DMAs, GIS and Involvement: an effective way to reduce loss in large and complex supply zones - Case study applied in Sao Paulo - Brazil

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Abstract

To implement a program to reduce losses in a sustainable manner and with satisfactory results, it is required much study and analysis of water supply system, so the challenge is to make a good diagnosis to identify the locations and areas that contribute to higher loss, to direct the investments in a planned and precise way.

This case study was implemented in Sao Paulo, Brazil, which is operated by Sao Paulo Water and Sanitation Company (SABESP), through the Central Business Unit (MC). One of its largest supply zones and with highest lost volumes is the Alpina Village supply zone, with 330 km of mains and 51,000 connections. After collecting the data and the characteristic of supply, the zone was split into 5 sub-zones and 24 district metered areas (DMAs), to prioritize actions to reduce losses, also using GIS (Geographic Information System)

Another key aspect to reduce losses was the staff involvement. To ensure the results and allow the execution of actions in a continuous way, it was created a loss team, with 8 professionals to make the intelligence work: study, planning and implementation of the activities.

With all these efforts, including actions to reduce real and apparent losses, the Alpina Village supply zone has been constantly reducing the losses indicators along the years. The process indicator for total water losses average reduced from 508 L/conn/day in 2007 to 336 L/conn/day in 2011, and the Infrastructure Leakage Index (ILI) reduced from 9.5 in 2007 to 5.4 in 2009

This paper will focus on the lessons learned and results obtained, showing that a loss control program requires much study, planning, staff involvement and good management, using analysis tools such as water balance, GIS thematic maps and a zone division in DMAs.

Introduction

To implement a program to reduce losses in a sustainable manner and with satisfactory results, it is required much study and analysis of water supply system, so the challenge is to make a good diagnosis to identify the locations and areas that contribute to higher loss, to direct the investments in a planned and precise way.

This case study was implemented in Sao Paulo, Brazil, which is operated by Sao Paulo Water and Sanitation Company (SABESP), through the Central Business Unit (MC)., which includes the downtown area and the expanded part of the eastern city of Sao Paulo, and has great social-economic diversity. The MC is composed of 32 bulk supply zones, with 5,930 kilometers of distribution mains and 720,000 service connections

One of its largest supply zones and with highest lost volumes is the Alpina Village supply zone, with 330 km of mains and 51,000 connections. It is a very heterogeneous area, where there are many houses, buildings, shops, industries and some slums.

This paper will focus on the lessons learned and results obtained, showing that a loss control program requires much study, planning, staff involvement and good management, using analysis tools such as water balance, GIS thematic maps and a zone division in DMAs.

Methodology

After collecting the data and the characteristic of supply, such as served population and pressure in the system, the zone was split into 5 sub-zones and 24 district metered areas (DMAs), to prioritize actions to reduce losses. This allowed the determination of individual losses indicators, and the diagnosis of the site with the highest total loss.

Figure 1 – Map with the 5 sub-zones

Focusing on real losses, the study was developed according to three basic factors, using Geographic Information System – GIS (PAIXÃO et al, 2010):

1. Mapping areas with high pressure and with variation between the static and dynamic pressure above 10% (Figure 2);

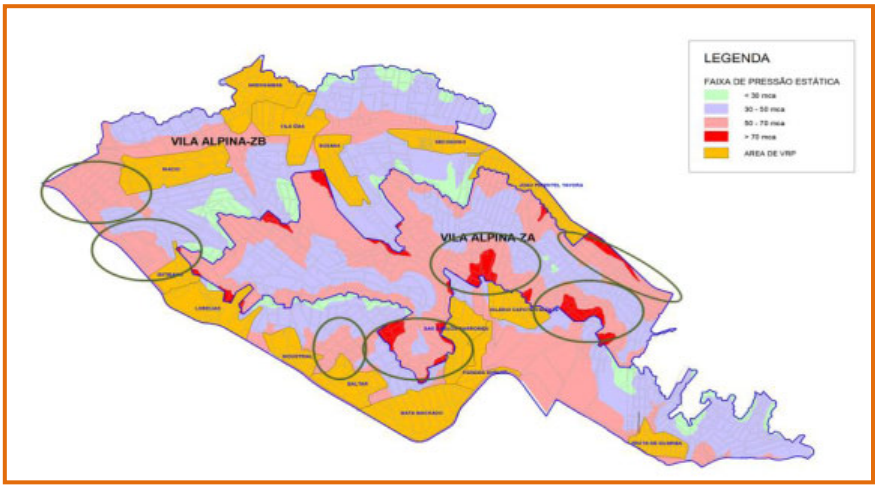

Figure 2 – Mapping of static pressure in Alpina Village supply zone.

