Successful NRW Reduction Experience in China

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Introduction

Sino French Water is a company created in 1992 between Suez Environnement of France and NWS Holdings Limited of Hong Kong. Sino French Water invests and establishes joint-ventures (JVs) with local water authorities and companies in China to improve the management and operation of water, waste water, industrial water services and sludge treatment. Today there are more than 25 JVs spread all over China and each one with unique characteristics. With such diverse conditions, systematic methodologies are put in place but applied in a pragmatic manner depending on the condition and maturity of the local company. This paper will explain the various actions taken by Sino French Water in five different phases over 15 years to reduce the non-revenue water (NRW) from 35% to 6% at its JV in Tanzhou, China.

Zhongshan Tanzhou Water Supply Company Limited (Tanzhou Water) is the first joint-venture of Sino French Water in mainland China and it is also the first Chinese-Western joint-venture in the water business in China.

Tanzhou is located in Guangdong province approximately 45 minutes from the border with Macao, a Portuguese colony for more than 400 years and handed over back to China in 1999. It is important to note that the supply of water in Macao is managed since 1985 by the Macao Water Supply Company (Macao Water) another subsidiary of Suez Environnement and NWS Holding. Its proximity to Macao has allowed the people of Tanzhou Water to closely witness the improvements made in Macao Water with the introduction of Suez Environnement methods and techniques and to quickly adopt the effective experiences and thus benefit significantly from being part of an international group.

