# NETWORK METERING AND ENSURING THE NECESSARY WATER SUPPLY BY PRESSURE MONITORING

*Prof. PhD.eng. FLORIAN STĂTESCU,*
*lect.PhD.eng. GABRIEL CONSTANTIN SÂRBU, lect.PhD.eng. VALENTIN BOBOC*
*"Gheorghe Asachi" Technical University of Iaşi, Romania*
*stud.Ph.D.eng. GHEORGHIŢĂ TATU, SC ApaVital, Iaşi*
*assoc.prof. PhD. eng. NICOLAE MARCOIE, lect.PhD.eng. DANIEL TOMA,*
*"Gheorghe Asachi" Technical University of Iaşi, Romania*

***ABSTRACT:*** *Adopting a smart water monitoring system must go beyond simply automating the reading and reporting of recorded flows and pressures. In order to know the water consumption of users in depth and to achieve a system capable of carrying out commercial and operational management, it is also necessary to combine other factors with automation, namely information technology, database science and other analytical skills .*

*In the present work, the study object was the water supply system of Miroslava commune. The Miroslava water supply system has as source the Iasi City distribution network. The capacity of the source is sufficient for a proper water supply to the system. The drinking water supply of Miroslava commune is a mixed one: from the Miroslava 5000 cubic meters water tank by gravity and also by pumping.*

*The quality of flow meters and network pressure are relevant parameters for determining water consumption.*

*In order to cope with an intermittent water demand, many water distribution networks, like the one in the case studied, include storage tanks, which allow users to store water during off-peak hours. This random consumption pattern can lead to longer residence times in the lateral pipes of distribution networks, which can negatively affect the quality of water reaching end users.*

*The use of water for purposes other than domestic ones (irrigation systems, filling of swimming pools, using water to wash concrete surfaces inside properties, etc.) leads to an increase in consumption beyond the maximum designed capacity of the water supply system, which causes difficulties in ensuring a minimum level of water in the tanks, which allows the pumps to operate in normal mode.*

*Increasing the degree of consumer satisfaction by increasing the pressure in the water network is a solution that also brings drawbacks, such as increasing the mechanical stress on pipes and fittings, which leads to an increase of breakdowns frequency, additional water losses and to the deterioration of environmental conditions.*

***Keywords:*** *water consumption; pressure monitoring; network pressure; networks;*

## 1. Introduction

Water distribution models are the subject of numerous scientific works that aim to approximate the values observed with pressure and flow measuring equipment to those calculated from developed hydraulic models. To increase their reliability, the correct determination of water consumption is a very important factor. The high variability and randomness of water resource use patterns greatly affect the adoption of correct values for flow and demand, a fundamental parameter for the accuracy of the results of the proposed models. As regards these issues, there are numerous works dedicated to elucidating the problem of water demand determination.

Carpentier and Cohen [1] presented a demand estimation and leak detection technique using steady status pipe flow values.

The hypothesis of the study carried by Buchberger and Wu [2] is that residential water use can be characterized by three variables: intensity, duration and frequency, because these three properties can be modeled as an non-homogeneous process of rectangular pulses.

Kumar et al. [3,4] proposed a method to

estimate status parameters for well-instrumented distribution networks. The method was applied to two urban networks, taking into account flow measurements in pipes, pressure at nodes and water demand values.

Torrent and Pérez [5] modeled average daily water consumption from real-time flow data from several measurement areas using potential curves.

In this context, pressure monitoring in different nodes of the distribution network can provide consumption data in a much more accurate spatial and temporal resolution. With information on flows at individual consumer level and at small time intervals, analytical tools can be used to more accurately characterize consumption profiles. The use of smart meters for pressure monitoring provides essential information for understanding consumer behavior patterns. In addition to being an important tool to help build consumption models, smart meter pressure measurement enables the construction of useful models for leak detection, water losses reduction and improved demand management.

Adopting a smart water monitoring system must go beyond the simple automation of reading and reporting the recorded flows and pressures. In order to know the water consumption at users in depth and as to achieve a system capable of providing a sound commercial and operational management, it is also necessary to combine other factors with automation, namely information technology, database science and other analytical skills .