Other actions were also carried out to interconnect networks to change the pressure zone (from upper to lower area) in order to reduce the pressure (Figure 3).

Figure 3 – Sequence of activities to interconnect a network in Alpina Village supply zone.

It is important to mention that in terms of pressure management, the work provided a coverage increase from 7.42% in 2006 to 52% in 2011, featuring the installation of a frequency inverter on the water pumping station (Figure 4), which allows the programming of the pressure according to the need of the system, responsible for supplying approximately 20,000 connections, whose range is now stocked with the following parameters:

- 22 mWc from 6 am to 20 pm;
- 12 mWc from 20 pm to midnight;
- 10 mWc from midnight to 6 am.

Figure 4 - water pumping station and the panel of the frequency inverter.

2. Mapping of break frequency in mains, connections and meter sets;

With this information on GIS thematic maps illustrated in a readable size, it is possible, through the overlapping of them, to make a crossing of the data and to identify the most critical areas, with higher break frequency in mains and service connections.

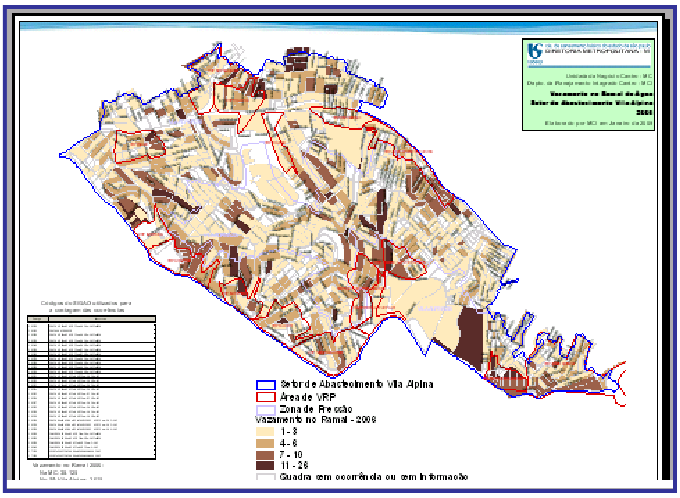

Figure 5 - Mapping of break frequency in service connections.

3. Mapping of unreported leakage in mains and connections.

Further, it was created 24 DMAs (Figure 6), taking advantage of 18 pressure reducing valves (PRVs) areas, 1 upper supply zone with frequency inverter with pressure controller panel, and 5 new DMAs, all of them with devices for measuring flow, allowing the calculation of the loss indicator, analysis and diagnosis of critical areas (Table 1).

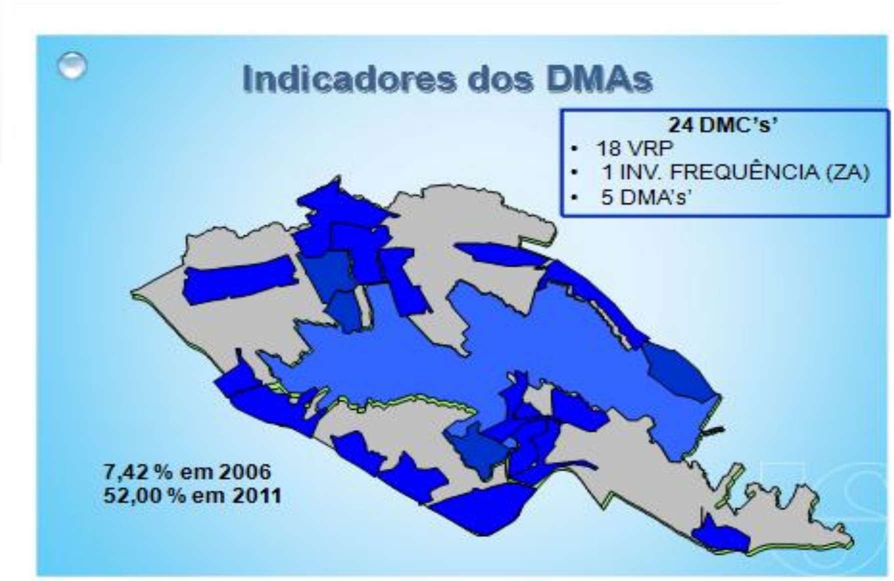

Figure 6 - Map with the 24 DMAs.

Table 1 – DMA water loss indicator 2010/2011.

