Water Crisis – Bridging the Gap

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Environmental Crisis

The world's population is increasing at a tremendous rate, the world's renewable water resources are reducing rapidly, the gap between supply and demand is widening with urbanization and climate change is making the gap even wider. This paper reviews how water utilities could contribute to lessen this gap and how the Water Board of Lemesos, a public water utility in Cyprus, which despite the fact that in recent years has been managing extremely well its distribution network is forced due to the changing climatic conditions to have intermittent supply, 3 times a week for an average duration of 16 hours each time.

Water is likely to become one of the limiting resources of this century as well as one with multiple often conflicting uses. Climate change is now a fact and must be taken seriously. Extreme weather phenomena, being flooding or drought, are occurring more frequently and are characterised by an erratic geographical pattern. The planet is warming up and some predictions refer to a temperature increase of up to 4 ^{0}C in some parts of the world by the end of this century. All these are conditions which will definitely impose additional stress on the renewable water resources of the planet and will certainly affect life as we know it today.

Water Resources at Great Risk

At the time of writing this paper my country, Cyprus in the Eastern Mediterranean, is going through its fourth consecutive year of severe drought with water reserves running out particularly for my home town of Lemesos on the southern coast of the Island. Despite the fact that the management of water, for both domestic and irrigation purposes, has improved tremendously over recent years by reducing losses from supply networks and adding recycled and desalinated water to the national water balance there is still an imbalance between water use and renewable water resources.

In my view climate change is a major contributing factor to this imbalance imposing additional water stress in many areas around the world. For the Island of Cyprus it is evident from the hydrological data available shown in Figure 1.1 that precipitation has been continuously decreasing over the last century with periods of low rainfall becoming more frequent.

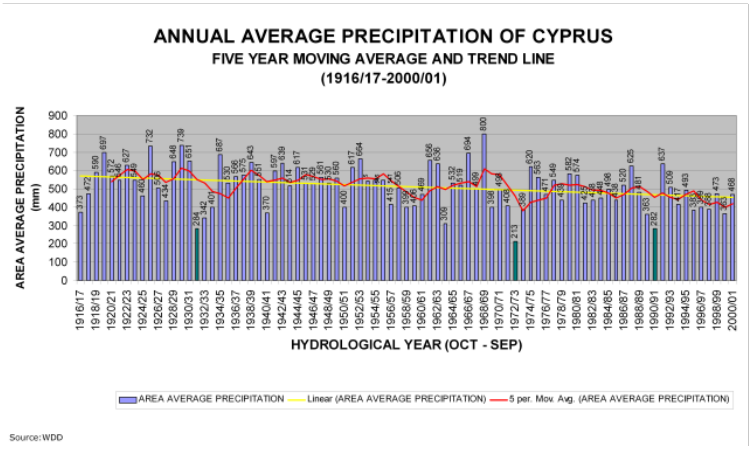

Figure 1.1 Cyprus Annual Average Precipitation from 1916 to 2001

As a result the runoff into the impounding reservoirs has been reduced imposing a tremendous task on the Government to try to manage the limited water quantities in the best possible way. It is worthwhile mentioning that the Hydrological year 2003/04 was an extremely good year in terms of precipitation with almost all the impounding reservoirs overflowing by the end of March 2004.

Although all reservoirs were full at the start of the summer period of 2004 at the start of the summer period of 2007, that is 3 years later, the reservoirs were almost empty and the Government was forced to impose water cuts in the irrigation sector. The situation became even worse in 2008 and in April 2008 water cuts were imposed in the domestic sector. The natural water reserves were depleted and the Government was forced to look for alternative sources to provide water to the domestic sector. To get over the crisis and until a sustainable solution is found water from Greece is being brought in by tankers to Lemesos on a daily basis since the beginning of August 2008. This of course is an interim measure and the Government is looking into increasing the production of desalinated water in order to cover the entire domestic needs for all large urban centres which amount to about 160.000 m^3 per day. The output from the existing desalination plants is about 100.000 m^3 day. But Lemesos seems not to be alone in this. Barcelona in the summer of 2008 also shipped in water to get over a water crisis. Therefore, there are regions around the globe that are under water stress.

