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Local solutions in Non-Revenue Water management through North–South Water Operator Partnerships: the case of Nakuru

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Abstract

Improving access to water (and sanitation) services in Kenya (estimated at 59 and 32%, respectively), is one of the country's commitments. However, although efforts to address the situation through a rigorous water sector reform have shown some improvements, challenges still persist. One key challenge is inadequate capacity of sector institutions to deliver on their mandates. In particular, high Non-Revenue Water (NRW) levels (averaging 45%) negatively affect financial viability of water utilities. Key stakeholders are currently collaborating to improve NRW levels. Through capacity development support, underlying issues have been addressed and service delivery improved. The case of Nakuru Water, Sewerage and Sanitation Company (NAWASSCO), where local and international partners are implementing an innovative NRW model has resulted in commendable gains, is described. The NRW pilot adopted an action research approach to implement the International Water Association methodology of reducing NRW to the local situation through a pilot (NAKA). Emerging best practices will be up-scaled to other areas within and beyond Nakuru. Geographic information system (GIS) and management information system (MIS) tools were developed to facilitate decision-making. The pilot resulted in marked reduction in NRW levels and increased revenue. It demonstrates that capacity, when properly developed and locally owned, can result in commendable development gains.

Keywords: Capacity development; Innovation; Non-Revenue Water; Up-scaling; Water Operator Partnerships

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List of acronyms

CCA	Customer Care Assistant
DMA	District Metering Area
EU	European Union
GIS	Geographic Information System
GPS	Global Positioning System
HR	Human Resources
ICT	Information and Communications Technology
IURS	Illegal Use Reduction Superintendent
IWA	International Water Association
JMP	Joint Monitoring Programme
KES	Kenya Shilling
KIWASCO	Kisumu Water and Sewerage Company
KPI	Key Performance Indicator
LDS	Leak Detection Superintendent
LVSWSB	Lake Victoria South Water Services Board
MDG	Millennium Development Goal
MIS	Management Information System
MR	Meter Reader
MWI	Ministry of Water and Irrigation
NAWASSCO	Nakuru Water and Sanitation Services Company
NRW	Non-Revenue Water
NWSS	National Water Services Strategy
O&M	Operation and Maintenance
OMS	O&M Superintendent
RVWSB	Rift Valley Water Services Board
SAR	Systematic Action Research
SMART	Specific, Measurable, Attainable, Relevant, Time-Bound
SMS	Short Message Service
SNV	Netherlands Development Organization
SPA	Service Provision Agreement
TM	Technical Manager
TMA	Territory Metering Area
TOT	Training of Trainers
VEI	Vitens Evides International
WASH	Water, Sanitation and Hygiene
WASPA	Water Services Providers Association
WSRB	Water Services Regulatory Board
WDE	Water Distribution Engineer
WSB	Water Services Board
WSP	Water Service Provider
WSTF	Water Services Trust Fund
ZM	Zonal Manager

1. Introduction

Improving access to safe and adequate water (and sanitation) services is one of the Millennium Development Goals (MDGs). In Kenya, access to water is also enshrined in the current Constitution of Kenya 2010 as a basic human right and is a key commitment of the government as contained in the country's development blueprint, Vision2030. Yet, access to water (and sanitation) remains low in most rural and urban areas. The WHO/UNICEF Joint Monitoring Programme (JMP) 2012 report estimates the country's access to water at 59% and for sanitation at 32% (WHO/UNICEF, 2012).

In spite of a conscious effort by the government to put in place measures to address improvements in water and sanitation service delivery through implementation of a rigorous water sector reform, a lot still needs to be done to achieve the desired levels of access. One of the key challenges beyond infrastructure development and the related issues is inadequate capacity of water sector institutions to undertake their mandates effectively and efficiently. It is clear that the solution does not only lie in funds for investment, but more so in developing the capacities of the institutions as well as individuals expected to propel this development agenda, and to put in their hands the 'tools' they need to take charge of the various initiatives in line with their institutional and individual mandates. In addition, the capacity development should go beyond this to create an enabling environment in which they are expected to operate.

Through the Non-Revenue Water (NRW) pilot described in this paper, the authors intend to show how such capacity development efforts of the mandated service provider have translated into remarkable results for residents of a small supply area in the Kenyan city of Nakuru, and how up-scaling the emerging model can improve not only the technical and financial performance of the service provider, but also translate into improved access to water for the residents.

1.1. Background

With a water availability of approximately 400 m^3 per capita per year, Kenya is ranked among the countries with significant water scarcity. One of the major reasons is Kenya's ever expanding population that is steadily growing at an annual rate of 2.5%. The 2010 census showed that Kenya is currently home to a total population of 38.6 million inhabitants, compared to 29 million in 2000.

Approximately 34% of Kenya's population lives in the cities. Most of the cities are growing rapidly and at rates that exceed Kenya's natural population growth. Rural–urban migration is high, leading to a strong growth of the informal settlements in and around the larger towns and cities. The UN Population Division expects an urbanization rate of 42% for Kenya in 2015. Urban growth poses large challenges for local authorities and Water Services Providers (WSPs) to service the city population with appropriate water and sanitation services.

The Water Act of 2002 heralded far-reaching institutional reforms in the Kenyan water sector. The heart of these reforms was the distinction of roles for water resources management and water (and sanitation) services provision; while providing an institutional framework that separates policy formulation, regulation and service provision in each of the two distinct areas. In terms of service provision, the reforms have decentralized functions to semi-autonomous institutions as illustrated in Figure 1. In this arrangement, the Ministry of Water and Irrigation (MWI) retains the residual role of policy formulation and sector oversight; the Water Services Regulatory Board (WSRB) is responsibility for regulation and performance monitoring; (8) Water Services Boards (WSBs) hold the mandate of providing water (and sanitation) services in their areas of jurisdiction through infrastructure development and asset management; and WSPs are contracted as agents of the WSBs to provide the services through Service Provision Agreements (SPAs) that spell out the requirements of their role. The WSPs are therefore responsible for the daily operation and maintenance of water production and distribution, waste water collection and treatment, billing and collection, and (ultimately) good service to consumers.

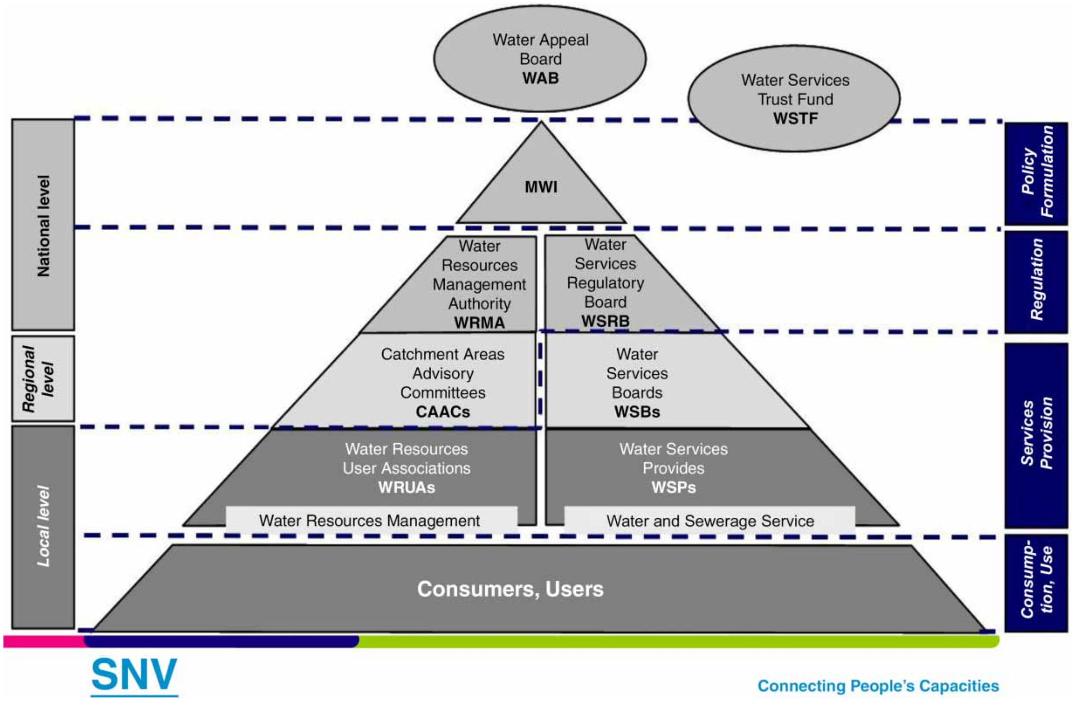


Fig. 1. The water sector institutional framework in Kenya. *Source: The National Water Services Strategy 2007–2015* (Ministry of Water and Irrigation, 2007).

Although a lot of gains have been achieved through the water sector reforms, sustainable access to safe water and basic sanitation remains elusive to many Kenyans. The main reasons for the dismal performance include old infrastructure, inadequate management and maintenance of existing infrastructure, insufficient sustainability measures, inadequate investments and inadequate focus on the options of fast tracking access and informal service provision within a framework of basic standards and regulation.

The latest report of Kenya's water sector regulator (WSRB, 2012) shows that the overall performance of Kenyan WSPs does not yet comply with standards. Especially water and sanitation coverage and NRW are still far below the targets set by the MWI and progress is slow. The access to water and sanitation services in Kenyan towns was 52 and 69% in 2010 and 2011, respectively, while the NRW percentage was 45%. The involved stakeholders, including the majority of the WSPs united in WASPA (the Water Services Providers Association), WSRB and the MWI are currently increasing their efforts to make a leap in performance improvement.

