Non-Revenue Water and Some Simple Economics for Developing Counties

Enkelejda GJINALI[a], Philip D. Giantris[b]
[a]Polytechnic University of Tirana, Albania
[b]Valuadd Management Services Company, Albania

Abstract

The issue of water loss, when viewed as non-revenue water (NRW), and further considered from the perspective of administrative losses, is one of the major problems when it comes to continuity of service and the unit cost of water supply in many developing countries. This paper has taken that perspective and viewed it more specifically through the lens of the Greater Balkans Region where the authors have particular experience. Based on data provided by countries that contribute voluntarily to the World Bank's IBNET program, a number of countries in the Greater Balkans, such as Albania, Kosovo, Montenegro, Bosnia-Herzegovina, Macedonia, and Moldova have NRW values, in recent years, in the range of 40% to 70%

The authors seek to emphasize that from their experience, the issue regarding NWR, in most of the countries of the Greater Balkans, should not be one initially focused on aggressive leak detection and network repairs, but rather one of aggressive, system-wide metering from sources, to production and storage reservoir meters, through district metering areas, and finally to customer meters. This must be paralleled with a strict program to identify non-registered (illegal) connections to the network and meter by-passes on customer connection piping.

With a commitment to system-wide metering and diligent "policing" of customer connections, enforced with painful economic penalties for violations of regulations contained in a customer service contract, well trained utility personnel will be able to routinely conduct highly quantified water balances and begin to take control of their water supply services. The authors are of the opinion that the funds being spent by donors on leak detection equipment, which places a morale burden on recipient utilities to have programs using this equipment, is a misapplication of resources, in the near term. Only when the utility has done all it can do to reduce administrative losses should the water loss/non-revenue water program be redirected toward methodical leak detection.

The beauty, initially, of aggressively pursuing NRW as an administrative issue, is that it immediately has the highly leveraged potential to reduce energy costs in largely pumped systems, as well as increase revenues, where unregistered connections are known to be common place.

The authors will also challenge the philosophy of slowly "climbing the technology ladder" with less expensive meters, and more manual reading and recording technology, by starting a system-wide metering program as close as possible to more state-of-the-art meters providing higher levels of flow measuring accuracy, as well as more automated

meter reading, recording and data transmission systems. In addition, the authors will stress the importance of training water utility staff in the use of relatively simple, but effective, water balance models to apply the same diligence to water that accountants apply to cash balancing. The findings, interpretations, and conclusions expressed in this article are entirely those of the authors.

KEYWORDS: Non-Revenue Water; NRW; Metering System Accuracy; Illegal Connection

Non-revenue Water and the Challenges in the Western Balkans

Most available data on Non-revenue Water (NRW) levels range from values like 7% in Germany to more than 90% in Nigeria. NRW levels are 10% in Denmark, 19% in England and Wales, 26% in France, 29% in Italy. In large Asian cities, NRW varies from 10% to 60% (Kingdom et al., 2006). According to a report by the European Environment Agency, NRW in Yerevan, Armenia, was almost 80%. Figure 1.1 shows NRW indicators in the Balkan Region.

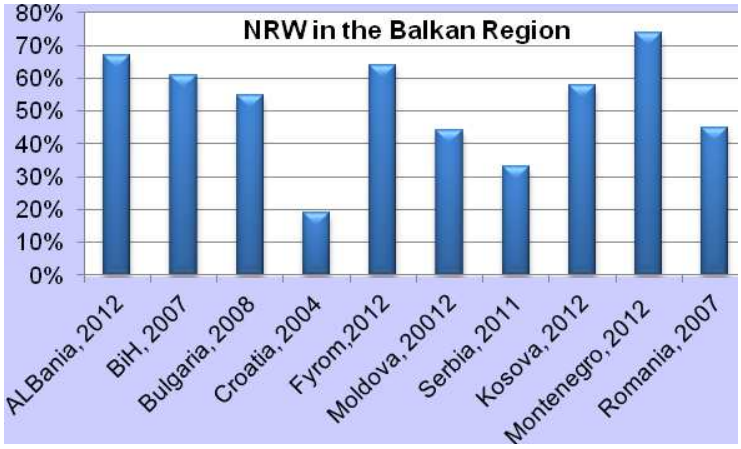

Figure 1.1 NRW in the Balkan Region
Data Source: The International Benchmarking Network for Water and Sanitation Utilities. http://www.ib-net.org