Water stress causes deterioration of fresh water resources in terms of quantity (aquifer over-exploitation, dry rivers, etc.) and quality (eutrophication, organic matter pollution, saline intrusion, etc.). The water stress indicator shown in Figure 1.2 (source: Water Gap 2.0 – December 1999) measures the proportion of water withdrawal with respect to total renewable resources. It is a criticality ratio, which implies that water stress depends on the variability of resources.

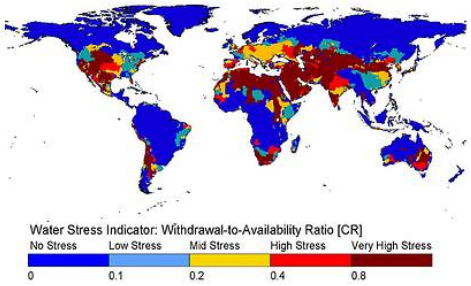

Figure 1.2. Water Stress Indicator Map

As it can be seen from the map in Figure 1.2 a large proportion of the densely populated part of the planet has high to very high water stress indicator. Cyprus is in an area with high to very high water stress indicator. It is therefore imperative to develop appropriate water management approaches in order to manage our water resources efficiently and effectively.

Improving the Situation

Today, there is a water crisis in many parts of the world and it is imperative that water is managed properly irrespective of its use. Reducing losses from distribution networks is of the utmost importance and water utilities must recognise this and respond positively. In addition we must all use water wisely and avoid wastage. Unfortunately water is wasted, and as long as people are not facing water scarcity, they believe access to water is an obvious and natural thing. With urbanisation and changes in lifestyle, water consumption is bound to increase and a combined effort by all concerned is very much needed in order to address the problem and to have encouraging results.

In a recent World Bank publication (Kingdom et al, 2006) the annual volume of Non-Revenue Water worldwide was estimated at a staggering 50 billion cubic metres from an annual volume of 300 billion cubic metres of water produced for municipal use. Faced with this situation, corrective measures must be taken in order to curtail the problem and to avoid worsening of the crisis.

Water Loss Control

Efficient and effective water loss control should be recognised as a first priority for improving potable water supply. Decision makers at all levels in water utilities must understand that any water loss control strategy in order to be effective must be a continuous activity based on a long term strategy and should form an integral part of the utility's vision. The success of the strategy will inevitably depend on the commitment and dedication at all levels within the utility and of course on the adoption of appropriate strategies and techniques.

The benefits of a water loss control strategy could be summarised as follows:

- Saving a precious and valuable resource.
- Increasing the efficiency of existing systems.
- Delaying huge infrastructure investments.
- Increasing the life expectancy of the systems.
- Increasing the revenues for the water utility.
- Reducing energy requirements.
- Improving the Carbon Footprint of the utility.

The Methodology

The IWA Water Loss Task Force (WLTF) has played a principal role in the advancement of water loss control strategies, methodologies and procedures world wide and in the development of world class tools and techniques to reduce losses and increase water accountability in revenue generation. The following steps are advocated by the WLTF as best practice in reducing the Non-Revenue Water:

Accurate and comprehensive water metering

Accounting for water is the first step that must be made by any utility. It is imperative that an accurate and comprehensive metering system is in place in order to establish how much water is produced, how much is used and how much is lost. Measurement systems must be in place for registering all water along the chain from production to the consumer, including measurement of the water produced and/or imported, water flow in and out of treatment plants and storage reservoirs and into the zones and district metered areas.

Continuous monitoring of the flows using automatic metered reading systems are becoming more widely used as technology advancement is providing appropriate solutions and their cost is getting lower. It is imperative to eliminate or minimise authorised un-metered consumption thus achieving the highest possible accuracy in accounting for all water produced.

The IWA Water Balance

A significant contribution to reaching the point of water accountability was the establishment of the IWA Water Balance (Figure 1.3) which is a useful tool in analysing the various components of water production, storage and distribution. Through this analysis the utility will gain an understanding of the magnitude of the water loss problem and will set priorities for rectifying the situation based on the component analysis of the Revenue and Non-Revenue Water elements.