Figure 1 - Map of Hong Kong region, with the location of Tanzhou

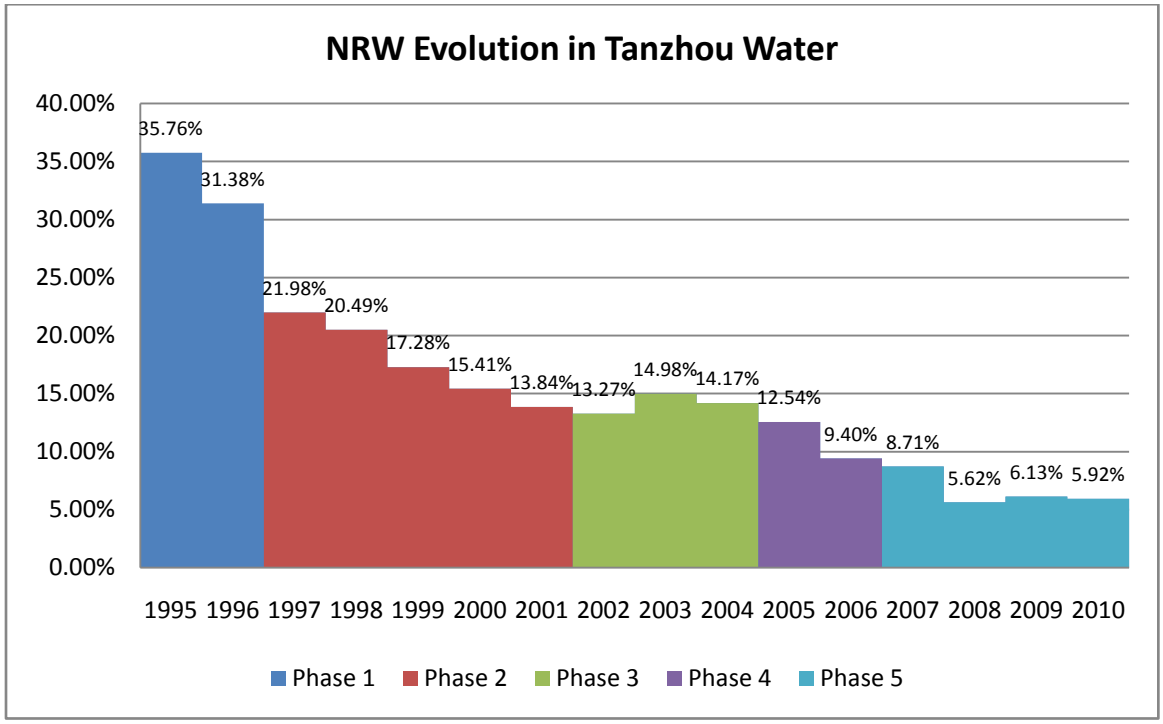


Figure 2 - NRW evolution of Tanzhou Water

Phase 1 [1995-1997] – Quick Wins

After the establishment of the joint-venture between Sino French Water and the local government, one of the key objectives for Tanzhou Water was to reduce NRW and to optimize revenue. Four key processes were put in place: rationalized meter replacement, inspection and repairs, leak report awarding system, and leak detection using check meters.

Rationalized Meter Replacement

Customer meters prior to 1995 were selected arbitrarily from various suppliers. The meters were not tested, so the metrology was questionable and the performance not guaranteed. In addition, no meter replacement had taken place between 1981 and 1995.

Thus starting from the end of 1995, Tanzhou Water started a company-wide program to replace all customer meters. In order to better manage their meter population and to guarantee their performance, Tanzhou Water only bought meters from reliable suppliers, which they limited to one or two for the ease of replacement and repair. Guided by the experience from Macao Water, the subsidiary of Suez Environnement, Tanzhou Water set up their own meter test centre in 1996 using the comparison method to verify meter performances.

To avoid under-metering losses due to ageing, a meter replacement policy was also introduced to replace all meters every 3 years.

Inspection and Repairs

The second action was the setup of a dedicated inspection team responsible for surveying the network that had dual benefit. First of all, at that time, leaks ran for a long time before anyone reported it and secondly, there was a serious fraud problem in the rural areas. By creating a dedicated inspection team which walked along the pipelines, Tanzhou Water greatly reduced leakage reporting time as well as the number of fraud cases.

To further reduce leak reporting time, the leak reporting awarding policy has been setup in 1995. This action not only motivated company staff to report leaks, but helped them develop a habit and a culture of reporting leaks. With the establishment of the inspection team and frequent network surveillance, the number of fraud cases naturally decreased.

In the area of repairs, Tanzhou water did not need to start from scratch. There was already a repair team. The repair techniques of the team were to be improved, as well as their transportation means (see Figure 4).The average repair time was too long, between 4 to 8 hours. By reinforcing the size of the repair team, equipping them with the proper transportation vehicles, tools and equipment, the repair time was greatly reduced to an average of 2 to 4 hours.

Figure 3 - Method of transportation of the repair team before and after

Leak Detection by Check Meter

Beside meter testing using a standard meter, Tanzhou Water also learned from Macao Water about organizing leak detection by areas using check meters. Since there was no dedicated leak detection team, this method was useful in optimizing their efficiency. Before 1995 in Tanzhou, leak detection was done by using listening sticks and stethoscopes and there were no systematic leak detection method. Macao Water provided technical support to train Tanzhou Water team 2 to 3 times per year, 1 week in duration each time. Together they identified 11 branched networks with single inlet where they installed check meters. By reading the meter and by taking manual night flow measurements, they were be able to determine if there were any leaks in the network, then carry out leak detection. This method helped Tanzhou Water leak detection team to narrow down the search area for leaks, increasing their efficiency as well as the confidence in their skills.