1.2. The NRW reduction pilot project

The NRW reduction project being undertaken by Nakuru Water and Sanitation Services Company (NAWASSCO) is part of a 4-year EU-funded partnership programme aimed at strengthening the capacity of a total of 19 WSPs under Rift Valley Water Services Board (RVWSB) and Lake Victoria South Water Services Board (LVSWSB) in sustainable development, operation and maintenance of water and sanitation infrastructure. The overall objective of the project is to strengthen the capacity of NAWASSCO (under RVWSB) and Kisumu Water and Sewerage Company (KIWASCO, under LVSWSB) in sustainable development and operation and maintenance (O&M) of water and sanitation infrastructure through a partnership between Dutch and Kenyan (North–South) partners and Kenyan peers (South–South). The specific objectives of the project are to:

(i) Increase access to water supply and sanitation services by the urban poor in Nakuru and Kisumu.
(ii) Strengthen the capacity of NAWASSCO (Nakuru) and KIWASCO (Kisumu) in sustainable development, operation and maintenance of water and sanitation infrastructure.
(iii) Scale-up best practices in NRW reduction to 17 'peer' WSPs through the Rift Valley and Lake Victoria South WSBs.

The emerging NRW model and the gains achieved from implementation of the pilot phase by NAWASSCO in Nakuru, Kenya, are the subject of this paper. An up-scaling strategy is included in the discussion.

1.3. The project partners

The implementation is done through a Water Operator Partnership (WOP) between Dutch and Kenyan (North–South) partners and Kenyan peers (South–South). It brings together Vitens Evides International (VEI) as the lead agency, working closely with Hoogheemraadschap de Stichtse Rijnlanden (HDSR), SNV Netherlands Development Organization and Sustainable Aid in Africa (SANA) International as supporting partners. VEI (Dutch) is spearheading capacity development activities with SNV and SANA (Kenyan) localizing, co-facilitating and documenting the learning process. The RVWSB as the contracting organization and WSRB as the regulator are Associate partners.

1.3.1. Rift Valley Water Services Board (RVWSB). RVWSB is one of eight Water Services Boards (WSBs) in Kenya, formed under the provision of the Water Act 2002. The Board was established in March, 2004 with a mandate of ensuring cost-effective and sustainable provision of water and sanitation services in its area of jurisdiction as per the Water Act. RVWSB is the asset holder and also the licensee of all the eleven WSPs in its area of jurisdiction. In this project, RVWSB will support NAWASSCO to prepare funding proposals to the Water Services Trust Fund, provide funding for specified equipment and participate in the up-scaling phase of the NRW action.

1.3.2. Nakuru Water and Sanitation Services Company (NAWASSCO). NAWASSCO is one of eleven WSPs under the jurisdiction of RVWSB, one of the eight WSBs in the country. NAWASSCO has been in operation since 2003, when it took over the role of water and sanitation services provision from Nakuru Municipal Council. Currently, it serves an area of 160 km^2 with an estimated population of 472,000 people. Water coverage is about 91%, which is commendable, but with a NRW level of 47%. This has kept revenues below optimum, resulting in an O&M cost recovery of 127% against WSRB's 150% benchmark for 'sustainability'. This underscores the relevance of the NRW reduction/management activities under the Water Operators Partnership, whereby NAWASSCO is expected to reduce water losses (both technical and commercial) and translate the savings into extra revenues. In this project, NAWASSCO is the beneficiary.

1.3.3. Vitens Evides International (VEI). VEI is a joint initiative between the two largest water companies of the Netherlands, that is Vitens and Evides. Together with Waterleiding Maatschappij Limburg, they serve some 8.9 million customers, that is 55% of the Netherlands' population. Through VEI, the three water companies realize their corporate social responsibility objectives, that is contributing to capacity development of water companies in Africa and Asia and to the MDGs on water and sanitation. Dutch water companies are internationally renowned for their knowledge and expertise in the areas of, among others, water technology, operational excellence and the installation of water pipe networks. With this experience, they are able to help countries for which a safe and reliable supply of drinking water and good sanitation is a priority. Over the last few years, VEI has supported reliable water services to more than 35 million drinking water customers in more than 15 towns spread over 16 countries in the world. To support capacity development in water companies in developing and transitioning countries, VEI deploys its Dutch experts, through WOPs, to improve water services delivery to their customers. It is through such a WOP that VEI is providing capacity building support to NAWASSCO to realize the objectives of the project.

1.3.4. SNV Netherlands Development Organization. SNV Netherlands Development Organization is a non-profit, Netherlands-based international development organization that delivers capacity development advisory services to over 2,000 clients in (until recently) 35 countries in Africa, Asia, Latin America and the Balkans.[1] SNV is dedicated to a society where all people, irrespective of race, class or gender, enjoy the freedom to pursue their own sustainable development. SNV's mission is to catalyse sustainable development processes. SNV specializes in supporting the resourcefulness of development actors by developing local capacities, improving performance and services, strengthening governance systems, helping create access for excluded groups and making markets work for the poor. This is achieved by focusing on four essential factors for lasting, sustainable development, that is inclusive development, systemic change, local ownership and contextualized solutions. In this project, SNV will provide capacity development support through three mutually reinforcing roles of advisory services, knowledge networking, evidence-based advocacy and up-scaling of the emerging practice models for example NRW.

1.3.5. Sustainable Aid in Africa (SANA) International. SANA is a Kenyan non-governmental organization (NGO) registered in October 2000. Previously, SANA was involved in the Rural Domestic Water Supply and Sanitation Programme (RDWSSP), a bilateral programme between the Government of Kenya (GoK) and the Government of the Netherlands (GoN), which ran between 1983 and 2001. Their aim is to encourage water and sanitation development in Nyanza region, although they are now expanding to other regions. SANA's current Strategic Plan aims to implement 1,000 water points and 10,000 sand units. Efforts towards positioning SANA within the water and sanitation sector have attracted considerable attention from partner stakeholders, including the local community other institutions. SANA's role in this project is to support establishment of Pro-poor Focal Persons in NAWASSCO (and KIWASCO) and development of pro-poor strategies and action plans for the under-served peri-urban communities.

[1] Latin America and the Balkans have since been weaned off and diversified their support to include other development partners.

1.3.6. Hoogheemraadschap de Stichtse Rijnlanden (HDSR). HDSR is one of the 25 Regional Water Authorities in the Netherlands that are responsible for local and regional water management. The water authorities are decentralized public authorities with defined legal responsibilities and a self-supporting financial system. HDSR is responsible for surface water management and treatment of wastewater for 750,000 inhabitants within its area of jurisdiction. Within the project, HDSR provides staff experience in operating and managing (waste) water treatment facilities and support improved asset management practices.

1.4. The role of capacity development

As quoted by the 5th Delft Symposium's Background Document, capacity in the context of the water sector is defined as 'the capability of individual, institution or society to identify and understand its development issues, act to address these, and learn from experience and accumulate knowledge for the future'.[2]

In the case of NAWASSCO, capacity development has been a key component of the NRW pilot and the project as a whole. It started during the proposal development phase and continued throughout the pilot and the whole project period. It was very much in line with the conceptual framework outlined in UNESCO-IHE's 5th Delft Symposium's Background Paper (UNESCO-IHE, 2013) as captured in Figure 2. The framework proffers that knowledge and capacity should happen at three levels, namely:

- Enabling environment
- Organizational
- Individual.

2. Approach and methodology

NAWASSCO's NRW pilot was successfully implemented in a District Metering Area (DMA) commonly referred to as NAKA in the Southern supply zone, with the support of partners.

The approach adopted in the pilot is Systematic Action Research (SAR), which is a Plan-Do-Check-Act process that ensures continuous learning and improvement of the emerging model, based on the local situation. It involves implementation of certain activities as part of a dynamic research process, while monitoring and evaluating the effects of the implemented actions with the aim of improving practice, then going back to the drawing board and applying the learning in a cyclic iterative process, as indicated in Appendix 1 (available online at http://www.iwaponline.com/wp/015/017.pdf).

The methodology adopted in the pilot is the International Water Association (IWA) Water Balance Methodology for Calculating Non-Revenue Water (NRW) (Lambert, 2003, Figure 1 on page 4).

[2] UNDP (2010).

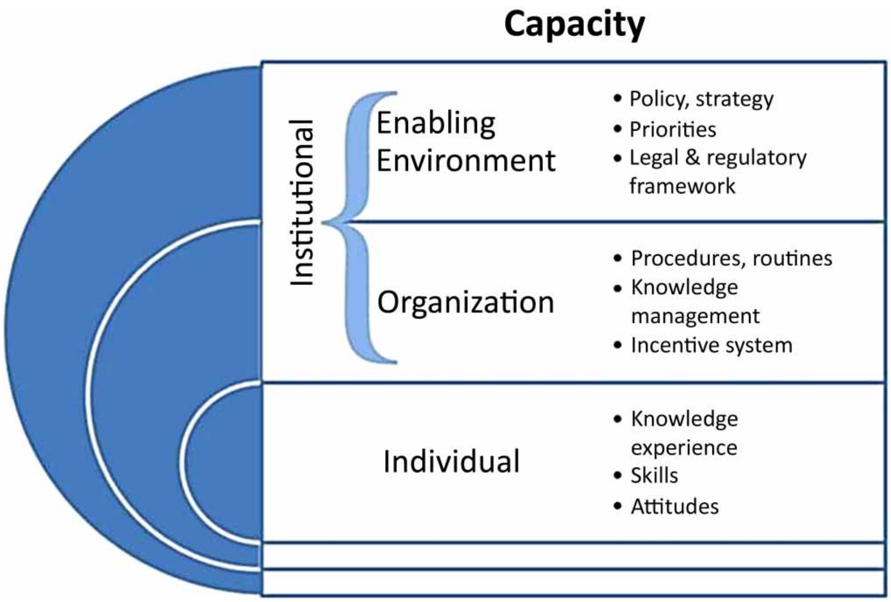


Fig. 2. Different conceptual levels of capacity. *Source:* UNESCO-IHE 5th Delft Symposium Background Paper.

Guided by the stipulated steps in the methodology, the NAWASSCO team undertook a number of steps based on the iterative learning and local context, as described in detail in Section 2.1.