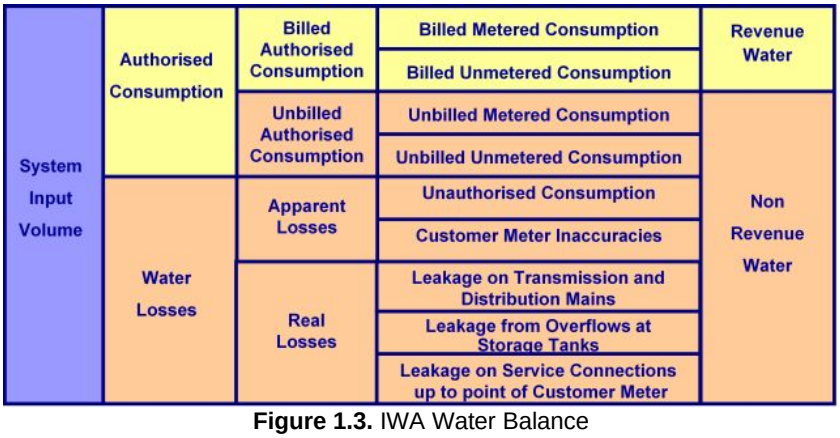

Figure 1.3. IWA Water Balance

Apparent Losses

WLTF practitioners have dedicated numerous hours over the last five years to study the field of Apparent Losses. Various conclusions have been reached. As a start, Apparent Losses have been clearly defined as constituting four components, and that these components can act and interact interchangeably (Figure 1.4).

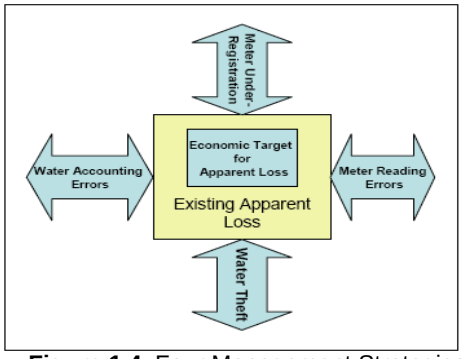

Figure 1.4. Four Management Strategies for Apparent Losses

The four components are briefly described as follows:

1. *Meter under-registration* is the inability of a revenue meter to accurately measure water, especially at low flows. This tends to increase with time and as the meter degenerates.
2. *Water theft* is easy to conceptualise and consists usually of bypasses to the revenue water meter, illegal connections, or wilful damage to the revenue water meter.
3. *Meter reading errors* consist of genuine mistakes or intentionally incorrect meter reading.
4. *Water accounting errors* consist of billing anomalies, such as computer-based estimations that do not reflect actual consumption values. This approach will assist utilities in reducing their Apparent Loss component thus increasing utility revenues.

Real Losses

The IWA Water Loss Task Force has been promoting for a number of years the four leakage control strategies to reduce Real Losses, namely:

1. *Active leakage control*
2. *Pressure management*
3. *Speed and quality of repairs*
4. *Targeted renewal of infrastructure*.

These have to be balanced in order to achieve the most cost effective leakage programme which reduces leakage to an economically, environmentally and socially acceptable level (Figure 1.5).This approach is well tested and has been applied around the globe with extremely positive results for utilities.

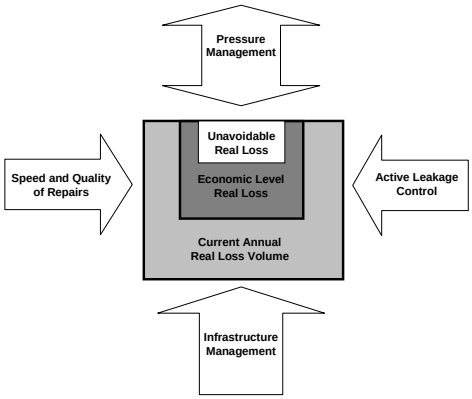

Figure 1.5. Four Leakage Control Strategies

The above WLTF methodologies and strategies have a global application and represent what could be termed “best practice” in the area of water loss control. They have been implemented successfully in countries in Europe, North and South America, the Caribbean, Australia, New Zealand, Pacific Islands, South Africa and South East Asia.