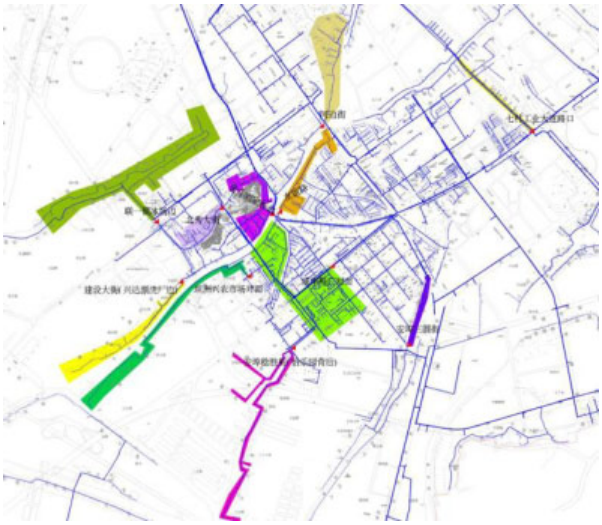


Figure 4 - The 11 check meter zones

Management

One crucial point to the success of these actions was the combination of experienced managers from Suez Environnement and motivated high potential local managers from Tanzhou Water. Suez Environnement managers had the experience of implementing these actions elsewhere before so they were able to anticipate the problems that might arise while deploying the actions and ensure the smooth operation and proper execution of these projects. Local managers were trained to develop further and maintain the implementation of the actions.

Phase 2 [1997-2002] – Documentation and Network Investment

Process Documentation

After the first 2 years of dramatic changes and hard work, the NRW of Tanzhou dropped from 35.76% in 1995 to 21.98% in 1997. These results proved that the actions put in place were effective. Thus the next step was to document and standardize the processes, so that they would become long-term practices.

Some of the work flow procedures established included leak detection, inspection, maintenance, network design, construction, and acceptance. Only writing these procedures was not enough to give the staff ownership of what they are doing. So in 1999 Tanzhou Water extended these procedures and wrote down the responsibility for each position. This allowed each staff to know exactly what their responsibilities were and what was expected of them. These documentations greatly improved the management allowing for smoother work communication and increasing efficiency.

These procedures marked the transition of management from foreign to local managers. Having worked alongside foreign managers and having a set of work flow documentation, by 2000 all departmental managers were local mainland Chinese.

Network Rehabilitation

With the additional income generated from accurate metering, investment in network rehabilitation was possible. At that time network rehabilitation was a passive action, pipes would only be replaced if there were so many leaks that it could not be repaired anymore. It was a major problem because the pipe materials that were used were poor: they were

mainly concrete, galvanized iron (G.I.), and cast iron pipes with rigid joints. In the 1980's, until 1998, there were many leaks and bursts due to pipe corrosion and blocked pipes.

In the beginning of 1999, a network rehabilitation and replacement plan for the entire network was drafted and there has been a yearly network rehabilitation plan and budget for rehabilitation every year since 2000.

With the problems that it had with the pipe materials, Tanzhou Water started to look for alternative pipe materials. In 2000, they replaced cast iron pipes with ductile iron pipes and in 2002 they replaced G.I. pipes by steel pipes with plastic lining. The combination of network rehabilitation and the use of alternate pipe material reduced the frequency of pipe bursts and improved the condition of water supply. By the end of 2002, the NRW in Tanzhou was 13.27%.

Phase 3 [2002 – 2005] – Extending the program to other areas and keeping up with technology

Maintenance of Production Meters

In 2003 the NRW increased to 14.98% and one of the first things that was checked was the production flow meter. The production flow meter was an insertion type single-beam ultrasonic flow meter made in China and large fluctuations were started to be observed in its measurement.

As a result, Tanzhou Water decided to replace the ultrasonic flow meter with an electromagnetic flow meter from Shanghai Krohne. In addition to the replacement of the meter, Tanzhou also set up a flow meter maintenance policy.

By replacing the ultrasonic flow meter, the NRW dropped from 14.98% in 2003 to 14.17% in 2004. From this experience, the team of Tanzhou Water saw the significance of the accuracy of the flow meter and production volume. So to minimize month to month variation and meter reading lag, they have set up a policy to manually read the raw and production flow meter on a particular day and a particular time each month and use it as the data for NRW calculation.

Establishment of Valve Team and Leak Detection by Acoustic Equipment

As Tanzhou's network started to age, the valves started to have problems. Through repair feedback, it was learnt that many of the main valves in the network could not be completely closed leading to additional water loss and increasing repair time. As a result, an additional team, the valve management team, was set up in the distribution department. The valve management team would be responsible for checking, repairing, and the replacement of valves on mains.