## 2. Material base and research methodology

### 2.1. Geographical delimitation of the investigated water supply system

In the present work, the water supply system of the Miroslava commune was studied (fig.1). The system is located at the south-western border of Iaşi City, 30 km from the Prut river (eastern border), 40 km from the western border and 25 km from the southern border of the county.

The commune borders the following territorial administrative units: in the north-eastern part - the City of Iaşi; in the north – the Valea Lupului commune and the Rediu commune; in the northwestern part – the Letcani commune; in the western part – the Horle ti commune and in the southwestern part – the Voine ti commune. It consists of 13 villages and spreads over an area of 8,270 ha.

### 2.2. Brief description of the water supply system

The Miroslava water system is supplied from the Iasi City's distribution network. The capacity of this source is sufficient for a proper water supply to the commune's system. The Miroslava commune drinking water supply is a mixed one, water being provided from the Miroslava 5000 cubic meter water tank and also by pumping. (fig.2).

At the end of September 2023, the drinking water distribution network in Miroslava commune had a total length of 172,407.59 m and was including 2,242 connections and 6,445 water meters.

The pumping group is equipped with 3 pumps (Q=16 $m^3$/h, H=44 mWC, P=37 kW). The pumping station is in good shape, both structurally and hydromechanically, and does not require investment work. The water supply system is sized to cope with the household consumption in accordance with the designed standards. The pressure in the drinking water distribution network is 9.5 bar.

The use of water for purposes other than domestic ones (irrigation systems, filling of swimming pools, using water to wash concrete surfaces inside properties, etc.) leads to an increase in consumption beyond the maximum designed capacity of the water supply system, which causes difficulties in ensuring a minimum level of water in the tanks, which allows the pumps to operate in normal mode.

This determined the need to monitor the pressures in the distribution network (fig.3).

The water and sewerage operator measures all Miroslava commune's input and output flows. The area is divided in 3 DMAs (fig. 4):

- DMA MIR-01-00 – Valea Adâncă + Horpaz that includes 7 micro DMAs (MIR-01-01, MIR-01-02, MIR-01-03, MIR-01-04, MIR-01-05, MIR-01-06, MIR-01-07);
- DMA MIR-02-00 – Miroslava – Balciu that includes 2 micro DMAs (MIR-02-01, MIR-02-02);
- DMA MIR-03-00 – Miroslava – V. Ursului that includes 7 micro DMAs (MIR-03-01, MIR-03-02, MIR-03-03, MIR-03-04, MIR-03-05, MIR-03-06, MIR-03-07);