Water Board of Lemesos

The Organisation

The town of Lemesos is situated on the south coast of the Mediterranean island of Cyprus and has a permanent population of 170.000. The Water Board of Lemesos was established in 1951 under the Water Supply (Municipal and Other Areas) Law of Cyprus as a non-profit, semi-government organisation charged with the responsibility of supplying potable water to the town and environs of Lemesos. Acting in accordance with the provisions of this Law the Water Board has traditionally set the minimum possible water prices in order to present balanced budgets and break-even every financial year. The institutional framework is therefore governed by stringent rules and regulations and there is very little scope for re-organisation or re-structuring.

Commercial Activities

It is extremely difficult to measure the economic value of the Water Board's water resources as the Board is obligated by law to supply water to its consumers irrespective of long-term economic implications. The Board must provide water at affordable prices that of course would enable the Board to generate enough revenues for its operations and projects. Consequently, there is little point in carrying out a cost-benefit analysis of water projects as the Board has a legal obligation to provide water of good quality and of sufficient quantity to all its consumers. Any increase in the water rates charged by the Board requires the approval of the Government and until 2008 of Parliament as well.

The Board maintains a comprehensive database for all its consumers, which allows quick and accurate issuing of water bills and of course retrieval of consumer information. The computerised consumers' information system on cash management offers a number of advantages:

- Consolidation of information,
- Multiple service billing,
- Custom made reporting,
- On-line validation of information,
- Speed-up collection of outstanding balances from consumers.

Network Management

The main activities of the Water Board are: planning and execution of technical projects, operation and maintenance of the water production and water supply systems and all associated financial services including collection of water revenues and determination of water tariffs.

In 1985, the Water Board embarked on an ambitious network improvement and expansion programme involving a major extension to the distribution system, which included division of the distribution network into pressure zones, each with adequate storage reservoir capacity. A number of pumping stations to lift water to higher zones were constructed. A comprehensive Supervisory Control and Data Acquisition system (SCADA) with remote terminal units installed at all sources of water, reservoir and pumping station sites with its central control room at the offices of the Water Board was commissioned in 1988.

The topographical location of Lemesos is such that the elevation of the supply area varies from zero at the coast to 450 meters above sea level at the foothills. To ensure acceptable pressure limits to consumers, the entire supply area (100km^2) is divided into nine pressure zones, each with its own storage reservoirs. Ductile iron trunk mains varying in diameter from 300mm to 800mm supply the District Metered Areas (DMA) from their respective reservoirs. The total length of the trunk mains and distribution mains is approximately 850km.

The development of the distribution network takes place in an organised fashion with new areas of supply being incorporated into their respective pressure zones, strictly governed by the new areas ground contours. Each pressure zone is subdivided into DMA's, which have a single metered source with physical discontinuity of pipe work at boundaries.

In late 1980 the Water Board embarked on a programme of leakage management. Since 2002 the Water Board has adopted the practices and methodologies advocated by the IWA Water Loss Task Force. The efforts made and importance placed by the Water Board for proper leakage management is reflected in the reduction of the non-revenue water over the years and the graphs

below show how the Water Board improved the operational performance of its network over the years.

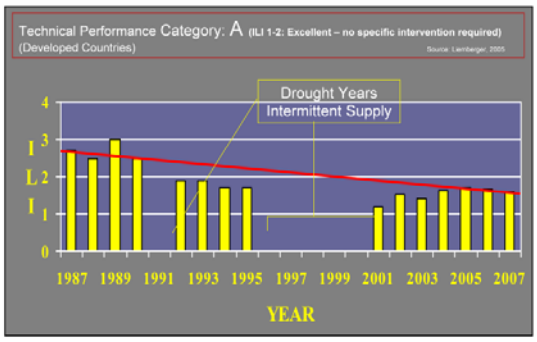

Figure 1.6. Infrastructure Leakage Index

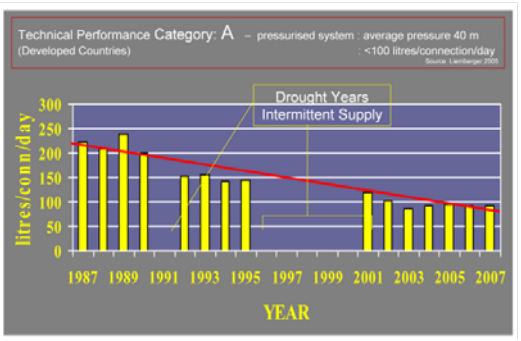

Figure 1.7. Litres / connection / day

Demand Management

The Water Board of Lemesos realised that water conservation is not to be equated with temporary restrictions on customer water use. Although water restrictions can be a useful emergency tool for drought management or water shortage situation, water conservation programs concentrate on continuous improvements in water use efficiency. To this end the Water Board embarked on a promotional campaign through television, radio and leaflets to increase public awareness for water conservation.