In addition to valve management, leak detection also needed to improve to further reduce NRW and to keep up with the ageing network; thus Tanzhou Water decided to create an active leak detection team and invited the Macao Water leak detection team to conduct training for them. From the training, Tanzhou Water realized that the equipment they were using, listening sticks and stethoscopes were outdated and needed to purchase new and more advanced equipment which included noise loggers and correlators in order to increase their efficiency and competence to pinpoint leaks.

Phase 4 [2005-2007] – Deepening understanding of NRW calculation and NRW indicators

Bulk Water Supply

Starting in May 2005, Tanzhou started bulk water supply to a nearby village, Sanxiang. This is Tanzhou Water's largest customer. Without significantly extending the network, Tanzhou increased its water sales by approximately 10%.

Even though Tanzhou Water did not need to deploy additional efforts to improve NRW, the NRW ratio improved from 12.54% to 8.71%, and this gave the staff of Tanzhou Water insight to the various components and factors that can affect NRW, how other indicators, like volume loss per kilometre of network, besides NRW ratio, are also important to assess the effectiveness of the NRW program.

Phase 5 [2007-2010] – Reaching World-Class performance

This last phase is the most remarkable and significant. It demonstrates how Tanzhou Water is a mature water company with practices comparable with water companies in Western, developed countries.

Establishment of a company-wide NRW team

Prior to 2007, actions contributing to the reduction of NRW were implemented independently by each department and there was little inter-departmental communication. From the experience of production meter influence and upon the recommendation of the Technical Department of Sino French Head Quarters (SFHQ), Tanzhou Water established a NRW team composed of the following: a team leader, a representative from the Water Supply Department, a representative from the Customer Services Department, and a representative from the Distribution Department.

The team leader is responsible for coordinating and overseeing the NRW program, drafting action plan, communicating with the company regarding the action plan and negotiating for budgets. The representative from the Water Supply Department (WSD) is responsible for organizing all activities in WSD, for example, monitoring and controlling pressure, checking the water level of reservoirs, and validating production data. The Customer Service Department (CSD) representative is responsible for activities in CSD such as meter reading, metering, setting up check meter systems, and analyzing customer data. Finally, the Distribution Department representative is responsible for activities in distribution such as consolidating and analyzing leakage data, setting up network zones, night flow activities, and repairs.

Metering Policy

The metering policy is an initiative from SFHQ. Its aim is to standardize meter management within all Sino French Water JVs and to ensure that all the meters used are approved and of good quality. The policy controls the entire life cycle a water meter from meter selection, purchasing, testing, acceptance, in-service meter management, to disposal; however, at the same time allowing a certain degree of flexibility for the individual JVs.

This policy serves as a general structure for Tanzhou Water's metering management. Previous documentations and ISO procedures regarding meters are a complement to this framework. Having this policy further enhances meter management in Tanzhou to minimize commercial and metering losses.

Geographic Information System (GIS)

In 2007, Tanzhou invested in the GIS system, the software and the pipeline survey of which 280km were outsourced and 150km were surveyed in-house by Tanzhou Water GIS team.

During the implementation of the GIS, Tanzhou Water worked with a subcontractor while developing an internal professional team dedicated to pipeline survey, composed of

3 to 4 people. This pipeline survey team is responsible for pipe detection and localization, coordinates measurement, network data verification, and uploading data to GIS database.

With the implementation of the GIS system, Tanzhou Water, created a set of documentation to control and maintain the system. The documentation includes: GIS management, as-built drawings acceptance standards, operation manual of pipeline survey, and forms for recording pipe failures.

It is not difficult to set up a GIS system, many water companies have one. However, the key is in the application of the system and how the water company can take the most out of it to their advantage. The following is a list of the most common actions used: inquiry and statistical calculations, network input and edit, base map management, valves shut-off, pipe failure management, project information management, and DMA (District Metering Area) management. This GIS system greatly helped Tanzhou Water's NRW program: pipe failure management provided accurate data to support the need to replace and rehabilitate the network; the valve shut-off function indicated which valves to shut off on the field avoiding the time wasted from trying to close mal-functioning valves and reducing the time to search for valves on the field; night flow data from the loggers on the check meter helped the management and analysis in organizing leak detection activities. In the long term, by building the GIS and inputting all network information, the GIS became the basis of more effective network asset management and an integral part of sustaining a lower level of NRW.