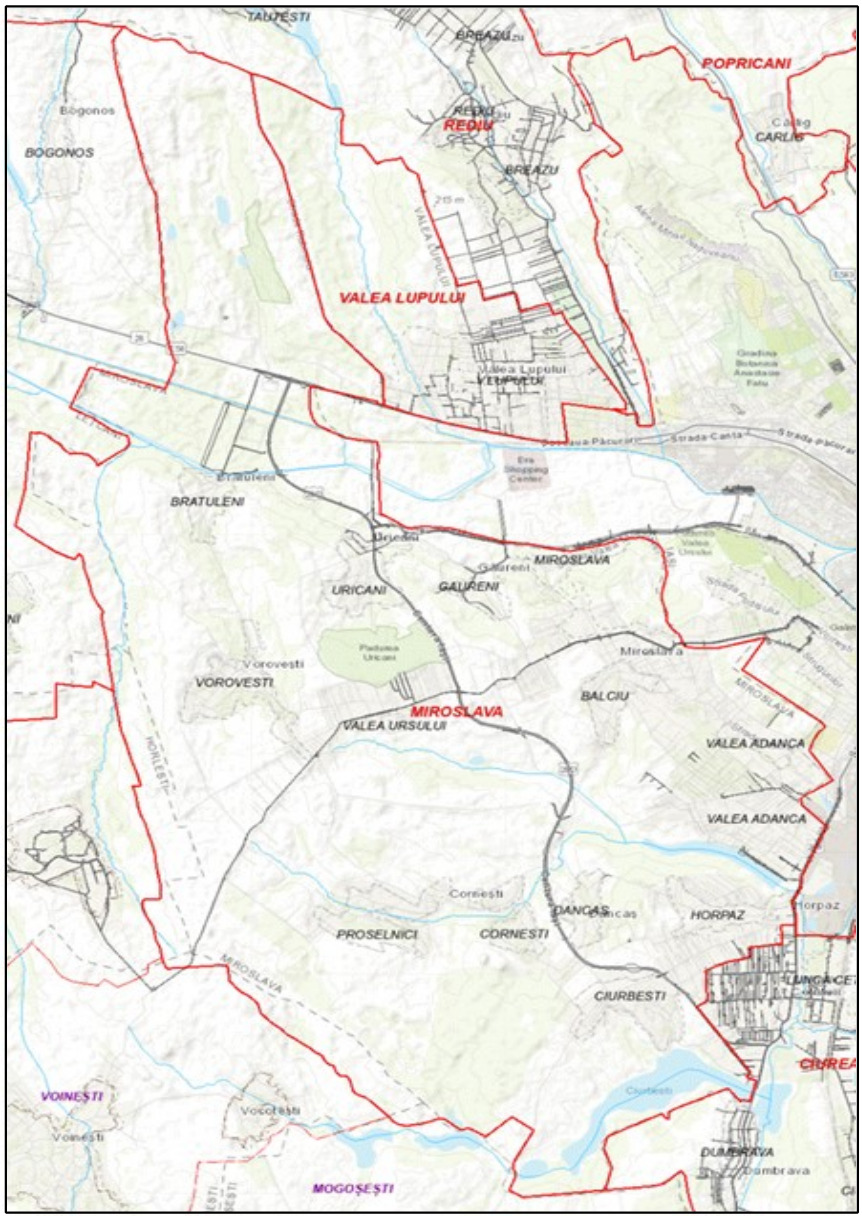


Fig. 1. Boundaries of the Miroslava Commune, Ia i County

## 3. Results obtained and discussion

The drinking water supply of Miroslava commune is a mixed one, and hence the minimum consumption at night is determined in two ways:

I -on the gravity supplied distribution network through the Miroslava 5000 cubic meter water tank (during night time the variation of water level in the tank is monitored);

II -on the pumped distribution network where the reading of the meter index and the monitoring of level in the suction tank are carried out; thus the pumped flow is obtained in accordance to the value of the operating point.

The pressure in the drinking water distribution network within the Miroslava commune was continuously monitored, in order to highlight the variation in water consumption and as to detect any failures (fig. 5a, fig. 5b, fig 5c).