COMPORTAMENTO DO INDICADOR MENSAL DMC'S'ANO 2010/2011																		
DMC	jan/10	fev/10	mar/10	abr/10	mai/10	jun/10	jul/10	ago/10	set/10	out/10	nov/10	dez/10	jan/11	fev/11	mar/11	RGI	VOLUME M3 ANUAL	IPDT MÉDIA 12 MESES
LOBELIAS	906,19	398,90	650,35	664,54	665,04	1002,16	750,34	553,63	612,05	224,90	427,27	295,60	115,12	234,80	366,69	492	87.263,31	493
INDUSTRIAL	649,58	1015,17	787,06	918,64	892,49	994,08	1003,41	787,18	942,69	463,86	609,49	383,48	569,70	291,94	290,68	452	110.481,98	679
MATA MACHADO	302,66	410,46	249,93	391,09	459,24	263,36	364,60	169,26	255,68	71,11	162,06	140,53	254,22	123,26	156,62	1638	138.134,08	234
INACIO	447,65	838,77	238,07	967,74	1203,07	-4,74	641,34	576,02	670,75	431,24	538,09	573,70	1017,53	680,51	498,76	1075	251.356,64	650
BALTAR	479,08	575,27	383,09	500,43	499,50	338,62	452,75	406,19	481,55	246,88	408,30	446,71	581,99	359,79	476,34	1062	165.641,37	433
FRUTA DE GUARIBA	167,04	798,99	668,14	806,60	714,12	936,83	802,98	778,41	1045,23	655,33	1030,72	865,44	1290,07	955,53	829,09	647	207.888,09	893
VILA EMA	-75,66	640,99	464,23	514,55	1156,62	-472,64	371,50	382,30	277,58	-117,61	54,14	85,16	112,02	43,38	-122,53	635	43.519,25	190
NHENGAIBAS	44,59	280,77	470,08	444,02	692,57	-115,60	-463,77	-414,74	609,59	316,97	338,88	270,76	244,66	80,12	-165,25	1138	62.756,79	153
HILARIO CAPOTE VALENTE	-448,89	-427,67	-485,28	instalado hidro novo (primeira leitura)					568,46	279,26	473,62	394,38	841,40	372,39	738,68	742	139.977,93	524
SÃO CARLOS BARROMEU				Local em obra pelo morador						111,88	223,51	191,30	326,26	166,66	239,54	835	63.083,09	210
SUZANA	403,44	468,02	367,32	495,46	634,62	324,51	559,37	500,76	855,88	555,13	589,33	537,02	950,12	-182,26	469,57	234	44.152,37	524
IBITIRAMA	-2284,80	3147,34	67,25	1160,42	576,97	720,62	276,58	614,06	1664,92	-59,82	-1877,88	3234,82	-800,17	-818,58	-2890,95	112	6.051,31	150
SECUNDINO	869,58	1114,76	984,43	1065,65	1467,32	578,69	1004,69	722,59	106,65	BAYPASSADA				0,38	225,99	512	119.161,92	646
JOÃO PIMENTEL TAVORA				Trocado hidrômetro			515,77	-167,25	239,36	75,71	196,53	942,94	430,81	155,71	108,77	1026	102.532,76	278
PEREIRA AVELAR	-699,41	969,60	4,35	82,51	284,19			169,35	221,08	-43,74	112,80	1085,77	20,95	-132,39	3740,70	156	31.119,54	554
TRES PEDRAS	19,25	24,01	3,46		336,20	106,48	199,45	119,42	164,51	-25,52	-59,46	-69,06	155,88	36,31	103,69	897	31.349,52	97
																11653,00	1.604.469,95	419

After reading and analysis of information, the actions and investments are defined such as PRVs, connections replacement and rehabilitation of mains to reduce losses (Figure 7).

Figure 7 – Study, planning and diagnosis of the actions.

Below there are some examples of the undertaken actions:

- In the areas with high service connection break frequency, it was defined to replace those service connections (Figure 8).

Figure 8 – Service connection replacement.

- With the history of PRV water loss indicators, one of the ways to diagnoses the water loss was monitoring the PRV, comparing the expected pressure reducing and the mapping of the local pressures, including the critical point, which allowed to improve the PRV performance and to locate accurately unreported leaks (Figure 9).

Figure 9 – Unreported leak located though PRV monitoring.

- For mains with a break frequency higher than 8 leaks/year and crust, it was decided to replace them as seen in Figure 10.

Figure 10 – Mains with high break frequency and crust.

- And finally, the installation of PRVs with totally Sabesp´s team, from design to construction project and pre-operation (SOARES et al, 2012), as seen in Figure 11.

Figure 11- Tres Pedras PRV project and installation by Sabesp´s team.

Another key aspect to reduce losses is the staff involvement. To ensure the results and allow the execution of actions in a continuous way, it was created a loss team, with 8 professionals to make the intelligence work: study, planning and implementation of the activities for reducing losses, as well as providing a trained operational staff and with technical knowledge to perform all work necessary to reduce real losses, such as installation of PRVs, valve replacement, extension of water mains, connections replacement and interconnection of mains.