Additionally, the GIS contains meter information which is connected to the customer database. Therefore when there is a pipe burst, a list of affected customers could be generated for the Customer Services Department to contact. In addition, Tanzhou Water is also planning to plot down customers with various types of complains to better understand and address their customers' needs.

Hydraulic Model

Prior to December 2007, Tanzhou Water didn't have its own hydraulic model and for the occasional master planning, Tanzhou Water received support from Macao Water. As Tanzhou Water's network grew and the company matured, they could not always rely on the support of Macao Water. Therefore in December 2007, they invested in the hydraulic modelling software and corresponding training. Since the purchase of the software, Tanzhou Water first developed a planning model in 2008, then a more accurate static model in 2009, and then a dynamic model in 2010. Now, the hydraulic model is part of Tanzhou Water's standard operations. The area of application includes: network assessment, master planning, network design, network renovation, network sectorization, energy savings, water age analysis, pressure management and emergency planning. Of which, sectorization and pressure management are particularly important to NRW control. Tanzhou Water first uses the hydraulic model to sectorize and create DMAs in the network to make sure that the zones are hydraulically sustainable afterwards; the DMAs are managed in the GIS.

Leak Detection Equipment and Strategy

In the first quarter of 2009, some of the noise loggers in Tanzhou Water started to breakdown and were sent back to the manufacturer for repairs. During this time, the number of invisible leaks found in Tanzhou dramatically decreased and the monthly NRW started to rise above 10%. As a result Tanzhou looked into purchasing new and advance leak detection equipment. The new noise loggers had correlation function which could further help narrow down the area of suspected leak and the correlator could make a correlation in within 5 minutes, while the current equipment required 20 minutes.

So in June 2009, Tanzhou Water received 2 sets of new leak detection equipment for a one month trial. Working overtime to take maximum advantage of these equipments

Tanzhou Water found 37 invisible leaks that month, bringing the monthly NRW down to 6.7%. The trial of the equipment was a great success, the NRW percentage and the number of invisible leaks detected clearly supported the success.