2.1. Translating theory into practice: implementing the NRW reduction pilot

The sequence of steps included the following.

2.1.1. Awareness raising on the EU-funded project and the NRW pilot. This involved a series of inception meetings and workshops followed by planning sessions with RVWSB and NAWASSCO key staff.

2.1.2. Setting up the NRW team at NAWASSCO. Once the decision was made and plans for implementing the NRW reduction pilot were in place, the next step was to set up a dedicated team and assign them responsibilities. The team was drawn from both the technical and commercial departments of NAWASSCO (two of the four departments under the office of the Managing Director – others are Finance and HR/Admin departments). This was based on the understanding that NRW is a company-wide responsibility in which each member of the organization has a role to play. Hence, the NRW team was in constant contact with the staff of other departments, for example Procurement Department whose staff are responsible for ensuring that all materials and equipment arrive expediently and are of the correct quality; Information and Communications Technology (ICT) Department whose staff worked closely with the NRW to map the assets using geographic information system (GIS).

The NRW team comprised of the following members.

Name:	Designation:	Role:	
1.	James Ng'anga	Technical Manager	Team Leader/Oversight role
2.	Anthony Chege	Distribution Manager	Coordination
3.	Leonard Mutai	Illegal Use Unit Superintendent/NRW-in-charge	Supervision, coordination of activities and preparation of reports
4.	Gilbert Mutai	Leak Detection Superintendent	Coordinating search for leaks and reporting to O&M staff for immediate repair
5.	Timothy Wanjohi	Zonal Manager, Southern zone	Addressing billing issues and handling customer complaints
6.	Sammy Karanja	Foreman, Illegal Use Unit	Working hand in hand with Illegal Use Unit Superintendent
7.	Peter Koimbutho	O&M Foreman, Southern zone	Supervise the isolation of the DMA and repair of leaks
8.	Various	Artisans/Meter readers (MRs)	Repair of leaks, Installation of meters, meter testing, Inspection of premises to check water anomalies, fixing of new connections and meter readings

2.1.3. Staff training on the theory of systemic action research and the IWA water balance model. This was done by VEI and SNV staff in training sessions/workshops and demonstrated to staff in the field.

2.1.4. Selection of the pilot zone/DMA. Out of 40 DMAs in the NAWASSCO service area, a pilot DMA was selected using specific criteria, including ability to isolate the area in a short time period by installing (few) district meters and valves on incoming and outgoing lines; reliable supply of water supply (with adequate water pressure throughout); high consumer metering levels and high suspected NRW levels. The selected area is NAKA, an area with about 700 connections which lies in the Southern zone (see Map 1).

2.1.5. Isolation of the pilot area DMA. This started with identification of the main distribution lines; installation of two bulk meters and construction of lockable chambers; installation of (4 inch) inlet and (3 inch) outlet meters; metering of two small diameter (3/4 inch) pipes exiting the DMA to neighbouring Free Area, Manyani and Mama Ngina DMAs (identified as a result of night flow measurements and step-testing).

2.1.6. Measurement of total input-output-NRW volumes. The total water injected to NAKA was measured on a (bi-)monthly basis through district meter readings and compared with the total sales volume from consumer meter readings to establish the NRW levels and trends. To improve on the accuracy of measuring NRW levels, both the inlet and outlet (territory) meters were tested. It was found that both were outside manufacturers' specification for accuracy range: while the 4-inch inlet meter was over-registering by (+27%), the 3-inch outlet meter was also over-registering at (+13%). Based on the verification exercise it was recommended to factor the deviation when calculating NRW figures.

2.1.7. Leak detection and repair. Since the NAKA network is not rationalized, it was necessary to concentrate on leak detection by constant patrolling of streets to locate visible leaks. All identified leaks were repaired immediately.

2.1.8. In-field assessment of service connections. A total of 684 connections were identified in the NAKA pilot DMA. All of them were assessed and the following irregularities identified: two illegal connections; five meter by-passes; four through connections; two meter tampering cases; and seventy-nine gate-locked cases. In addition to resolving the issues during follow-up visits, a penalty of Kenya Shillings (KES) 15,000 was levied on the illegal connectors.

2.1.9. Customer meter testing, servicing and sealing. Service meters were tested for accuracy on site at the customers' premises. The purpose of this exercise was to compare the accuracy of the meter being tested with a calibrated meter tester. In the absence of specialized equipment, the team used a calibrated bucket and timer (see Figure 3). Of all the 684 meters tested, 16 were found to be faulty; 60 were under-registering; and two were over-registering. The under-registering and over-registering meters were replaced; faulty meters were serviced as necessary. The main problem was identified as turbidity of water entering the system after repair works of the main supply pipes from Gilgil (a neighbouring town) was done, hence the need to install washout valves that allow technicians to flush the distribution lines following repairs. All customer meters were later sealed with a unique tool both at the liners and the meter itself as a way of reducing/deterring meter tampering.

Another issue of concern was the quality of meters in use, which is fundamental since sub-standard meters impact negatively on billing and eventually revenue. In determining accuracy, the team established that there were three types of meters in NAKA, namely Dunwell, Kent and Younso (respectively as in Figure 4).

According to the various tests carried out, the Kent meter's accuracy is more precise and has longer lasting performance, while the Younso type performs better than the Dunwell but the lifespan performance of both is shorter.

Fig. 3. NAWASSCO staff testing customer meters.

Fig. 4. Dunwell, Kent and Younso meters in use in NAKA.

At the end of the exercise, the following recommendations were made on customer meter provisions:

(i) Random tests to determine meter accuracy should be done once a year in every DMA.
(ii) Sealing of meters immediately they are installed.
(iii) Carrying out inspection once in a while to check meter by-passes.
(iv) Ensuring all test results and servicing reports are properly kept and recorded for future purposes.
(v) Calibration of meters should be done regularly to provide valuable information on the accuracy of the quantity of water being supplied, leading to appropriate decisions on maintenance or replacement frequency. Meters with results beyond accuracy limits should not remain in service unless repaired/replaced.

2.1.10. Testing of production and territory meters. For correct measurement of NRW levels, all production and district meters in the pilot area were tested with ultrasonic ‘clamp-on’ flow meters to establish the variance used in the complete network and pilot area water balance calculations. Each meter was tested three or four consecutive times for 5 minutes at a go (total duration 15–20 minutes) whereby the average (in red) was calculated. The results showed that only two out of 14 production meters were within limits of accuracy, 10 were over-registering and two were under-registering; and out of the three territory meters (distribution lines) two were over-registering while one was under-registering (Appendix 3; available online at http://www.iwaponline.com/wp/015/017.pdf).

It was decided to repeat the exercise after 3 months to validate the calculated variance, during which the testing duration would be increased to 4 hours (up from 15–20 minutes). This generates a more reliable average variance.

Applying the variances to the monthly production figures decreased the total water being pumped into the system by 3.5–4.5%, thus reducing the calculated monthly NRW figures by a similar figure. This led the NRW team to also test the two installed zonal ‘master’ meters on the incoming and (main) outgoing lines in the NAKA pilot area. The test results revealed a significant variance between the mechanical and ultrasonic flow meters (see data in Table 1) despite the fact that the meters are only a few months old. Once the variance was applied to the water balance calculations, the NRW levels dropped significantly.

Table 1. Test results.

Station	Meter Size (inches)	Time Intervals (minutes)	Percentage Variance	Meter Status
Railway (incoming)	4	5	Master meter = 4.075 Flow meter = 3.202 (0.873/3.202)*100 = +27.27%	Over-registering
Dog section (outgoing)	3	5	Master meter = 0.6275 Flow meter = 0.556 (0.0715/0.556)*100 = +12.86%	Over-registering

The significance of the variances underscores the need to repeat these calibrations on a regular basis to validate earlier figures and identify possible causes. As an example, NAWASSCO has decided to install strainers before all master meters to prevent them from clogging up with fine silt. To address the problems at the root, VEI is supporting the production team in improving the effectiveness of the treatment process by remove fine silt. Support to the water distribution team will increasingly focus on improving the quality of repairs to prevent dirt from entering the system.

2.1.11. Subdivision of the assessed connections into sub-zones A, B, C. Sub-zones were established along the main distribution lines in preparation for night flow and step-testing measurements to quantify and locate invisible leaks.

2.1.12. Minimum night flow measurements to quantify (in)visible leakages. Minimum night flow measurements were carried out for 3 consecutive nights between 1 a.m. and 4 a.m. at night (Figure 5)

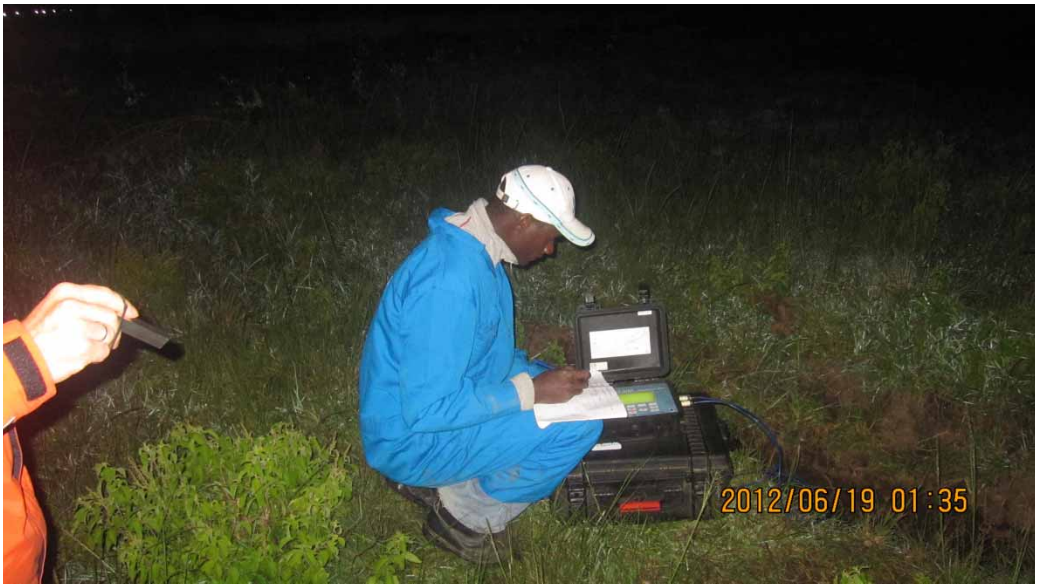


Fig. 5. NAWASSCO staff taking minimum night flow measurements at NAKA.

to determine water losses which may translate into invisible leaks. They were accompanied by VEI staff and NAWASSCO's Technical Manager who showed a lot of commitment to the whole process.