Water Utilities in the developing world are significantly impacted by the difference between the volume of water produced, which is input to the distribution system, and the volume of water billed to consumers.. To illustrate this point, the paper will analyze the complex implications and effects of the current level of NRW in the Western Balkan Region, by considering the following questions:

- How is this challenge it is perceived at the institutional level?
- How to require change in focusing on NRW when there is a historical understanding of the issue?
- How to bring greater customer/user connection verification procedures into common practice?
- How to communicate the link between NRW and Continuity of Service?

- How to educate, train and communicate the urgency of reducing NRW to the lowest levels of the workforce?

Need for Water Demand Management in the West Balkans

Since 1990 water demand management has been increasingly promoted in the management of freshwater resources, and it is recognized as an important adaptation measure to climate change worldwide (Danilenko et al, 2010) However, the Balkan Region is largely blessed with significant quantities of high quality water resources, and statically reported to have some of the highest availabilities of water resources per capita in Europe. Although this fact might suggest that the Balkan Region would have no apparent major risk relative to reduced water resources, just the opposite may be true. In Albania, for example, the government's policy is focused on the expansion of the water supply distribution infrastructure, where as investments and programs in water loss control are very sporadic and largely donor driven. Should countries in the Balkans expect that these abundant resources will be there forever?

Records document that in the last decades; the Balkan countries have been getting warmer and are projected to continue on this warming trend generally in proportion to the expected increase in global temperatures. Similarly, the region is receiving less precipitation and is projected to experience further decreases, although precipitation will continue to vary according to terrain, elevation and proximity to the sea. (Bogdanovic et al, 2012). The effect of warmer temperatures on evaporation, together with the decline in precipitation, will make the region drier. So, the time to start acting is now for Balkan countries.

The ability of the Western Balkan countries to respond effectively to Demand Management which is directly connected with Non-revenue Water, either alone or together – depends on their overall vulnerability, which today is a function of the following three important factors:

- ***Institutional Structures:*** Good/bad water governance practices
- ***Statistics:*** Knowing the customer base and documenting them as users with zero tolerance for unregistered connections.
- ***Accuracy:*** Implementation of nationally based strategic goals on achieving a high level of metering accuracy.

Water Governance - Missing Management Focus

Not understanding the magnitude, sources, and cost of NRW is one of the main reasons for insufficient NRW reduction efforts around the world (Kingdom et al, 2006). From a regional perspective, the data being reported suggests poor management practices, a lack of regulation, and a lack of motivation due to currently different water governance policies and practices. The Balkan countries need to establish a common philosophy as to how to reduce NRW. This will demand that policy and decision makers see the bigger picture surrounding these actions, since NRW does not occur independently of other factors.

In keeping with this common philosophy, Balkan countries need to reform current laws and institutions applying new policies and legal frameworks based on the principle of rigorous water balance procedures and analyses, leading to correctly identifying NRW. Central governments of the Western Balkans need to consider redefining their role to one that is more to set up visions and missions, to be a facilitator and regulator, rather than an implementer of projects.

It is an interesting observation to make, but when considering the "first cousin" of water, which is electricity, it is possible to identify a similar phenomenon in terms of losses or better said, "Non-Revenue Electricity". Data for the years 2010, 2011 and 2012 is presented in Figure 1.2 below.

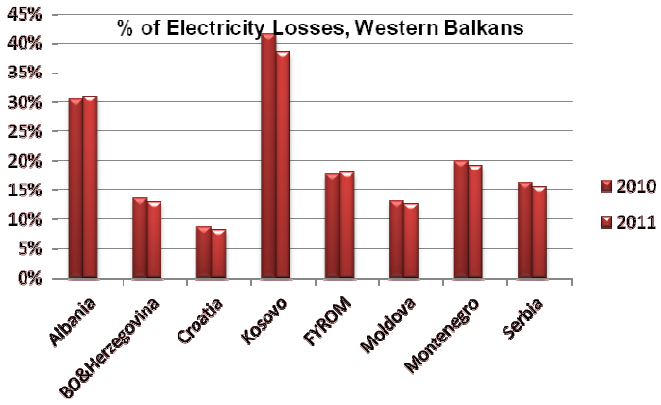

Figure 1.2 Percent Electricity Losses in the Balkan Region
Data Source: ERRA (Energy Regulators Regional Association) confirmed by the Energy Community Secretariat, 2012

The pattern of behaviour, particularly in the four Western Balkan countries of Albania, Kosovo, Macedonia and Montenegro, mirrors that NRW behaviour shown in Figure 1-1. Understanding that electrical transmission and distribution does not have "leakage", then it underscores the need to focus on management practices and administrative procedures.