Through monthly meetings, this team discussed the methodologies developed to diagnose and identify areas with higher real losses within the supply zone to direct the actions more efficiently, using the water balance, the component analysis and another tools already mentioned.

Results and Discussion

With all these efforts, including actions to reduce real and apparent losses, the Alpina Village supply zone has been constantly reducing the losses indicators along the years. The process indicator for total water losses average reduced from 508 L/conn/day in 2007 to 336 L/conn/day in 2011, and the Infrastructure Leakage Index (ILI) reduced from 9.5 in 2007 to 5.4 in 2009, as showed on the following figures.

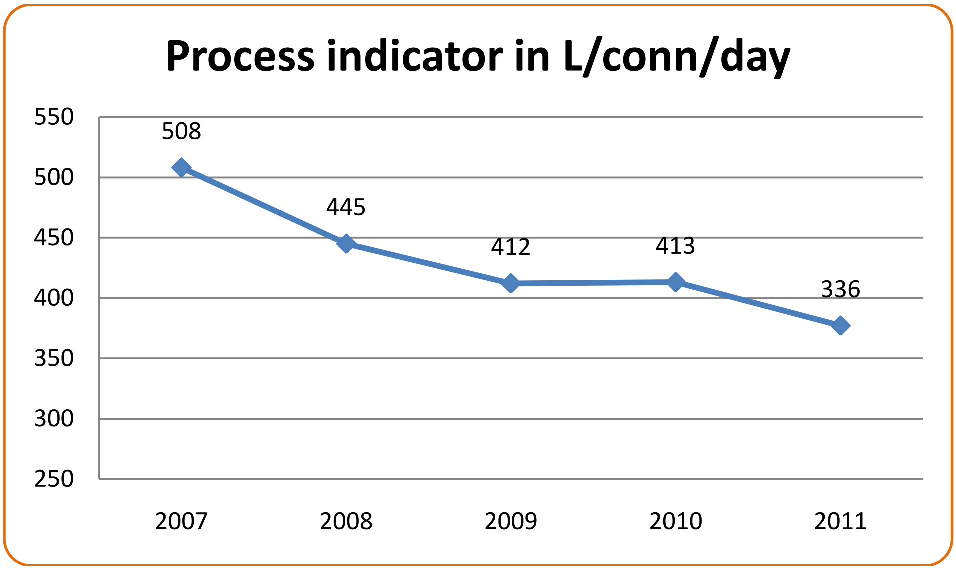

Figure 12 - Process indicator for total water losses in L/conn/day

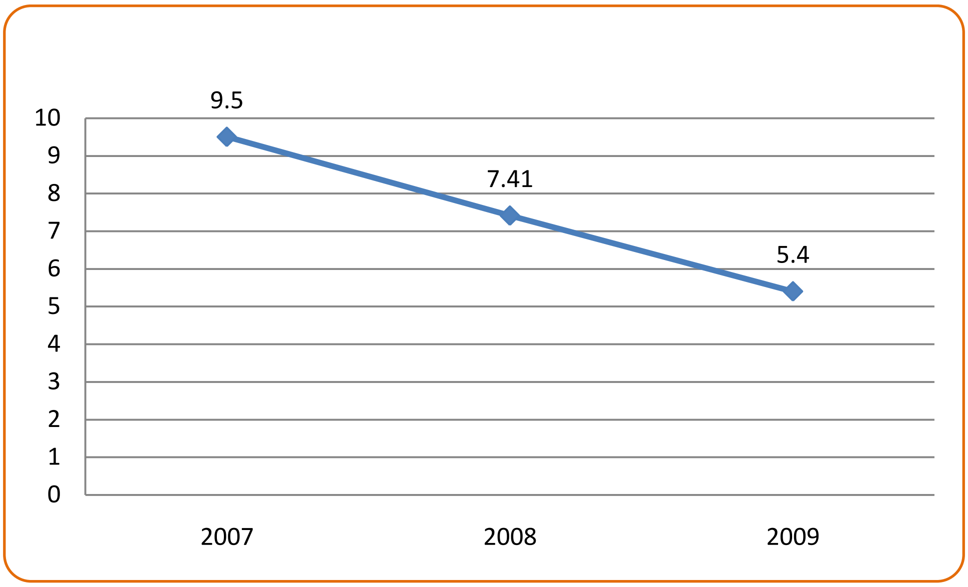

Figure 13 - Infrastructure Leakage Index – ILI.

Conclusions

Therefore, the experience has shown that a loss control program requires much study, planning, and good management, using analysis tools such as water balance, GIS thematic maps and a zone division in DMAs.

Whereas the reduction actions usually have high financial cost, it is necessary to direct efforts in places that really can bring results that justify the investment. And as important as a good diagnosis is the staff involvement, those who are responsible for implementing actions.

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