In 1991, the government legislated against the use of hosepipe for washing cars and pavements at all times, a law, which the Water Board enforces during drought periods only. During the last drought period (1997-2000) the government was forced to announce in early 1997 a reduction of 20% for potable water and 40% for irrigation water supplies. In 1998 the water situation became worse with water reserves at their lowest ever. The restriction measures became more stringent as the available quantities of water were diminishing and the government, much to the discontent of the public, went ahead with further measures, enforcing greater restrictions to the water supplies with targeted figures of 28% for potable water and 56% for irrigation use.

The Water Board of Lemesos promptly responded to the government's declared drought measures and in February 1997 restricted supply to consumers to four days a week. In 1998 with the announcement of the increased restriction measures the Water Board was forced to decrease further the availability of water reducing the time of the water being available to consumers to 12 hours every 48 hours.

In addition the Water Board enforced the following measures:

- Production and distribution of 100.000 plastic water bags for use in toilet cisterns.
- Hosepipe ban for washing cars, pavements, patios, etc.
- Public awareness programs to promote water conservation.
- Promotional leaflets on water conservation sent with water bills.
- Cost-of-service-based water rates.

The above actions resulted in an overall reduction in the use of domestic water of approximately 15% per annum, proving that the supply of water to the domestic sector is to a large extent inelastic.

One would have thought that after the above 4 year period of intermittent supply measures would have been taken so that there will be sufficiency of at least water for domestic use. However, this was not the case and 8 years later in 2008 water cuts were imposed both to agriculture and domestic water. Water is currently being brought with tanker boats from Athens, Greece. For many this dire situation is blamed on the politicians for not taking the right decisions at the right time. For others there is the argument that there has been mismanagement of the water reserves prior to the drought period and not sufficient forethought has gone into the planning of such a severe drought taking place so soon after the last one. For those who wish to be diplomatic the answer is somewhere between the two positions above.

In any case fact remains that the Water Board of Lemesos even though it has improved its network to such an extent that it is consider amongst the world's best with losses from the network being extremely low, it is now facing a situation which is beyond its control. Of course the situation would have been a lot worse if the Board did not continuously improved the network in order to minimise losses thus saving valuable quantities of water.

CONCLUSION

In Cyprus, in order to meet the increasing water demands, there is a need to develop policies which emphasise integrated and sustainable water resources management based on the perception that water is an integral part of the ecosystem, a natural resource of social and economic value.

The Water Board of Lemesos operates a well-organised supply and distribution system with permanent pressure zones and District Metered Areas thus providing a solid foundation on which an effective leakage control policy has been developed. Through the adoption of conservation oriented pricing policy as well as an effective leakage management strategy the Water Board has managed to maintain a balance between supply and demand. It has systematically and continuously improved the quality of its commercial function through customer-oriented policies and by maintaining an accurate and up-to-date database employing appropriate information management systems.

The implementation of the above components for effective water utility management enabled the Water Board to be more efficient and effective in its operations thus providing the best possible service to its customer at an affordable price.

The target of the Water Board of Lemesos is to reduce the NRW to about 10% of the system input volume, which is considered to be the economic level of leakage. The Water Board demand forecasts indicate an increase of approximately 30% by the year 2020 and the leakage reduction will go some way towards offsetting this increase in demand as well as a provide considerable cost saving.

The efforts need to be continued and intensified by all concerned in all areas of water management including water loss control striving towards water sustainability through better planning, management, innovation and technological advancements. It may not be possible to close completely the gap between supply and demand but I believe that we could certainly make it small enough so that we could easily bridge it.

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