NRW in the Balkans is still a relatively unknown issue in government, with no tradition, no mandatory laws, and virtually a "missing chapter", in university education. If we take Albania as an example, which in many ways, is similar to the rest of the Balkan countries. water supply issues at the central level come under the Ministry of Transportation and Infrastructure. The Water Regulatory Authority (WRA) is the independent body that has the exclusive right to set tariffs and license operators in the water sector.

At the local level, all water utilities have been transferred to local government units (LGU). The corporate form of water companies in Albania is referred to as "joint stock companies". Supervisory Councils, named by the local government shareholder assemblies, represent the governing body of the utility and oversees the performance of the director of the utility. The Supervisory Council reports to the Assembly of Shareholders (local level) on its obligation to supervise the compliance of the company's

activities with regard to the legal acts in force and the applicable accounting standards and principles (Giantris, 2011). It is apparent that in such a decentralized structure, getting the right message for an integrated action, down through the chain of authority and responsibility, is challenging, at best, and nearly impossible in reality.

Focusing this Water – Energy comparison only on Albania, Figure 1.3 shows year-to-year data for Water Loss (NRW) and Electricity Loss. The comparison shows common behaviour and the trend for the period 2010-2013, in both cases, is not good.

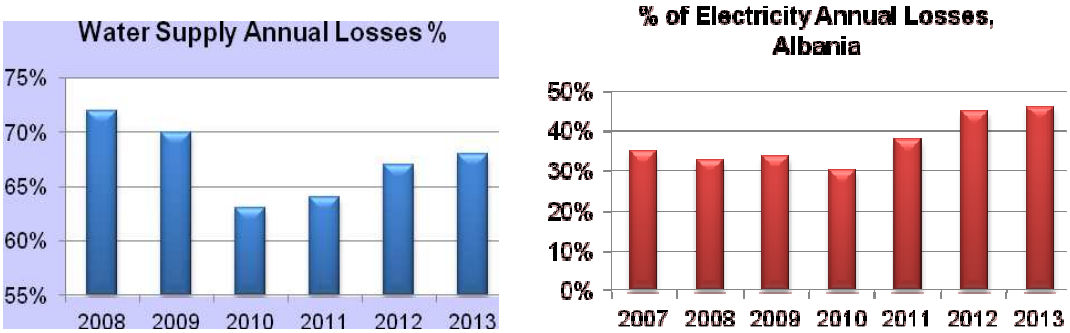

Figure 1.3 - Percent Water Supply and Electricity Losses in Albania

Data Source (on the left): Benchmarking Unit of Water Supply and Sewerage Sector in the Republic of Albania, Data Source (on the right): Albanian Energy Regulator (ERE), http://www.ere.gov.al/

NRW expressed as a percentage is a simple calculation that professionals in the water sector all understand. To the uninformed, largely elected and appointed public officials, it simply says "lost water". Given that the Balkans has excellent water supply resources, they don't see it as a "today" or "election issue". Therefore, it can be put to the back of the line. However, if we translate it into monetary terms, it can quickly become one of today's more significant issues, when the magnitude of lost revenue or unnecessary expenditures in capital and operating costs are understood. This should serve as an incentive for each water utility to come up with a strategy in order to realize these revenues or reduce these costs.

Table 1.1 below, takes selected data for the four countries of the Western Balkans, plus Bulgaria and Romania to try to illustrate the point of NRW in monetary terms. When countries, on average, are experiencing NRW in the 45% to 74% range, they are also experiencing potentially avoidable expenses in the same range. Therefore, it is not the loss of water, but rather the loss of the cost of producing that water that should have public officials concerned.

