier, water resources are under pressure during the dry months reflecting poor water-use behaviour among locals.

**Recommendation 5: Both market and non-market based economic and policy actions should be implemented at the municipal and local level to improve the management of water and encourage behaviour for water protection and practices in Sigri. This can include the following:**

1. **The need to increase prices for water use by 50% to cover environmental costs and externalities.** This policy measure reaffirms the proposal set by the EU Water Framework Directive (WFD) to increase water prices which has to be implemented in Greece in 2010 (EU 2000). A new pricing system accounting for cost recovery of water extraction should be aimed at changing behaviour of irrational water consumers and reduce water consumption and wastage of water. The survey showed that people are generally against a price increase, therefore any such an increase should be complemented with community based training on ways to save water, introduction of efficient technologies and practices described under capacity development.

2. **Channeling of subsidies for more sustainable irrigation methods (i.e. drip irrigation).** The survey indicates that irrigation constitutes a large amount of total water demand, whilst the agriculture sector is subsidised in Lesvos. Incentives such as subsidies should be redirected towards more widespread use of drip irrigation (practised by small-scale farmers) thus gradually eliminating traditional ones (spray irrigation). The expected results would be increased efficiency of irrigation techniques that, in turn, will decrease water consumption (GWP 2005).
3. The need to provide incentives via discounting water bills for community water saving. This measure will further facilitate change of behaviour by rewarding those consumers (mainly at the household sector) who sustainably manage water at the household level. Therefore these consumers get a discount on water bills for the next payment period.

4. Introducing regulatory policy instruments such as standards, permits and fines at municipal levels (GWP 2005). These should be directed towards farmers, individuals and local hotels not complying with municipal regulations such as drilling boreholes without permits, improper maintenance of wells and discharge of wastewater into the coast. Seasonal restrictions should accompany these permits and standards, to control quantity of water use in Sigri during the dry summer months (June-August). Examples can include restricting washing cars, housing infrastructure, and watering of lawns during July and August.

5. Encouragement of recycle and re-use of water (GWP 2005). Water from washing and household grey-water can be used. Currently a separate tank in the ‘mana’ extracts additional water for agricultural fields. Reuse and recycle of water will reduce the amount of freshwater that is pumped from underground sources for competing uses such as irrigation and watering of fields/lawns (GWP 2005).

Recommendation 6: Establishment of an environment trust fund to assist locals in implementing water, waste and other environmental initiatives.

Such a trust fund can be replenished via visitor user fees, water fees/charges and waste/litter fines. The purpose of this trust fund will be to provide coordinated funding for local initiatives on water, waste and environmental management. The management of this trust fund should be jointly established between the municipal council and local people through a board. The board should be responsible for deciding and executing environmental and eco-tourism projects.

5. Conclusion

Sigri like many other areas in Lesvos, suffers from seasonal shortages of water that is attributed to lack of irrational use and low awareness of alternative solutions of water an overall lack of know-how and on a smaller scale increased water demand due to human activities (agriculture and tourism). While the present research indicates that this is not a major threat to water resources depletion, in future it may present a case of severe water shortage especially in the face of climate stress and increased water demand and irrationality. The local villagers are well aware of these scenarios, but also choose to ignore these problems, which is typical of the ‘Greek island lifestyle’ – why worry today when the threats are for tomorrow. The challenge lies in changing this behaviour in Sigri and making people more aware of the water resource problems.

The report strongly recommends that initiatives centre on demonstrating applications of water use efficiency and local water resources assessment and protection. It is vital that these initiatives are coupled with policy and economic instruments reform, and capacity building to change the current pattern of ‘one size fits all’ and irrational behaviour. Overall these initiatives require long-term monitoring linked to feedback of information to different local stakeholders. The Sigri residents are the first to face local problems and are in a better position to create more local solutions than the tourists. In essence the locals bestow immense faith and trust in their local municipality, who should take lead and coordinate work in the area of water resources/environment management.
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<td>1.</td>
<td>What are the sources of water (irrigation, drinking) in Sigri?</td>
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<td>2.</td>
<td>Over the years what sort of changes have you observed in water supply &amp; use?</td>
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<td>3.</td>
<td>What do you think about the quality of water in Sigri?</td>
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<td>4.</td>
<td>Did you experience any problems with water supply in Sigri? Why/Why not?</td>
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<td>5.</td>
<td>How much do you pay for water prices currently? Is this sufficient?</td>
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<td>6.</td>
<td>Are there different tariffs for water supply and any meters?</td>
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<td>7.</td>
<td>Who do you think should take lead in addressing these issues and how?</td>
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<td>8.</td>
<td>What is the municipality/govt. doing to help them to manage water?</td>
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<td>9.</td>
<td>Do you know of any govt. policies relevant to water?</td>
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<td>10.</td>
<td>How can your municipality help to address water related issues in your community? What forms of assistance do you need?</td>
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</table>
**LIST OF REFERENCES**


Chiotis, A. 2000. Sigri. The legend, the history, the dream. Sigri.


Han, M. 2007. Rainwater harvesting as the first water supply option to solve the MDG. Seoul: National University, Rainwater Research Center.


**Personal communications:**