The initial findings that day time measurements (43.8 m^3/h) were more or less the same as night flow measurements (42 m^3/h) called for step-testing measurements to assess how this flow is spread across the entire pilot area, that is the three sub-zones. The results confirmed that the night flow measurement were more or less the same as those for daytime. This indicated that most of the NAKA residents have huge tanks which are continuously filled at night, which was later confirmed. The calculated flow rate diagram is shown in Figure 6.

2.1.13. Step-testing to locate (in)visible leaks. Step-testing was done with the ultrasonic flow meters to locate (in)visible leaks in the three sub-zones. The results revealed that the losses were spread across the three zones, that is the spaghetti network and service connections. Two significant leaks were identified along the 4-inch main and repaired immediately. Several small diameter pipes were also repaired. The presence of the spaghetti network calls for further network rationalization. In addition, it was on the basis of step-testing that it was discovered that three small diameter pipes were supplying water to neighbouring DMAs to NAKA.

2.1.14. Gate-locked premises. Sixty-five gate-locked customers who were previously billed on an average consumption were followed up and actual meter readings done. This contributed to a reduction in NRW levels. To capture accurate consumption and improved billing, gate-locked cases were minimized through the following process:

(i) Getting the cell phone number of every customer to facilitate access to meter readings by Short Message Service (SMS) and counter checking on subsequent visits.
(ii) Re-visiting unread meters the following day.

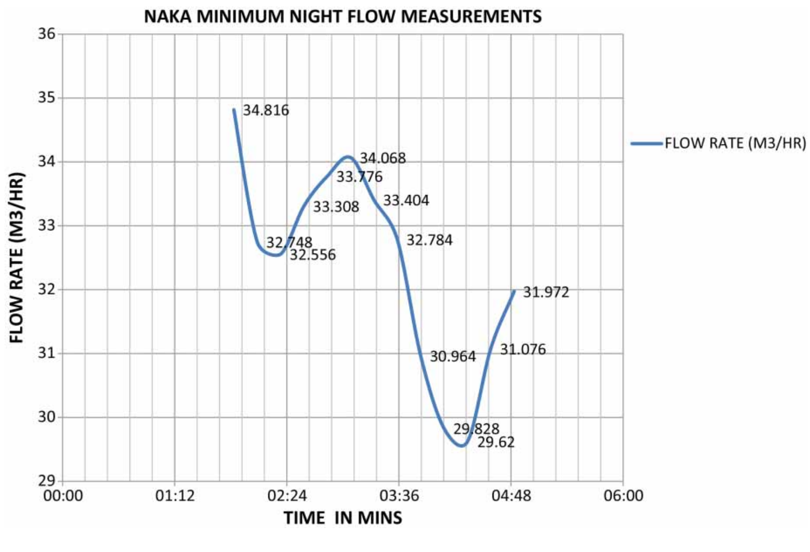


Fig. 6. Minimum night flow measurement results, NAKA.

(iii) Sticking to a definite meter reading cycle to ensure residents avail themselves during this period.
(iv) Indicating customer accounts immediately at the entrance point to facilitate proper and easier tracing of meters.

2.1.15. Applying the SAR approach in follow-up activities. As a result of applying the SAR approach to address emerging issues, much progress has been achieved in the NAKA pilot within a very short time, for example follow-up and reading meters in gate-locked cases (leading to a reduction from 79 to 15); servicing of under-registering meters (15 down from 60); replacement of 16 faulty plus sixty under-registering meters; regularization of illegal connections; continuous repairs of leaks and bursts; etc. This has resulted not only in NRW reduction, but in increased revenues for NAWASSCO.

A summary of progress in dealing with the identified commercial issues is given in Figure 7.

2.2. Supporting the SAR approach in the NRW reduction pilot: development of GIS and management information system (MIS) systems for asset management

While the NRW pilot was successful in its achievement (sustained low NRW levels), it forms an integral part of a holistic asset management strategy with a GIS and MIS as key components. To support the NRW pilot, VEI brought on board short-term Technical Advisors to provide capacity development support the NAWASSCO team in preparing the necessary GIS and MIS tools to provide NAWASSCO's management with necessary information for decision-making. This bottom-up approach has contributed to an improved understanding of how a GIS can be used in daily asset management practices and future asset development activities[3]. Examples include the utilization of the GIS in the following:

- Delineating new DMAs with mapped distribution lines prior to (hydraulic) isolation.
- Identifying potential illegal connections by projecting meter locations on Google satellite imagery and pinpoint plots without a service connection.

NRW - Commercial	**Initially Discovered**		**Pending**	
	Connections	**% 684 connections**	**Connections**	**% 684 connections**
Faulty meters	16	2.3%	0	0.0%
Through connections	4	0.6%	8	1.2%
Gate locked cases	79	11.5%	15	2.2%
Illegal connections	2	0.3%	0	0.0%
By-passes	5	0.7%	0	0.0%
Under registering	60	8.8%	15	2.2%
Combined	**166**	**24.3%**	**38**	**5.6%**

Fig. 7. Summary of identified commercial issues in the NAKA pilot.

[3] A responsibility that currently lies with the (Rift Valley) Water Services Boards though this is likely to change in the foreseeable future under the new Constitutional dispensation in Kenya.

- Mapping out new meter reading routes within these DMAs to optimize the meter reading effectiveness and efficiency.
- Mapping the location of reported leakages to assess and prioritize network rehabilitation needs.

Although the mapping initially started with the NAKA pilot, the plan was to extend the same to the other areas within NAWASSCO's service area. The GIS system was developed using available maps from Nakuru Municipal Council and updating them with relevant data for the NAKA pilot area and on to NAWASSCO's overall service area. The commitment of the management team and department/section staff is reflected, among others, in the adoption of innovative asset management 'tools', including the GIS. The cordial relationship with the Nakuru Municipal Council enabled NAWASSCO to acquire a wealth of existing GIS data, some of which is currently published online (see http://nakinfo.unibe.ch).

Under the able leadership of the Technical Manager, the ICT Manager and his team have worked hand in hand with the department/section heads to spearhead the collection, validation and utilization of supplementary data for NAWASSCO's main assets (see Map 1) including:

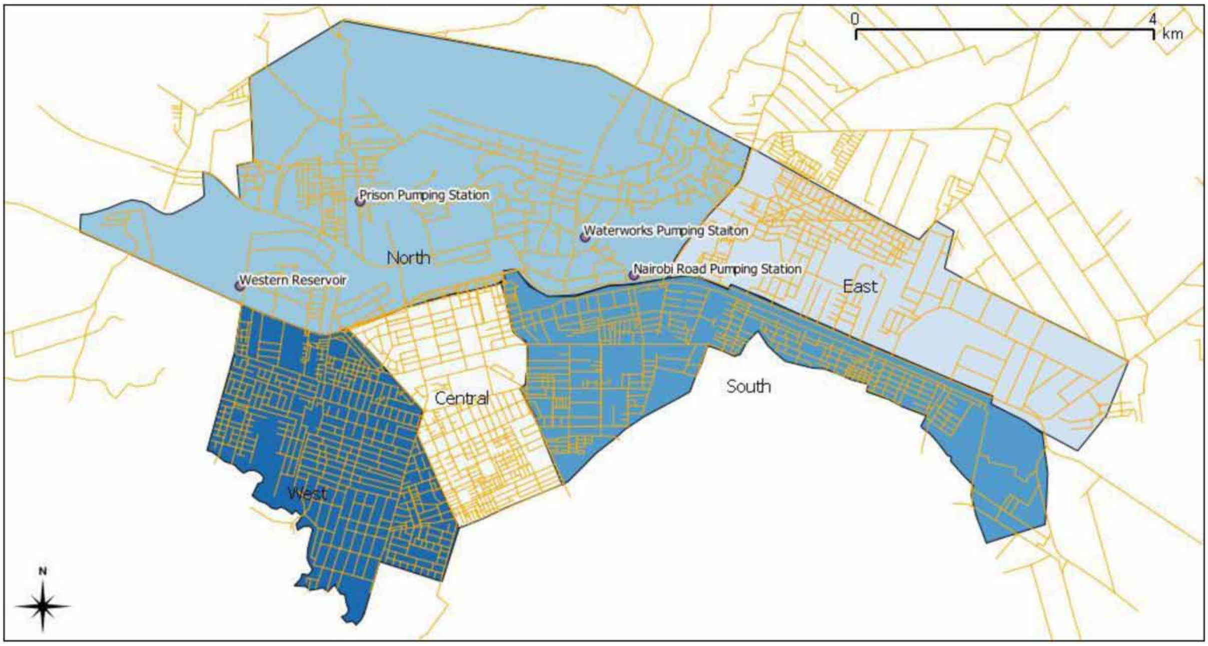
- Water supply zones.
- Well fields, individual boreholes and production plants.
- Water transmission lines and storage tanks.
- Water distribution lines.
- Sewer lines.
- Waste water treatment facilities.
- Low income areas (obtained from the Water Services Trust Fund).

Within the context of the NRW pilot in NAKA,[4] supplementary data were collected with procured global positioning system (GPS) devices to trigger interest and understanding of GIS utilization in improving asset management (O&M) and development practices.

