# Achieving efficient water management at the Federal University of São Paulo, Brazil

## *Alcançando um gerenciamento eficiente de água na Universidade Federal de São Paulo, Brasil*

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## ABSTRACT

In 2015, the water crisis affecting the São Paulo Metropolitan Region reached its peak. The Federal Government published an Ordinance establishing good practices in the management and use of water and electricity. This work aims to verify if management actions performed at the Federal University of São Paulo were effective for water consumption reduction. We assessed measures such as awareness campaigns, water reuse, water pressure regulator installation, identification of leaks, irrigation and washing

of floors reduction. It was analyzed secondary data of the monthly water consumption at *campuses* and Rectory, from 2014 to 2016. Statistical analyses were carried out comparing the water consumption between the pre and post-intervention periods, which occurred in February 2015. The results show that the intervention reduced *per capita* water consumption by 33% in 2015 and 35% in 2016, saving up more than 65,000 $m^3$ of water. These management actions proved to be effective, and the academic population achieved a more efficient use of water and financial resources, becoming more sustainable.

**Keywords:** University environmental management. Sustainability in Public Administration. Rational water consumption. Consumption reduction.

## *RESUMO*

*Em 2015 culminou a crise hídrica que atingiu a Região Metropolitana de São Paulo, levando o Governo Federal a publicar uma Portaria que estabelece boas práticas de gestão e uso da água e energia elétrica. Este trabalho buscou verificar se as intervenções realizadas na Universidade Federal de São Paulo foram efetivas na redução do consumo de água, como campanhas de conscientização, reúso de água, instalação de redutores de pressão nas torneiras, identificação de vazamentos e redução de regas e de lavagem de pisos. Foram analisados dados secundários do consumo mensal de água dos campi e Reitoria, no período de 2014 a 2016. Foram feitas análises estatísticas, comparando-se os consumos de água entre o período pré e pós-intervenção, ocorrido em fevereiro de 2015. Os resultados mostram que a intervenção provocou uma redução per capita de 33% em 2015 e 35% em 2016 no consumo de água, economizando mais de 65.000 $m^3$ de água. Essas ações de gestão foram efetivas e ajudaram a população acadêmica a utilizar com mais eficiência os recursos hídricos e financeiros, tornando-se mais sustentável.*

***Palavras-chave:*** *Gestão ambiental universitária. Sustentabilidade na Administração Pública. Consumo racional de água. Redução de consumo.*

## 1 INTRODUCTION

The concept of environmental sustainability varies in the literature. It is considered ambiguous, multidisciplinary, and variable, acquiring different meanings in different contexts and moments (BUCHANAN et al., 2005). In 1987, the Brundtland Report presented a clear definition of sustainability (PLIETKER, 2010) and established the sustainable development concept: "Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UNITED NATIONS, 1987). Another important concept of sustainability emerged in the late 1990s. The term "Triple Bottom Line" is a sustainability concept comprising three dimensions: social, environmental, and economic (ELKINGTON, 1997), and it aims to be socially fair, economically inclusive, and environmentally responsible (SETTI; AZEITEIRO, 2016).

Higher Education Institutions (HEIs) are significant agents of change (LEAL FILHO et al., 2019) and play an important role in preparing a future generation concerned with sustainability (AMARAL et al., 2019). But it is essential to highlight that the effective concern with the environmental theme in HEIs around the world is recent. After the 1970s, the environmental issue arose in HEIs. However, it was only in the 1990s that this concern grew, and the main actions focused on educational and research solutions related to the environment and sustainable development (TAUCHEN; BRANDLI, 2006). The first meeting to define and promote sustainability in HEI happened in France in 1990, attended by 22 presidents and rectors of universities worldwide. Among the objectives of HEIs sustainable principles and practices should be incorporated. All this to promote knowledge capable of improving the environment in which they operate, and serve as an example for other entities (KRUGER et al., 2011; MACHADO et al., 2013). There are several difficulties in introducing new practices of sustainability in HEIs, such as the lack of knowledge and interest on the part of the academic community, staff resistance to new attitudes and procedures, and lack of pressure from society (MARINHO et al., 2014).

São Paulo is the largest Brazilian metropolis. Like other metropolises, it has grown in a disorderly manner and without concern with sustainability. This city's *multicampi* public HEI is the Federal University of São Paulo (Unifesp). The Unifesp consists of a *campus* and the Rectory in the capital plus five *campuses* in municipalities close to the city of São Paulo, which were called: Baixada Santista, Diadema, Guarulhos, Osasco, and São José dos Campos. A university *campus* is such a diverse space that it resembles a community or a small town (ÁVILA et al., 2017) and the *campuses* of Unifesp present different realities. They are located in multiple areas of the São Paulo State, with different academic structures and administrations. Then, the articulation of the university management and workflow became a challenge to be overcome.