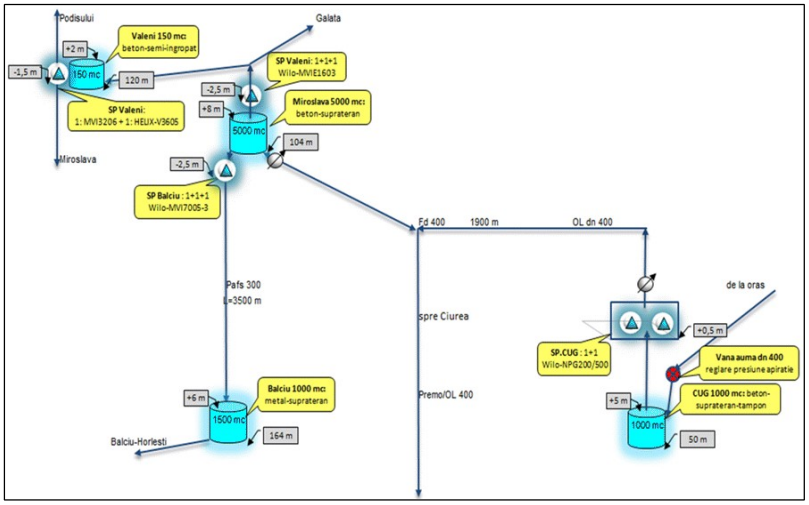


Fig. 2. Diagram of the Miroslava commune water supply system

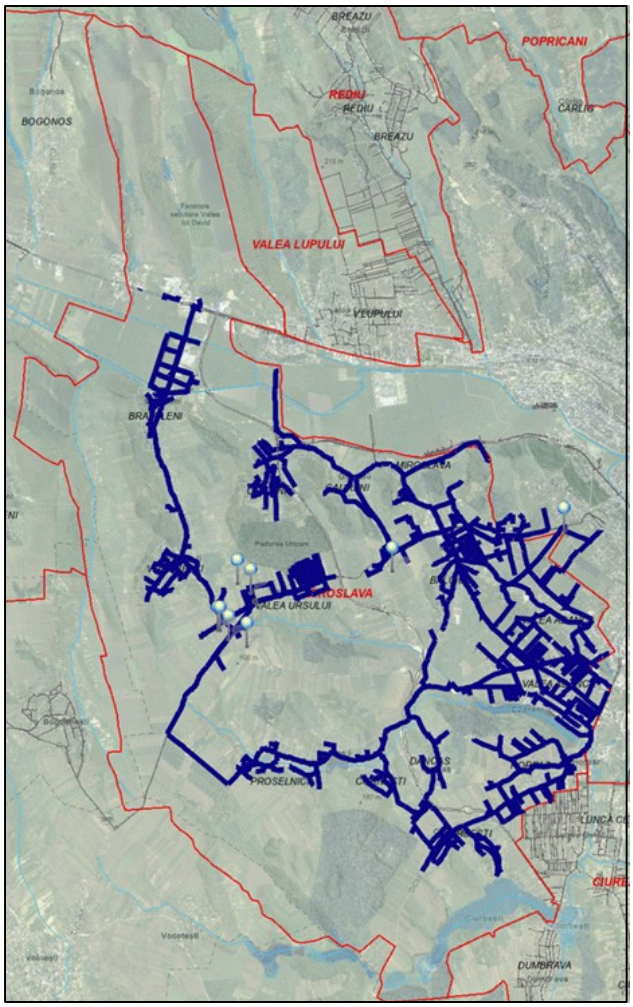


Fig. 3. Location of the pressure monitoring devices

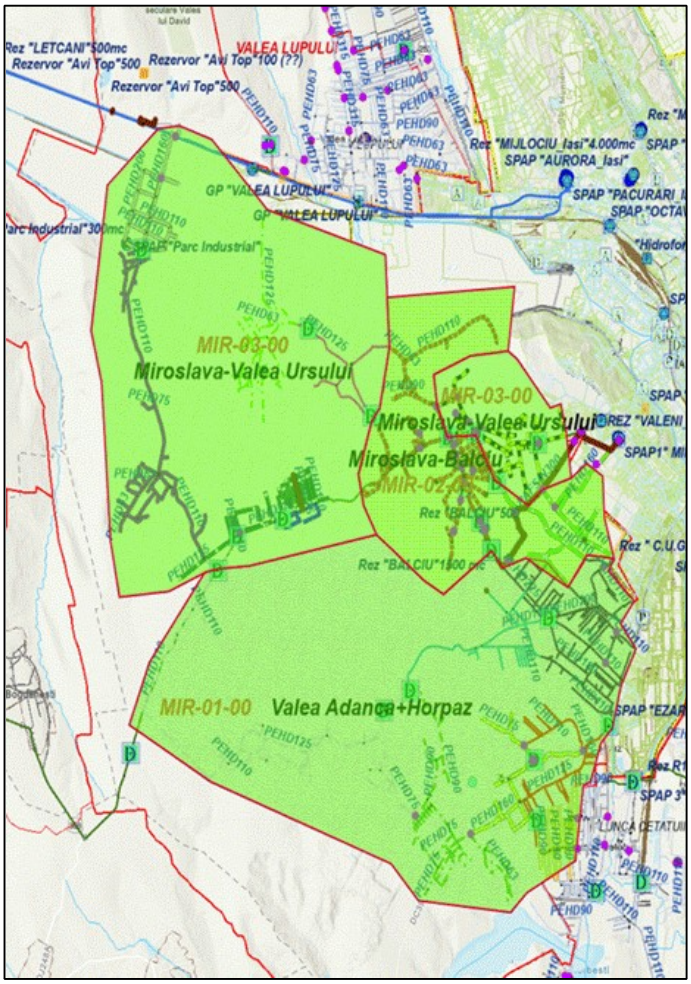


Fig. 4. The Miroslava DMAs

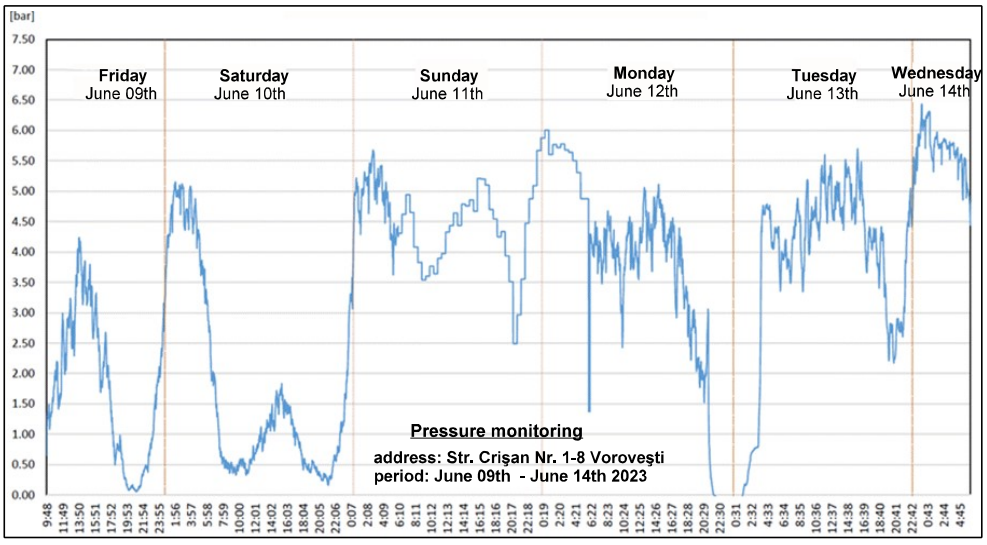


Fig. 5a. Monitorizarea presiunii în diferite puncte din DMA MIR-01-00

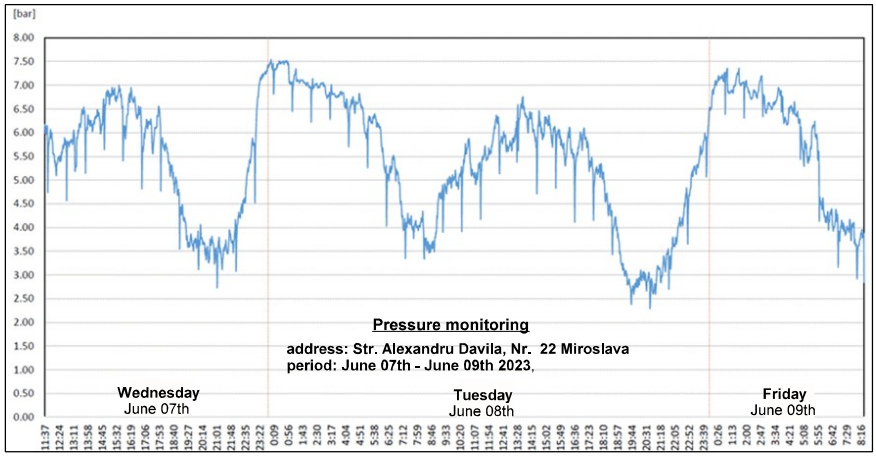


Fig. 5b. Monitorizarea presiunii în diferite puncte din DMA MIR-02-00

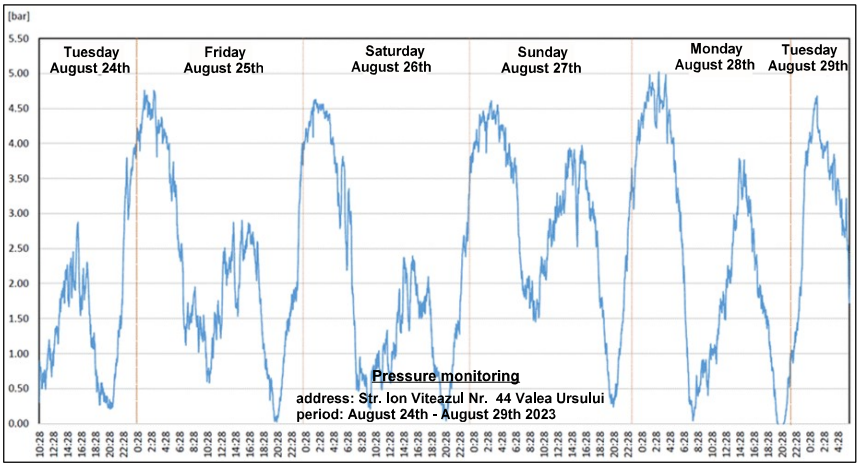


Fig. 5c. Monitorizarea presiunii în diferite puncte din DMA MIR-03-00

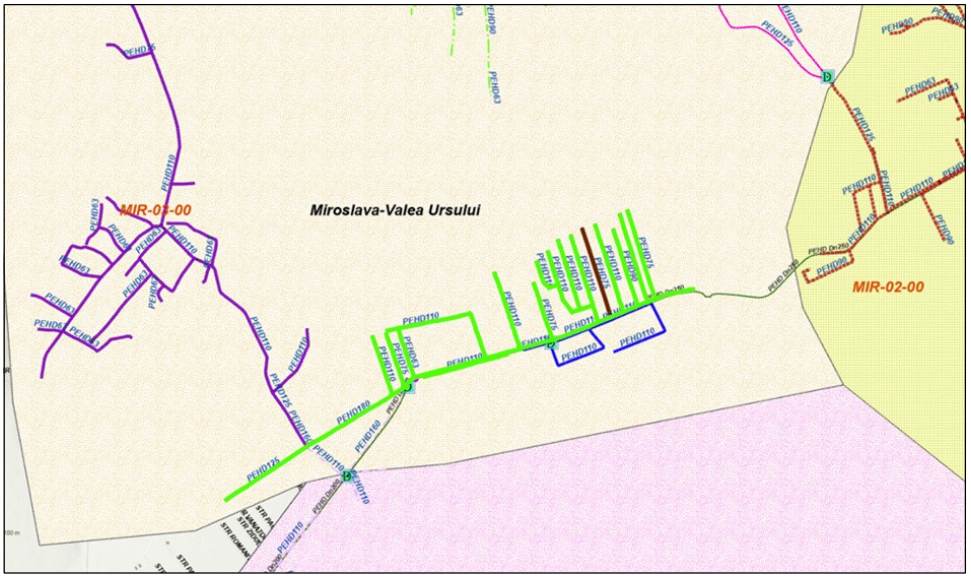


Fig. 6. DMA MIR-03-00 – Miroslava – Valea Ursului, micro MIR-03-04 and MIR-03-05