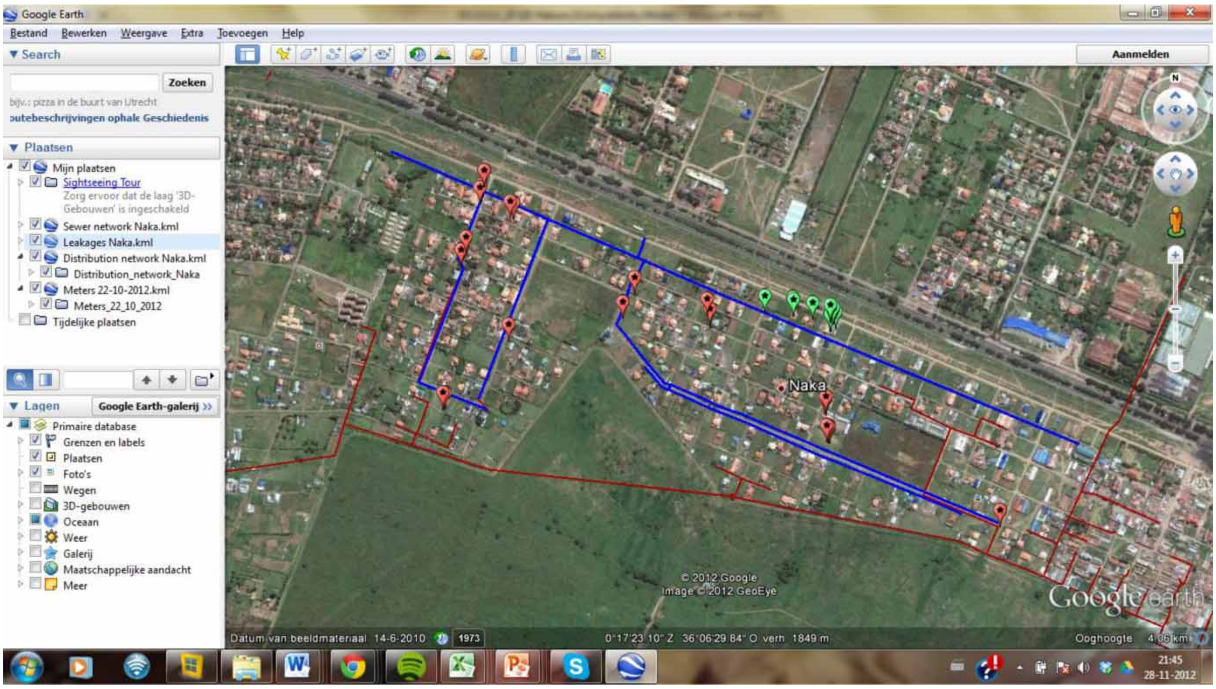
Locations of ± 500 consumer meters (see green markers in the Google Earth projection of a 1-day sample, Map 2), for example, will enable the zonal managers to optimize the meter reading routes and visualize the location of faulty meters, defaulting or disconnected clients, etc. Locations of reported leakages (see red markers in the Google Earth projection, Map 2), on the other hand, allow the water distribution team to assess the status of the distribution network as supplementary attribute data (for example material, diameter, year of construction, leakage history) is collected over time. (A full colour version of Map 2 is available online at http://www.iwaponline.com/wp/toc.htm.)

Hand in hand with the GIS mapping, the MIS system consisted of a NRW MIS scorecard for facilitating/documentation of the action research approach. VEI experts introduced the tool, which is being utilized by VEI-supported utilities world-wide. Based on the Balanced Scorecard methodology, the tool allows the implementing teams to analyse and evaluate the impact of prioritized measures aimed at reducing NRW (based on customized performance indicators (PIs)) in the eight focus areas distinguished by the IWA (see Appendix 2, available online at http://www.iwaponline.com/wp/015/017.pdf). The first component of this Excel-based tool provides the user with a snapshot of monthly progress in one or more of the prioritized focus areas (see Figure 8 for an example on NRW).

[4] In which NRW levels have been reduced from $\pm 50\%$ to $\pm 20\%$ within a 6-month period.



Map. 1. NAWASSCO's asset map with zones.



Map. 2. Mapped leaks in NAKA pilot. A full colour version of this map is available online at http://www.iwaponline.com/wp/toc.htm.

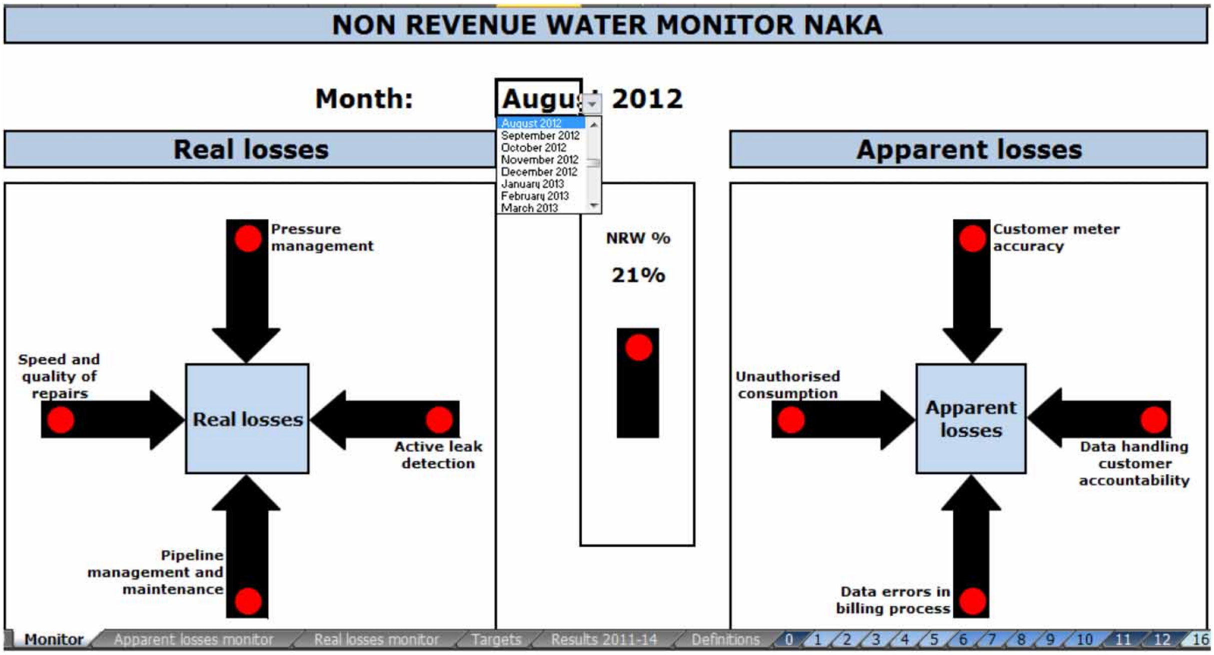


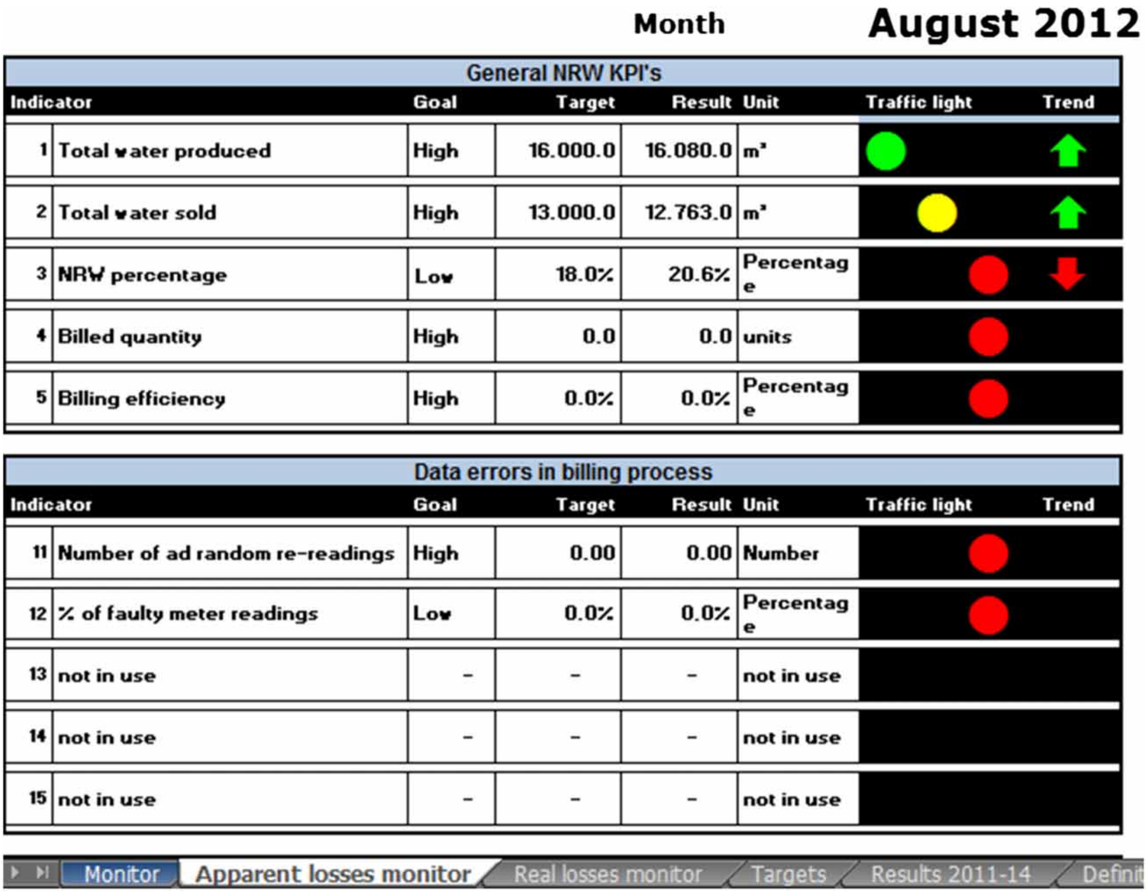
Fig. 8. The NRW monitor, NAKA.