Table 1.1 Cost of NRW as Element of Total Cost

Parameters	Albania	Montenegro	Macedonia	Bulgaria	Romania
Water Production Volume (000 m^3)	277,603	76,650	120,235	593,515	496,820
Water Sold (000 m^3)	91,609	19,929	43,284	267,082	273,251
NRW (000 m^3)	185,994	56,721	76,950	326,433	223,569

NRW (%)	67%	74%	64%	55%	45%
Total Cost of Water Production (000 €)	177,864	90,666	74,073	375,398	375,454
Total Cost of Water Sold (000 €)	58,695	23,573	26,666	168,929	206,500
Total Cost of NRW (000 €)	119,169	67,093	47,407	206,469	168,954

Data Sources:

- The International Benchmarking Network for Water and Sanitation Utilities. http://www.ib-net.org
- Benchmarking Unit of Water Supply and Sewerage Sector in the Republic of Albania
- Kosovo Water Regulatory Authority (2012)

Speaking in gross terms, if each of these countries could simply reduce their NRW by 50%, which means that no one country would have to be less than 22.5% NRW, there could be from Euro 23 to 85 million Euro available, per year, for necessary investments, with no change in tariff structure.

Taking Albania as a specific example, the Government prepared a medium term Strategic Plan for the Water Supply and Sewerage Services Sector (2011-2017) that had an annual capital investment need of Euro 75 million to Euro 116 million per year over the planning period. Referring to Table 1.1, all of that need, over the seven year planning period, could be met by simply reducing NRW to acceptable levels.

The current investment strategy for the Albanian water sector, under the current Seven-Year Water Supply and Sewerage Sector Strategy (2011-2017) is to target programs on reducing NRW from 67% to 40% of water sent into system. The main goals to support that target are: achieve 85% consumer metering, achieve 100% zone metering, achieve 100% production metering, and identify and legalize or disconnect all unregistered or illegal connections. The total cost associated with these actions is estimated to be 33 million Euro.

Service Area and Customer Data – Key to Commercial

If utilities do not know the accuracy of population figures, how can they assume that they know the accuracy of registered of customers. Every time a utility finds an unregistered user and turns it into a utility customer, they are automatically increasing revenues, and given constant production, automatically reducing NRW.

Again, taking Albania as an example, according to the Ministry of Interior, the total population registered in Albania, based on the data provided by the National Register of Civil Status, is 4,200,000 people. However this total number of registered population includes Albanian citizens who have emigrated, and who live permanently or mostly outside Albania. The number of individuals that can be considered to be in this category is estimated to be approximately 700,000 people.

According to Albania's Institute of Statistics (INSTAT), the official resident population, registered in the 2001 Population and Housing Census, was 3,069,275. In 2010 the population of Albania was estimated by INSTAT to be 3,195,417.. According to INSTAT, Albania's official resident population, registered in the 2011 Population and Housing Census, was 2,821,977. It has declined around 8% compared to the 2001 Census.

The Republic of Albania has been managing a Performance Monitoring and Benchmarking Program for its water supply and sewerage sector since 2005, and has completed seven annual data cycles as of 31 December 2013. The Program includes all fifty-eight (58), corporatized water supply and/or sewerage utilities across the country. The Benchmarking and Monitoring Unit reports a total population living within the jurisdictional urban area of water supply and sewerage companies to be 2,572,753 people. This data source would suggest a total population of 3,233,664 people. This kind of large inconsistency in population data, and the lack of focus at water utilities to account for all users/connections to the water supply system is one of the principal contributors to high NRW indicators.

In addition the inconsistent population data situations, internal migration is also an issue in the West Balkans as many people leave rural areas to seek opportunities in the more urbanized areas. The population of the capital city of Albania, Tirana, has grown from approximately 200,000 to almost 1 million people, since the end of the communist era, taxing the City's infrastructure and the ability of the water utility to consistently meet the demand for water supply. Belgrade, Sarajevo and Skopje have similar situations. Since 1992 the percentage of the population living in rural areas has declined in every West Balkan country (Bogdanovic et al., 2012). So, all these inaccurate demographic data have a direct influence on the NRW indicator.