The pressure monitoring process in Miroslava have shown that pressure variations are important, these reaching a value of approx. 5 bar, the vulnerable area the DMA MIR-03-00 – Miroslava – Valea Ursului, and the micro areas MIR-03-04 and MIR-03-05, where several times at night time, pressure fell down to 0 bar (fig. 6).

In order to ensure the flow rate necessary for a nonstop distribution, taking into account the daily and seasonal variations in water demand and the commune's development trend, the pressure was increased up to 11 bar, in the distribution network during the periods when maximum consumption was recorded.

This increase in pressure by 1.5 bar eventually led to an increase of water losses and an increase of the stress on pipes and fittings (fig. 7a,b).

An increase of minimum consumption can be noticed, that is from 3.420 $m^3$ when the network pressure was 9,5 bar, up to 3.704 $m^3$ when network pressure was increased up to 11 bar.

## 4. Conclusions

Pressure fluctuations in water distribution networks affect hydraulic performance and the accuracy of water consumption control. These are caused by pumps mechanical failures, interruption of power supply to water pumping stations, variation in water demand and frequent pipe breaks. The quality of flow meters and network pressure are relevant parameters for determining water consumption.

In order to cope with intermittent water demand, many water distribution networks, like the one in the case studied, include storage tanks, which allow users to store water during off-peak hours.