There are many barriers and difficulties in the implementation of environmental sustainability in Brazilian universities (BRANDLI et al., 2015). Despite the "United Nations Decade of Education for Sustainable Development 2005-2014" (UNESCO, 2005) and the crucial role of education in supporting Sustainable Development Goals (LEAL FILHO et al., 2019), there is a lack of policies, interest and know-how (BRANDLI et al., 2015). Through public policies, Brazil has been aiming to encourage tools that promote society involvement, public and private companies in the sense of creating a sustainable system. Currently, Brazilian federal public universities are obligated to monitor their consumption. They need to consciously administrate the resources used in academic activities of teaching, research, extension, and management, considering the reduction of the environmental impact. The Project Sustainable Esplanada (PES), instituted by an Interministerial Ordinance 244/2012, is an example of monitoring. It proposes the adoption of a management model and evaluation of expenses with water and sewage, electricity, cleaning, vigilance, consumption material, mobile and fixed-line telephony, and as a consequence, aims to contribute to the reduction of natural resource consumption (ALENCASTRO et al., 2014).

The university implemented, in 2013, the Department of Environmental Management and Safety (DGA-Unifesp), a structure for the central administration to organize and articulate environmental actions at Unifesp. The department designed policies to establish general guidelines, orientations and tools for environmental management at the *campus*. Few Brazilian HEI has an environmental policy or an environmental management system (MARINHO et al., 2014).

A serious issue faced by Unifesp was a severe water crisis that affected the São Paulo Metropolitan Region (SPMR) between 2014 and 2015. Water is essential for life and the development of society. However, water resources are constantly suffering from several factors such as population growth, land-use changes, agricultural and urban expansion and overexploitation because of economic development (ZHANG et al., 2017). The water crisis between 2014 and 2015 has its cause, not only in the degradation but also in the increased demand for water, the lack of adequate water supply planning, coupled with low rainfall amounts and lack of awareness among Brazilian consumers (MARENGO et al., 2015). During this period, public water supply companies fined users who increased their consumption above their average due to high water availability restrictions. The impact of this water crisis at Unifesp *campuses* was not equal since they are located in different regions. The Guarulhos *campus* water supply is coming from the Cantareira System. The São Paulo, Osasco and Diadema *campuses* are supplied by the Guarapiranga and Billings Systems. They were connected to the Cantareira System, increasing the water supply to that population. All these *campuses* had to adequate their consumption profiles. The São José dos Campos *campus* also went through a restriction period, but it was less severe than in the SPMR. The Baixada Santista *campus,* supplied by the Pilões-Cubatão System, did not face water restrictions.

In this context, DGA-Unifesp designed and published the "Good practices for rational water use", in February 2015. These practices should be adopted by *campuses* considering the water serves cleaning, irrigation of green areas, toilets, scullery, and infrastructure actions. During the same month, the Ministry of Planning, Budget and Administration (MPOG) published the Ordinance 23/2015, establishing good practices for water and electricity use in the Federal Public Administration. Still, in 2015, Unifesp published its Sustainable Logistics Management Plan, according to Presidential Decree 7746/2012 and Normative Ruling 10/2012. In this plan, each *campus* established goals for water and

electricity consumption reduction, among other themes, as a tool for planning sustainability and expense rationalization practices. All initiatives were considered vital to environmental management interventions, being monitored ever since their implementation.

The adoption of essential measures to reduce water consumption rose in the most different sectors of society. Among the most used strategies is the water use monitoring with frequent analysis of variations, which allows quick detection of leaks, water-saving devices, preventive maintenance and water source substitution, such as rainwater harvesting (ABU-BAKAR et al., 2021; JAVANMARD et al., 2020; MARINHO et al., 2019; SOARES et al., 2019; WU et al., 2020). In HEIs, users' awareness (students and employees) and the commitment from top management are other important aspects with an impact on water consumption reduction. The latter is one of the main factors of solidity and success of initiatives that aim to impact the academic community (MARINHO et al., 2019; SOARES et al., 2019).

Thus, this paper presents the management actions adopted at Unifesp and discusses those efficient in reducing water consumption, providing perspectives of the potential tools for sustainable management.

## 2 OBJECTIVES

This article aimed to analyze the effectiveness of the interventions performed at Unifesp in 2015 concerning water consumption evolution, comparison through *campuses* (pre and post-intervention) and the relative indicators of *per capita* water consumption.

## 3 MATERIAL AND METHODS

### 3.1 STUDY AREA

The analysis considered all six *campuses* of Unifesp plus the Rectory head office, located out of the *campuses*. Unifesp's *campuses* are very different from each other in terms of structure, academic population (undergraduate and post-graduate students, professors and technicians), and profile of the courses and academic activities (Table 1). These characteristics affect the numbers in water and other resources consumption.

Unifesp counted with a total population of at least 17,173 people in 2014, 20,057 people in 2015, and 20,872 people in 2016. This population is higher than 71% of Brazilian municipalities and did not consider people visiting the units, such as health consultations in *campuses* of that profile.