National Strategy toward Metering Accuracy

If countries want to see a reduction in NRW, then they must show leadership in making comprehensive metering and meter accuracy priorities for all utilities. To do that, they must establish enforceable standards and capital funding mechanisms that incentivize utilities to make the effort to achieve the NRW reduction targets. The investment in these goals will have dramatic impacts on service quality.

Continuity of Water Supply Service

Continuity of water supply service is related to the ability of a water utility to maintain the distribution network under a defined service pressure in order to deliver water to its customers on a continuous, uninterrupted basis. The IBNET data for West Balkan countries reported continuity of service of an average of 16 hours/day for the water supply sector in the year 2012. Although this indicator has improved over time, water utilities still tend to over-produce water to try to meet the needs of the served population for hours of daily supply and pressure. Currently only two of the water utilities in Albania are able to provide 24-hours of pressurized water supply service, across their entire systems, throughout the year. In the other systems, the population compensates for this lack of "continuity of service" by purchasing and installing booster pumps and water

storage tanks that fill up when the distribution system is under pressure. The main factors that cause this low continuity of service are a lack of system wide customer metering/flat rate billing that undermines water demand management, illegal connections, and technical losses in the networks.

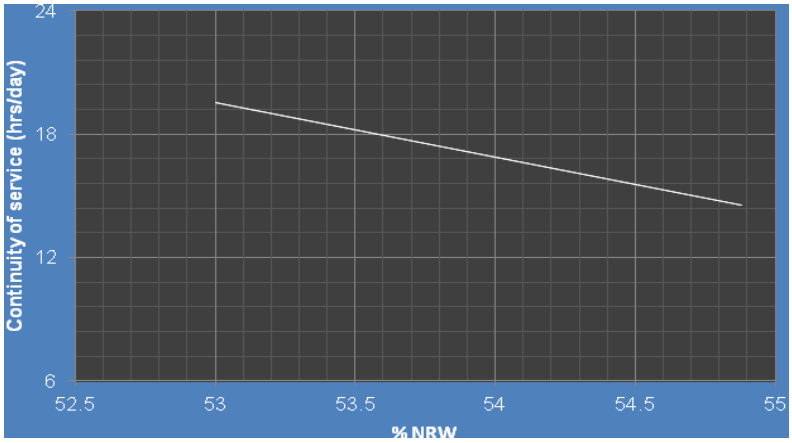

Figure 1.4 Effect of NRW in the Continuity of Service hours/day, Western Balkan Region.
Data Source: The International Benchmarking Network for Water and Sanitation Utilities. http://www.ib-net.org

If it is assumed that a system consists of 100% registered connections than Figures 1.4 and 1.5 seem would suggest that pumping more water into the system with higher NRW doesn't help to provide a greater continuity of service, only Water Demand Management will improve continuity of service, which is achieved with metering system.

Water production and water sales are the indicators that best define the needs for production to fulfill the total demand of the population for water supply. The relationship between these two values provides a way to assess the extent of "non-revenue water" on a demand basis, representing the quantity of water that is "produced but not billed" for each equivalent person that is supplied. To establish completely right relations between the water producers/vendors and customers as its users, billings should be based on the measured volumetric units. When users are billed on the basis of measured consumption, experience has shown that water demand is greatly reduced and continuity of service is greatly increased.

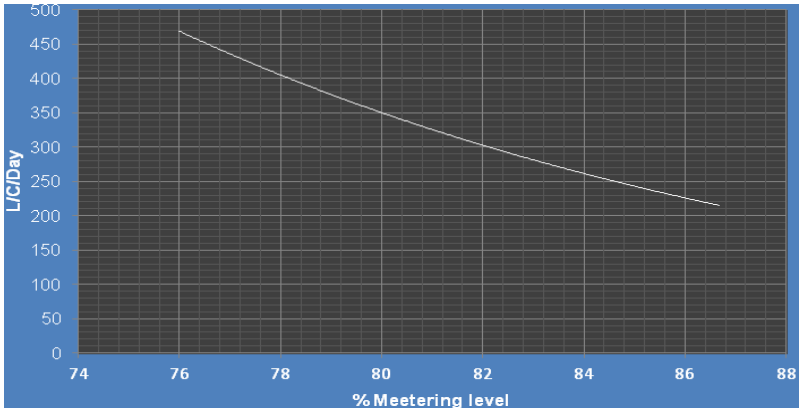

Figure 1.5 Effect of % Metering Level on Per Capita Demand, Western Balkan Region
Data Source: The International Benchmarking Network for Water and Sanitation Utilities. http://www.ib-net.org

If it is assumed that a system consists of 100% registered connections and full pricing of water service is being applied, based on measured flow to the customer, than Figure 1.5 suggests that demand in liters per capital per day will come down.