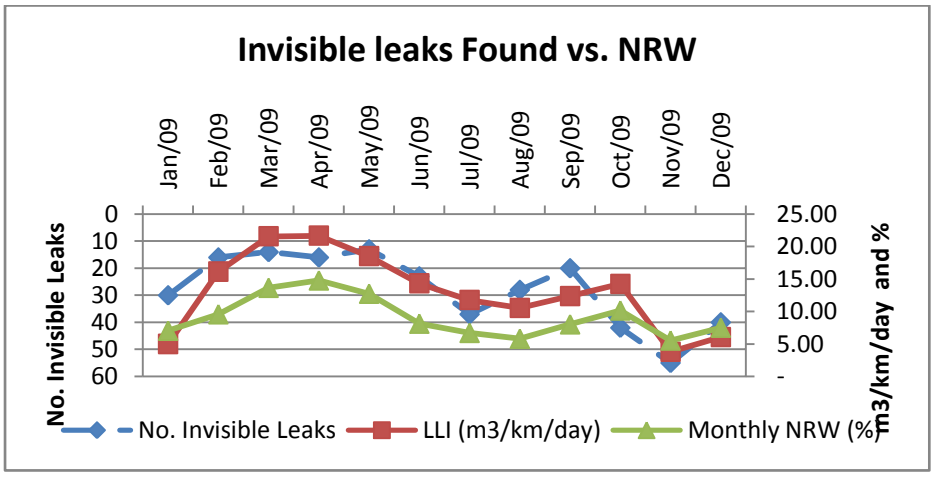


Figure 5 - Relationship between NRW and invisible leaks found

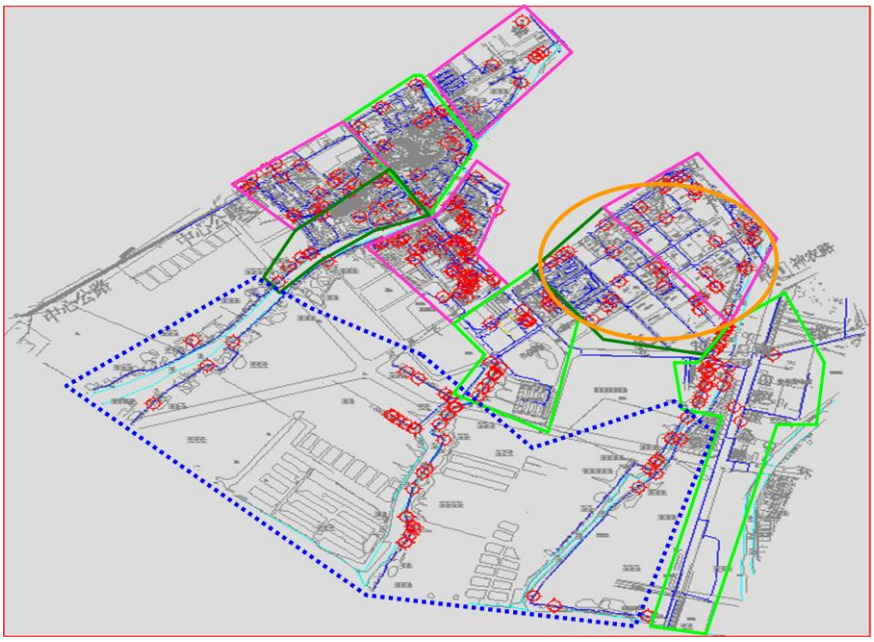
In addition to acoustics leak detection equipment, Tanzhou Water also looked into new leak detection technology: helium, which was a new technology for the water industry in China. This was a portable helium leak detection unit developed within the Suez Environnement group.

In the past 2 years, with network expansion, Tanzhou Water has laid over 200km of PE pipes. The acoustic leak detection on non-metallic pipes was not very effective. So originally Tanzhou Water purchased the helium equipment for this purpose. However, since these pipes are new, they do not have many leaks, so now they use it on metallic network as well, particularly in areas where acoustic equipment doesn't work very well, such as noisy areas, industrial zones, and areas where the network is complicated and correlation is difficult. One notable example is outside a factory in Tanzhou where it was noisy 24-7. When Tanzhou Water leak detection team used acoustic leak detection equipment, both the old equipment and the new ones purchased in 2009, they only found dry holes. However, with the helium, they found 2 leaks on the pipe with precision within 1.5m.

Figure 6 - Helium detection outside factory

With the addition of new equipment but needing to keep the same number of staff, Tanzhou Water needed to revise their leak detection plan to optimize their resources. Considering the network conditions, the leak detection team decided to use the most

suitable leak detection equipment for each area. From the figure below, the solid polygonal pink and green areas are most suitable for noise loggers; the orange circular area is an industrial zone, which is suitable for helium gas; finally blue dotted area is suitable for geophone and listening sticks as there are not many valves on the pipe.



Solid polygonal (pink and green) : noise loggers

Dotted polygon (blue): geophones and listening sticks

Circle (orange): helium

Figure 7 - Leak detection strategy of Tanzhou Water

Zones and DMAs

With the recent growth in Tanzhou's network, they needed to restructure the DMAs. So with the construction of the hydraulic model, Tanzhou Water took this opportunity to purchase real-time flow and pressure loggers to set up some big sectors. Using 8 flow meters, they divided the entire Tanzhou network into 4 big zones. Within these 4 zones, there are 30 DMAs. With these real-time data, night flow monitoring could be done more easily and efficiently. In some sectors, not all the network can be further split in to smaller DMA at the moment due to pressure and water quality constraints. However, Tanzhou Water is working towards this gradually through network rehabilitation and replacement.