The second component enables the user to zoom in on a set of prioritized general and specific key performance indicators (KPIs) for the prioritized performance areas. If the traffic light is red, the current result is less than the target (when goal is set as 'high' or above the set target when the goal is set as 'low'). If it is yellow, the current result is within the indicated deviation (on the definitions page) of the target. If it is green, the current result is above the set target (when goal is set as 'high' or below the set target when the goal is set as 'low'). A green arrow upwards or red arrow downwards depicts a positive or negative trend (respectively) since the last month (see Figure 9; a full colour version of this figure is available online at http://www.iwaponline.com/wp/toc.htm).

The last component allows the user to zoom in on the KPI trends for the entire year. This page allows the user to re-prioritize NRW reduction measures to achieve the desired progress (for specific KPIs) in the prioritized focus areas (see Figure 10). The tool can be used within a (pilot) DMA setting or for the network as a whole.

While the utilization of the tool has not yet taken root, the systemic action research 'thinking' has. Without a doubt, the need to monitor progress within the fast growing number of Territory Metering Areas (TMAs),[5] however, will require these or related data/information management and decision-support tools to be introduced or institutionalized. The same applies to the 'consumption monitoring' tool that was conceptualized on the basis of emerging demands of utility staff. This tool allows the caretaker(s) to identify clients that are consuming (significantly) more or less water than the moving 3-month average – hereby

[5] First readings for 36 TMAs planned in the first week of April following the zero-reading in March – the basis for the first water balance (NRW) calculations.



Month August 2012

General NRW KPI's							
	Indicator	Goal	Target	Result	Unit	Traffic light	Trend
1	Total water produced	High	16.000.0	16.080.0	m³		
2	Total water sold	High	13.000.0	12.763.0	m³		
3	NRW percentage	Low	18.0%	20.6%	Percentage		
4	Billed quantity	High	0.0	0.0	units		
5	Billing efficiency	High	0.0%	0.0%	Percentage		

Data errors in billing process							
	Indicator	Goal	Target	Result	Unit	Traffic light	Trend
11	Number of ad random re-readings	High	0.00	0.00	Number		
12	% of faulty meter readings	Low	0.0%	0.0%	Percentage		
13	not in use	-	-	-	not in use		
14	not in use	-	-	-	not in use		
15	not in use	-	-	-	not in use		

Monitor / Apparent losses monitor / Real losses monitor / Targets / Results 2011-14 / Definit

Fig. 9. The NRW monitor on selected KPIs, NAKA. A full colour version of this figure is available online at http://www.iwaponline.com/wp/toc.htm.

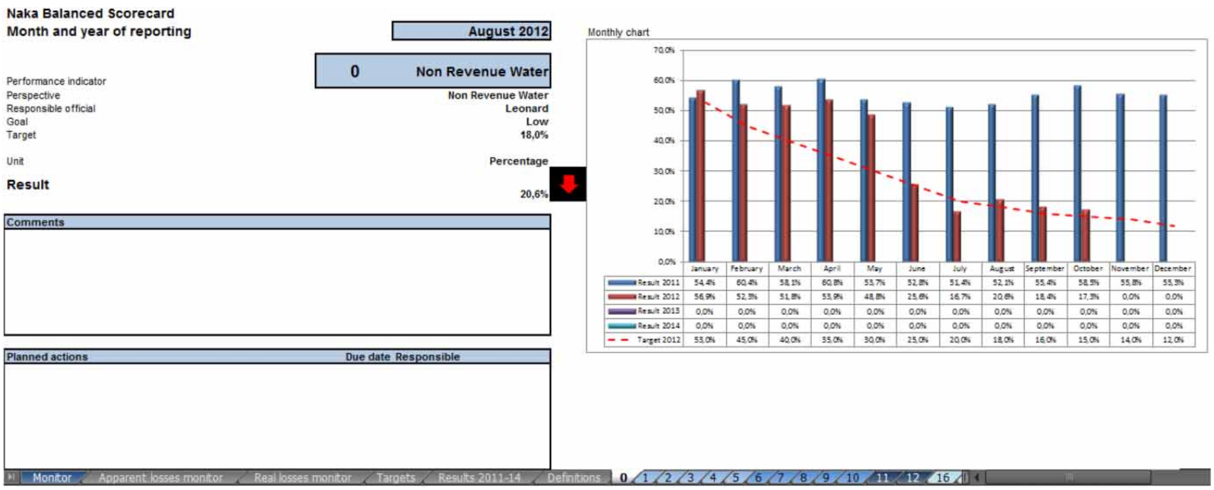


Fig. 10. The NRW monitor showing trends on selected KPIs, NAKA.

pinpointing and minimizing (potential) commercial losses. This approach has been adopted – in very different contexts – by Evides (in the Netherlands) and WSPs in Nyeri and Meru (Kenya).

2.3. Embedding the action in the organization: adoption of the caretaker approach

Experience in supporting water utilities to reduce NRW levels world-wide has led VEI to develop and promote a 'caretaker approach' in which a dedicated area manager, referred to as a Caretaker, is given the responsibility to lead a joint (commercial/technical team) effort to reduce and sustain NRW achievements within a designated DMA. This arrangement also ensures that the gains from the action are not lost, but are sustained by being part and parcel of the organization's regular activities.

With NAWASSCO planning to start scaling-up the piloted approach to other supply zones, VEI and SNV initiated support in embedding the caretaker approach in the organizational set-up. During a 1-day workshop (November 2012), participants agreed that the Zonal Manager would serve as Lead Caretaker for the respective (Southern, Central, Western, Northern and Eastern) supply zones. In this set-up, s/he delegates responsibilities to MRs who are the 'eyes and ears on the ground' in hydraulically isolated TMAs within the larger supply zones. There was general agreement that:

- The Zonal Manager, in consultation with the Water Distributions Engineer (WDE), will delineate the TMAs within the supply zones.
- The Zonal Manager will assign the TMAs to individual MRs who will be responsible for achieving progressive NRW targets in the CTAs, individually and collectively for the larger supply zone.
- O&M of the distribution system: the WDE will continue to coordinate this activity with his unit heads,[6] his foreman and team of 21 plumbers.
- O&M of service connections: the WDE will continue to coordinate this activity with his foreman and team of 21 plumbers. The plumbers will also be assigned to the TMAs so that they can increasingly liaise with the MR (assistant caretaker from the commercial side) and the Customer Care Assistant (CCA) in the zonal office to jointly serve TMA clients. This will enable the foreman to focus on supervising the works of his plumbers/assistant caretakers.
- Technical customer services: the foreman will liaise with the CCA and TMA plumbers in spearheading repairs under the auspices of the WDE.
- NRW reduction: responsibility of the TMA MRs (assistant caretaker 1) with foreman, LDS, IURS, OMS and TMA Ps (assistant caretaker 2), whereby the foreman and LDS (and OMS, once recruited) focus on reducing physical losses and the IURS liaises closely with the zonal manager (ZM) and the MRs in addressing commercial losses.
- Development of the distribution system: responsibility of the WDE as is currently the case in liaison with the OMS upon recruitment (see footnote).

In a nutshell, the ZM (lead caretaker) will prepare monthly water balance calculations for each TMA with cumulated daily TMA meter readings obtained from the WDE.[7] The two will sit together on a

[6] Leak Detection Superintendent (LDS), Illegal Use Reduction Superintendent (IURS), O&M Superintendent (OMS).

[7] Used as an early warning system for larger leaks and bursts or seasonal influences for example by monitoring $\pm 20\%$ deviation from the 3 month moving average on a *daily* basis.

monthly basis to prioritize the NRW reduction activities and/or monitor trends of specific PIs pertaining to commercial (to be collected by the ZM and his/her team members) and/or physical (to be collected by the WDE and his team members) losses. The ZM and WDE will supervise and coach their respective assistant caretakers in achieving set NRW targets (see Figures 11 and 12).

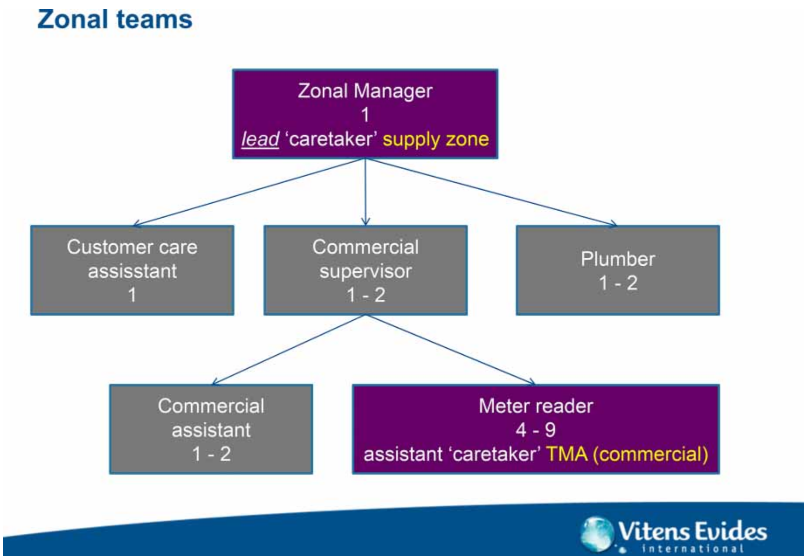


Fig. 11. Zonal teams implementing the caretaker approach.