It is a fact that most systems in Balkan Region have a significant number of "illegal" or "unregistered" connections to their transmission and distribution systems, which means that a portion of the NRW% is in fact being used and providing a necessary service. Similarly, the level of consumer metering is still low, as a percent of the number of connected customers (% metered connections and % metered water sales), which says that there is no clear information, on a national basis, to arrive at true demand.

Water Metering

Water metering is the most efficient tool for reducing domestic water consumption (Danilenko at al 2010). Metering allows for greater accountability to both a consumer who pays for water according to actual use, and to utilities that are paid according to the volume of services they provide. Coupled with an appropriate tariff policy, this can result in a significant drop in water demand. It must be noted that the introduction of metering can at times result in unanticipated outcomes. In a number of cases, consumers may react if reductions in consumption are followed by increases in the tariff (to keep revenues at necessary levels). On the other hand in many cases, lower consumption may also reduce costs (for example pumping costs) and this has to be fed back into tariffs.

It is also important to note that metering programs are expensive given that meters require regular calibration and replacement. In the case of England and Wales, OfWat calculated that metering would cost an additional $48 per year per connection compared to an average bill of water $174 per year and $308 for water and sewerage combined. Therefore, many utilities in OECD countries have decided against metering in cases where the decision to install meters cannot be justified by the marginal cost of water and a potential reduction of investment costs as a result of a reduction in demand. However,

metering has indirect benefits, such as increasing consumer awareness and helping to detect and estimate leakages.

Lack of Awareness and Knowledge

There are problems inside the utility when it comes to addressing NRW and that is the lack of educated workforce (Kovac, 2013). The data shows that although numerous donations and loan programs have provided significant investments in water distribution infrastructure, still this had little or no effect on water losses levels. This can be largely blamed on the fact that most water utilities operate their systems without a dedicated water loss control policy.

Addressing this lack of capacity toward NRW requires a range of skilled staff, including managers and professional engineers at one end of the spectrum right through to street crews, technicians, and plumbers at the other. "NRW reduction," in its broadest sense, is not taught at universities or technical colleges nor in many of the water industry training institutions around the world. As a consequence, staff with necessary skills is not widely available (Kingdom, at al 2006). Addressing this issue will require both an acceptance of the widespread challenges and consequences associated with NRW, and then the development of appropriate training materials, methods, and institutions. A major initiative is required to build such capacity.

Overall Concussions

The case to reduce levels of NRW is, in fact, so compelling that any sensible person would wonder why this problem has not been addressed more urgently. Within the sector, there have been many attempts to tackle this issue (Kingdom, at al 2006). NRW reduction is a common element of past projects funded by multi- and bi-lateral organizations, but they have often not delivered the desired result because reducing NRW goes to the heart of many of the failings of developing country water utilities, and to the lack of good governance and an enabling environment for efficient service delivery to the population.

The non-revenue water, made up of both real and apparent losses, are the result of network depreciation, illegal connections, unmetered connections with flat rate (norm) billing, lack of billing for all consumers, and other factors. The utilities do not yet have a clear estimation of the demand for water, and identification and assessment of non-revenue water according to the cause of the loss. Most of the countries have no strategies and programmes for loss reduction in place.

Best practices of some utilities in the Balkan region demonstrate that improvement of this indicator can be achieved not only through investments, but also through better management of the water supply system. Having an overview and better evaluation of the situation and the setting of strategic objectives for loss reduction are solutions that mainly depend on the work of the utilities. Metering of water use at the level of production (wells, bulk water supply), at key points in the distribution network and for consumers is essential to estimate levels of NRW.

Lastly, it is an important to stress the training water utility staff in the use of relatively simple, but effective, water balance models to apply the same diligence to water that accountants apply to cash balancing.

The above stated goals can only be achieved by developing a detailed metering needs assessment for each licensed water utility; developing a national metering program; and channeling funds to specifically target and address these goals.

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