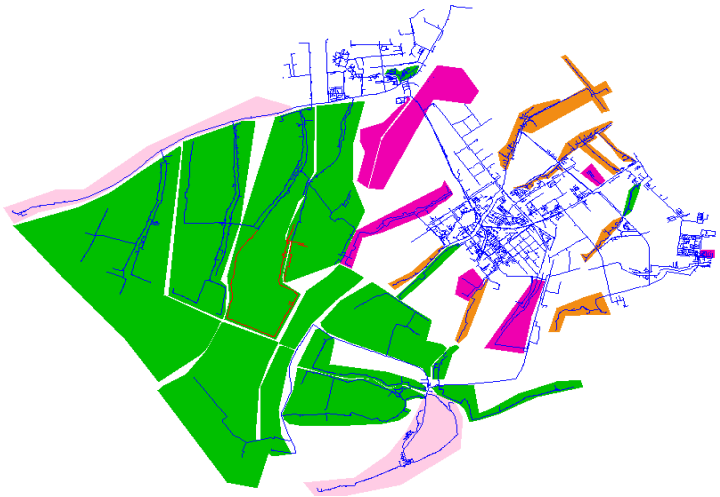


Figure 8 - DMAs in Tanzhou in 2010

Meter information is collected in the GIS from the customer database. So Tanzhou Water uses the monthly meter reading data from CSD to manage their DMAs and to prioritize leak detection activities.

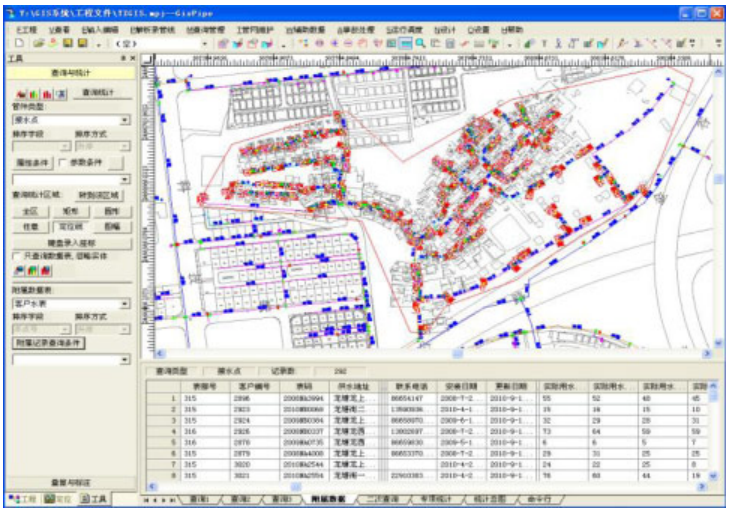


Figure 9 - DMA management in the GIS

Conclusion

From the experience in Tanzhou Water, it can be seen that technical improvement is an important part in reducing NRW; however it must be complemented at the right time with proper management to sustain and continue its improvement. Having a step-by-step approach is critical to its success. If the documents and policies were put in place at the very beginning of the establishment of the JV they might not have been as effective since the knowledge and trust in the new practices were not established among the local teams making it difficult for them to understand the purpose and the importance of procedures. They could even develop a sense of resistance against paperwork and the initiatives launched by the management. In other words, launching proper initiatives at the appropriate time according to the development and maturity of the local teams and management is of utmost importance.

Over 15 years, there had been five stages during which Tanzhou Water progressively enhanced their leak detection. This was done step-by-step, according to the maturity of the leak detection team. If noise loggers or even helium were introduced in the very beginning, they might not have developed the best practice of separating the network into DMAs and prioritizing leak detection activities.

The success of Tanzhou Water relied heavily on the motivation and determination of local staff. However, being in an international group such as Suez Environnement allowed them to accelerate this success due to the support from mother and sister companies and exposures to best practice and new technologies.

Now Tanzhou Water is not only a reference for other JVs within Sino French and subsidiaries in the Suez Environnement group, it is often visited by other water companies in China.