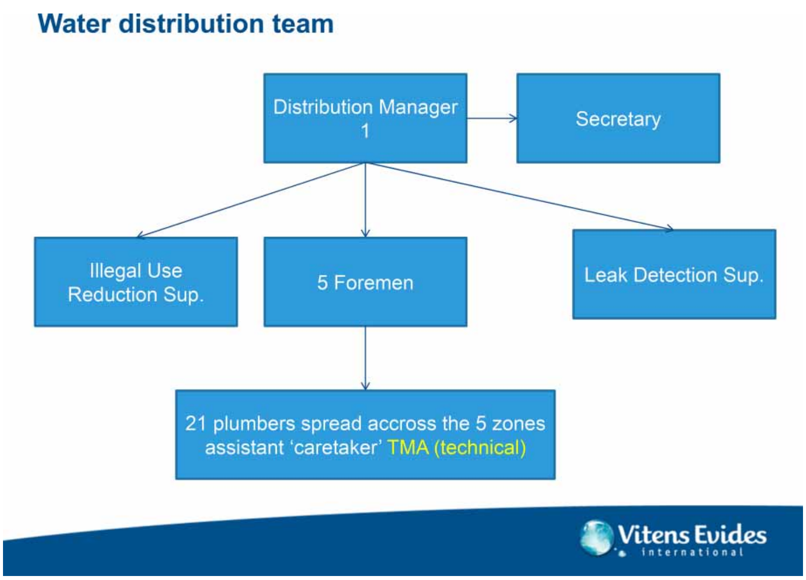


Fig. 12. Water distribution teams supporting the caretaker approach.

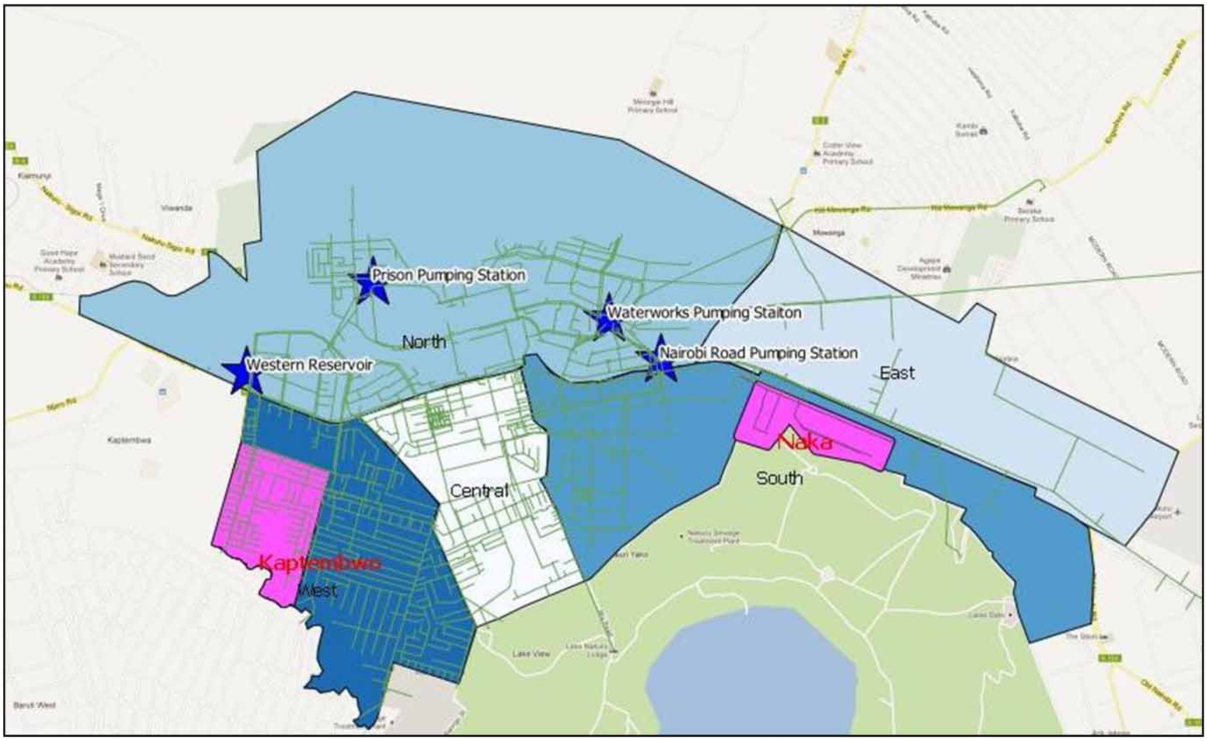
2.4. Replicating the NRW pilot to other DMAs under NAWASSCO

Following the completion of the NRW pilot, NAWASSCO has proactively developed plans to replicate the demonstrated NRW reduction measures within hydraulically isolated DMAs and TMAs in their other supply zones. Within the Western supply zone alone, a total of 50 meters have been installed in tamper-proof chambers to isolate 35 TMAs.

Map 3 depicts the five supply zones (in shades of blue), the NAKA pilot area (in purple) and a cluster of TMAs (also in purple) within NAWASSCO's supply zone (a full colour version of this map is available online at http://www.iwaponline.com/wp/toc.htm). Map 4 shows a DMA at the southern tip of the Western supply zone that contains two TMAs. With the strategic placement of master meters on the incoming line to the DMA and second TMA, NRW levels for the two TMAs can be established through monthly water balance calculations. Following the zero-readings for the 3,000 consumer and 50 master meters in the second week of March, baseline NRW values will be known by the second week of April.

2.5. Up-scaling the NRW pilot to other WSPs under RVWSB

As part of the up-scaling phase of the project, discussions with RVWSB are underway to implement the emerging NRW model in the other 10 WSPs under the jurisdiction of RVWSB. This up-scaling



Map. 3. Location of zones/DMAs in NAWASSCO service area. A full colour version of this map is available online at http://www.iwaponline.com/wp/toc.htm.

Map. 4. TMAs in the Western zone.

phase will adopt the proven steps implemented in the NAKA pilot which, subject to the specific context of a newly delineated DMA or TMA, should be implemented (mostly) in sequential order as follows:

- Develop a hardcopy sketch map (or, increasingly, where possible printouts of digital GIS maps) of the main distribution lines, valves, fire hydrants, service lines and meters, etc.
- Install 'master' meters on all incoming and outgoing lines to (hydraulically) isolate the area.
- Meter all unmetered consumers.
- Establish baseline NRW values through a zero and 2 week (later) meter reading – based on the IWA water balance methodology.
- Monitor the impact of all NRW reduction measures on a monthly basis and refine or re-prioritize them on the basis of what works (SMART KPI trends – see section on NRW MIS):

    - Physical losses 1: organize a swift response to reported or identified (patrolling) visible leakages, starting with large diameter pipes.
    - Commercial losses 1: test/service/replace all faulty or under-registering consumer meters (starting with large consumers) and validate the accuracy of installed master meters.
    - Physical losses 2: quantify and localize invisible leakages through 'minimum night flow' (with temporary or clamp-on flow meters) and 'step-testing' measurements.

- Commercial losses 2: estimate the remaining commercial losses (water theft) by subtracting the minimum night flow from the total NRW volume lost.
- Commercial losses 3: reduce water theft by formalizing illegal connections and inspecting consumer connections with 'zero-readings' and 'below average' consumption.[8]
- Physical losses 3: managing high pressures if they occur to reduce (in)visible leakages.
- Physical losses 4: identification and repair of invisible leakages through active leakage control (advanced leak detection equipment).
- Physical losses 5: improve workmanship and choice of materials to reduce/sustain NRW achievements.

- The emerging GIS and mapped locations including repaired leaks and bursts can be used to develop an asset rehabilitation plan. The anticipated costs and benefits will allow the utility to prioritize commercially-viable investments in the multi-yearly Strategic/Business/Capital Works Plans.
- The following roadmap remains useful in informing prioritization of short, medium and long-term measures by NAWASSCO and other WSPs, and sustaining the gains of the NRW pilot into the up-scaling phase:

  - Quantify NRW levels: 100% production $\Leftrightarrow$ 100% consumer metering (currently $\pm 85\%$) as a basis for utility-level water balance (NRW volume) calculations.
  - Verify NRW levels: testing/servicing/replacement of production and consumer meters to establish a (sufficiently) reliable baseline.
  - Locate NRW losses within the network through the establishment of DMAs.
  - Reduce NRW losses: (a) at water production facilities and (overflows at) storage tanks, (b) along transmission and distribution lines starting with a pilot DMA to gain experience in applying the 'full scale' of NRW reduction measures.
  - Scale-up demonstrated experiences to other DMAs based on prioritized needs (i.e. total volume lost in isolated DMAs) and 'value for money' considerations that is the size of the DMA, ease of splitting the DMA in TMAs, suspected quick wins, etc.
  - Sustain acceptably low NRW levels (20%).

3. Results of the action

3.1. Improved technical (NRW) and financial (revenue) performance of NAWASSCO

Through the NAKA pilot, the NAWASSCO team has achieved the following results:

1. There was great achievement in narrowing the gap between produced volume and billed volume, resulting in NRW figures dropping tremendously from 48.8% to below 15% within the period of the pilot.
2. In terms of billing there was great improvement, which has translated to increased revenue in the range of KES 550,000 every month. The slight drop in the month of December was attributed to lack of water supply

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[8] Validating the consistency between registered meters (identified through a meter inventory in the field) and billing system entries.