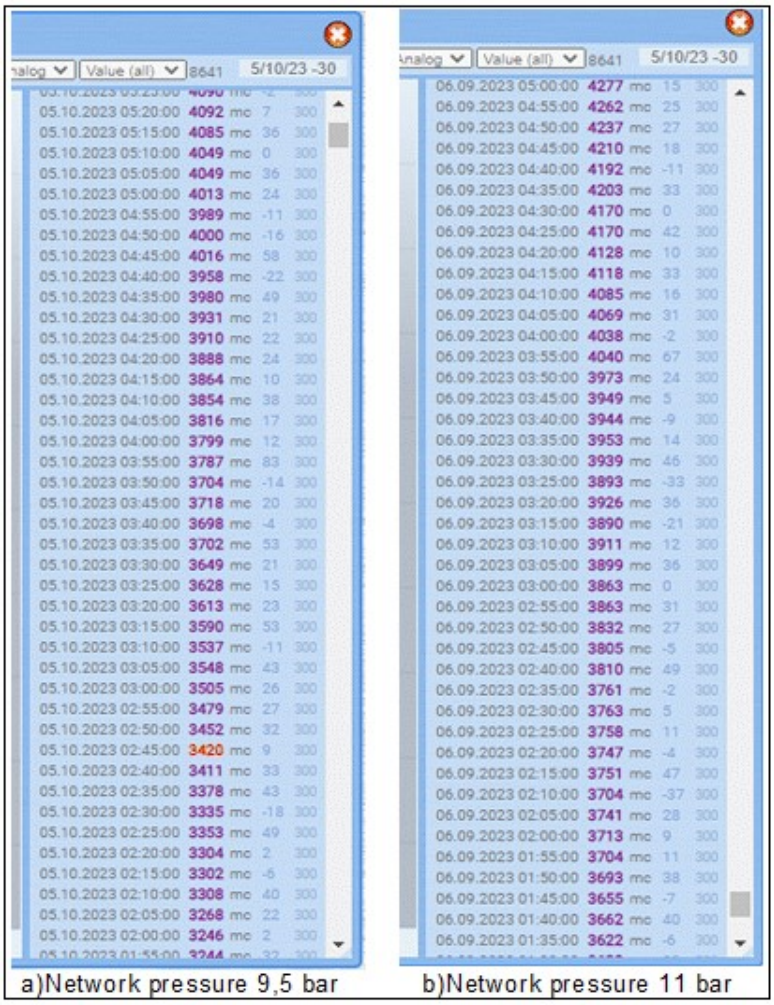


Fig. 7a, b. Night time water demand

This random consumption pattern can lead to longer residence times in the lateral pipes of distribution networks, which can negatively affect the quality of water reaching end users.

Increasing the degree of satisfaction of consumer requirements by increasing the pressure in the water distribution network is a solution that also has drawbacks, such as increasing the stress on pipes and fittings, which leads to an increase in the frequency of breakdowns, additional water losses and to the deterioration of environmental conditions.

## References

1. Arregui F. J. et. al., *Performance Analysis Of Ageing Single-Jet Water Meters For Measuring Residential Water Consumption*, Water, 10 (5), 2018.
2. Buchberger, S. and L. Wu. *Model For Instantaneous Residential Water Demands*. U.S. Environmental Protection Agency, Washington, D.C., EPA/600/J-95/491, 1995.
3. Isaac G. Musaazi et. al. *Assessing The Impact Of Working Pressure On Water Meter Registration*, Water Infrastructure, Ecosystems and Society, Volume 70, Issue 6, sept. 2021
4. Male J.W., Noss R.R., Moore I.C. (1985). *Identifying And Reducing Losses In Water Distribution Systems*, Noyes Publications, 1985.
5. Machell, J.; Boxall, j. *Field studies and modeling exploring mean and maximum water age association to water quality in a drinking water distribution network*. J. Water Resour. Plan. Manag., 138, 624–638, 2012.
6. Moahloli A. et al., *Domestic Water Meter Optimal Replacement Period To Minimize Water Revenue Loss*, Water 45(2), 165-173, 2019.
7. Wiek, A.; Larson, k.l. *Water, people, and sustainability—a systems framework for analyzing and assessing water governance regimes*. Water Resour. Manag., 26, 3153–3171, 2012.