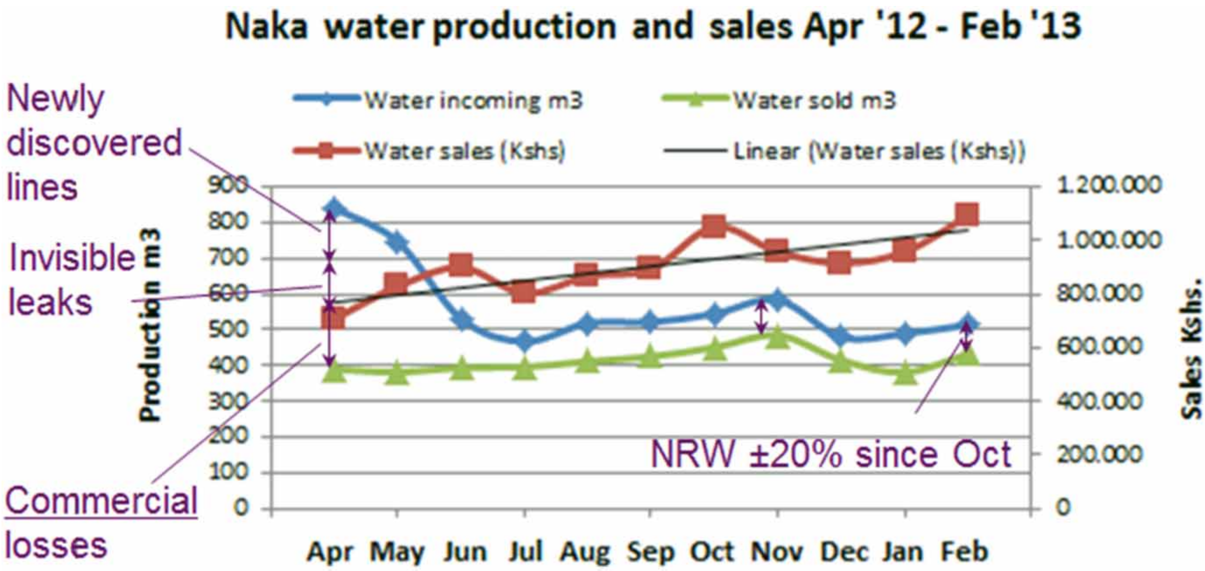

Fig. 13. NAKA water production and sales – April 2012 to February 2013.

to the area for 5 days. Thereafter, the upward trend continued. Considering the cost implication of about KES 350,000 (see calculation in Appendix 4, available online at http://www.iwaponline.com/wp/015/017.pdf), this is a worthwhile gain which will continue into the future.

The NAKA pilot has demonstrated how:

1. NRW volumes and percentages can be halved (from $\pm 50\%$ to $\pm 20\%$) within a 6 to 9 month time period without any investment in network rehabilitation;
2. this achievement led to a 100% increase in the sales value from KES 550,000 to KES 1.1 million.

The August and December 2012 figures further reveal (see Figure 13) that the sales volume has practically remained the same, while: (a) the incoming flow to the pilot area decreased by 8%, and (b) the sales amount increased by 6%. This implies that (a) water demand has decreased, making more water available to other consumers, while (b) actual consumption levels are better known[9] – in this case, higher, the basis for the increased sales value.

The graph in Figure 13 depicts the decreasing difference between the incoming (supply) and sales volume (= NRW) over time. While the metering (= inclusion in the water balance) of newly discovered

[9] As a result of tested/serviced/replaced (faulty and under-registering) meters and acquired access to meters on 'gate-locked' premises of consumers.

outgoing lines could initially account for part of the NRW volume, the figures under activity 4 and 5 (in the table on the previous page) underline the daunting reality that the achieved reduction (of almost 30%) is largely a result of addressed commercial losses – not requiring any substantial investment in network rehabilitation while simultaneously boosting sales.

3.2. Enhanced capacity of NAWASSCO (organization and staff)

NAWASSCO as an organization and its staff are completely in charge of the implementation of the pilot and replication of the demonstrated model to other zones within their supply area. This is a sign of developed capacity which will remain with them long after the end of the project period.

Evidence of this enhanced capacity, which greatly contributed to the success of the pilot and subsequent related activities for example replication in other zones, is clear from the following examples, among others.

(1) Personal initiative: visionary leadership and commitment of the coordinating 'Partnership Manager' (TM) to appreciate and mobilize the inherent capacity of middle level management staff and technicians in the field. His personal involvement in a series of night flow measurements with the NRW pilot team is a case in point.

(2) Organizational support to the process: open-mindedness of the Corporate Management Team (CMT) members, demonstrated by: a) (temporarily) giving the water distribution team an opportunity to assess and reduce the commercial losses of their responsible colleagues (zonal team under the Commercial Manager) – with success, and b) efforts to institutionalize the demonstrated 'caretaker approach' (see section 2.3) in the organizational set-up. The utilization of savings on previous investment programmes to establish DMAs within the Western supply zone is also indicative of the good corporate governance standards that the CMT adheres to.

(3) Enabling environment: the RVWSB successfully mobilized KES 20 million for district meters to: a) hydraulically isolate two other supply zones, and b) establish TMAs within these supply zones. The three (Western, Central and Southern) supply zones combined to more than half of the total service area, providing solid ground for the reduction of NRW levels at scale.

3.3. Lessons and best practices from the NAWASSCO NRW reduction pilot

Some of the best practice lessons emerging from the pilot include the following:

1. The technical and commercial departments worked in tandem to address emerging issues, leading to the greater success of the pilot.
2. Effective utilization of the (emerging) GIS helped the team in understanding the distribution network (e.g. mapping of consumer meter locations in spaghetti networks) and planning pilot interventions (e.g. night flow and step-testing measurements).
3. Supporting the SAR approach through development of the monitoring of KPIs (pertaining to commercial and physical losses) trends using the Excel-based NRW MIS/Balanced Scorecard 'Monitor' is invaluable in facilitating timely and informed decision-making.
4. Identification of commercial losses as 'low-hanging fruit' which, when scaled-up to other supply zones, will enable NAWASSCO to quantify network rehabilitation needs to address (remaining) physical losses.

5. The team work and knowledge sharing between local and international (North–South) partners has resulted in shared achievements, local ownership of the action and changing roles in terms of leadership and initiative.

4. Conclusion and discussion

It is clear from the foregoing sections that the greatest contributor to the success of NAWASSCO's NAKA pilot is the capacity development that was done at all three levels outlined by the 5th Delft Consortium's Background Paper (2013) in its conceptual framework for capacity development, namely: enabling environment; organizational; individual.

4.1. Enabling environment

The enabling environment was strengthened at RVWSB level, who were involved throughout the preparation and implementation process and whose Strategic Plan guided the planning of the activities in line with sector priorities and the Water Act 2002. In particular, VEI has been 'walking the path' with RVWSB in filtering out what needs to be done based on their priorities and those of their respective WSPs. In the up-scaling phase, SNV has adopted a coaching and mentoring approach to develop RVWSB's capacity to document, disseminate and replicate the emerging NRW model in 10 other WSPs in their area of jurisdiction.

4.2. NAWASSCO (organization) level

At the NAWASSCO level, VEI worked closely with the management and staff to share knowledge on the theoretical aspects of NRW, prioritize the most immediate as well as future areas of intervention and constitute a team that has been responsible for implementation of the NRW pilot. Additionally, the WSP was encouraged to put in place an incentive system to boost the morale of the team members, which they did. All in all, the capacity of NAWASSCO as an organization was developed sufficiently to enable them to take the lead in the planning and implementation of the pilot.

4.3. Individual staff

At NAWASSCO's individual staff level, VEI's international staff (led by the Resident Project Manager) and SNV's Water Sanitation and Hygiene (WASH) Advisors trained the selected NRW team in the theory of SAR approach (detailed in Appendix 1; available online at http://www.iwaponline.com/wp/015/017.pdf) and how it can be applied to the NRW reduction (IWA model; Appendix 2, available online at http://www.iwaponline.com/wp/015/017.pdf). Building on their experience and knowledge of the subject, VEI worked closely with the NRW team and NAWASSCO management to undertake all the steps of the NRW and reduction model. Through coaching and mentoring, VEI succeeded in transferring the skills necessary for the action and also built in them the capacity, and confidence, to take charge of the pilot and the up-scaling to other zones.

Through the above, VEI and their partners have successfully built local ownership of the action in NAWASSCO, as well as RVWSB. The latter will contribute to capacity development of other WSPs through dissemination workshops, training, field visits and coaching. It is very commendable that through this project, NAWASSCO management and staff, as well as RVWSB, have a very good understanding of the NRW model and are ready to go even further to help the remaining ten WSPs replicate the same in their areas.

In conclusion, it is clear that the work that was put into this seemingly simple NRW reduction model by the partners has gone a long way in developing the capacity of NAWASSCO to take charge of their own mandate and agenda. It has also set the stage for both NAWASSCO and other WSPs in the RVWSB region and beyond to take responsibility for translating theory into practice by crafting local solutions to international policies/strategies to enable them improve their performance and deliver sustainable services to their consumers.

The Nakuru experience is an excellent case that demonstrates the importance of capacity development by highlighting the following:

- Capacity development (at the personal, organizational and enabling environment levels) can translate into immense benefits without necessarily investing a lot of funds. In fact, it shows that the main constraint at NAWASSCO was not financial, but rather a lack of adequate capacity. In any case, contrary to the prevailing thought at the onset of the pilot, it became evident that most of the achievements in the pilot were attributable to the reduction of commercial losses, the 'low-hanging fruits' of this whole exercise.
- While the pilot area covers only a small percentage of the total service area (700 / 29,000 connections $= 2.5\%$), up-scaling the emerging model and best practices to other areas will multiply the effect and bring a lot of savings, which can be re-invested to improve infrastructure and improve service delivery to the consumers, hence improving access to people who would otherwise remain un/underserved.
- The (North–South) WOPs has evidently added a lot of value to the processes, especially in leveraging knowledge and resources to maximize impact.
- There is therefore a lot of scope to use WOPs as a vehicle for capacity development, which translates into improved performance (of the recipients). When done properly, capacity development at individual, organizational and institutional levels builds local ownership by contextualizing existing knowledge to the local situation. This means putting the 'steering wheel' of the development agenda firmly in the hands of the beneficiaries of the capacity development to ensure sustainability of the interventions.

From the foregoing, there is need to acknowledge and profile the role of capacity development in the general development agenda, and to promote WOP as a vehicle for achieving capacity development in the water sector.

Acknowledgements

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