**Table 1 |** Qualitative and quantitative data at Unifesp during the study period.

| *Campus* | Thematic Areas | Academic population in 2014 | Academic population in 2015 | Academic population in 2016 | Area ($m^2$) in 2015 |
|---|---|---|---|---|---|
| Baixada Santista | Human Health, Society, and Marine Sciences | 2,237 | **2,653** | **2,747** | 30,322.77 |
| Diadema | Environmental Sciences, Chemistry, Engineering, Pharmacy, and Education | 3,026 | 3,093 | 3,298 | 54,080.67 |
| Guarulhos | Social and Human Sciences | 3,745 | 3,873 | 4,123 | 20,876.10 |

| *Campus* | Thematic Areas | Academic population in 2014 | Academic population in 2015 | Academic population in 2016 | Area ($m^2$) in 2015 |
|---|---|---|---|---|---|
| Osasco | Applied Human Sciences | 1,319 | 1,665 | 1,858 | 19,946.00 |
| São José dos Campos | Computer Science, Technology, and Engineering | 1,267 | 1,538 | 1,727 | 8,530.48 |
| São Paulo | Human Health | 5,579 | 6,802 | 6,759 | 72,374.81 |
| Rectory | Administrative | * | 433 | 360 | 4,888 |

* data not informed

*Source: Elaborated based on the data provided by Unifesp.*

## 3.2 DATA GATHERING

We carried out a descriptive study, using the analysis of case study and ex-post facto research. We used exclusively secondary data collected by the DGA-Unifesp from the official site of the Sustainable Esplanada Project System (SisPES) on April 24, 2017, from 2014 to 2016. The period is justified by the publication of the MPOG Ordinance on February 23, 2015, which established that entities must provide monthly electricity and water consumption information through the SisPES (BRAZIL, 2015, 2017). Within this system, other Brazilian Federal Universities can collect their data and perform a similar study.

Several approaches were conducted towards diminishing water consumption, classified in two categories: education measures and implementation of physical instruments. The first one includes awareness campaigns directed to students, teachers and technical staff. Different media, such as emails lists, inserts on the university website, folders and lectures with specialists helped with this action. Additionally, the environmental teams from *campuses* passed through training for the rational use of water and identification of misuses. The second category consisted of the implementation of several physical instruments to inhibit and limit water use. The administration installed water pressure regulators in the faucets and toilets. Besides, it has identified leaks through periodic inspection and supported the reduction in the frequency of irrigation and floors' washing. Other tools the administration used were: water reuse system, dry cleaning of a clean vehicle fleet, acquisition of cleaning products that dispense water use, preventive and corrective maintenance in the restroom facilities, cistern installation.

At the same time, DGA-Unifesp designed and published the "Good practices for rational water use Manual", in February 2015. These practices were adopted by *campuses* considering the above-mentioned actions in detail. This serves as an orientation guide for reducing water consumption.

## 3.3 STATISTICAL ANALYSIS

We ran statistical analyses of water consumption data from the university on the IBM® SPSS Statistics® Version 21 software.

For annual consumption comparison, we used an average of the 12 months of water consumption *per campus* and from the Rectory, between 2014 and 2016.

The Southeast of Brazil went through a substantial water shortage between 2014 and 2015. Thus, for this study, we considered the segmentation of the time series in February 2015. Therefore, it was separated the pre-intervention period (January/2014 to February/2015) from the post-intervention one (February/2015 to December/2016).

For pre and post-intervention consumption, the segmented regression equation served as a strategy for pre and post-test comparison for temporal data. This regression's model is given by Equation 1, adapted from Wagner et al. (2012):

$$Yt = b_0 + b_1T + b_2D + b_3P + e_t \qquad \text{(Equation 1)}$$

In which:

$Yt$ is the result of the intervention throughout time;

T is the time past since the observation period;

D is a dummy variable for pre or post-intervention, using zero for before the intervention and 1 for post-intervention;

P is the time past since intervention and uses zero for the period previous to the intervention;

$b_0$ is the value at time zero;

$b_1$ is the slope before intervention;

$b_2$ is the change in the level immediately after the intervention;

$b_3$ is the change in slope from the period pre-intervention to post-intervention one;

$e_t$ represents random variability not explained by the model.

This study focuses on b2 values to evaluate the effect of actions for rational water use. They correspond to the difference between consumption pre and post-intervention. When coefficients values are significant and negative, they indicate a crucial reduction after the intervention.

To obtain a parameter for comparing the *campuses*, we analyzed relative indicators of *per capita* water consumption. This rate was calculated by water volume (in litres) *per* academic population (person) *per* day (L/ person/day).

The indicators allow for the verification of the existence of a relative consumption pattern among similar *campuses*. Thus, the *campuses* that have or not have experimental laboratories are prone to have a similar consumption pattern due to using resources such as water similarly (MENDES, 2006).

## 4 RESULTS

### 4.1 ANALYSIS OF WATER CONSUMPTION

The total water consumption at Unifesp reduced every year, reaching a reduction level of around 30% between 2014 and 2016 (Figure 1). Overall, there was a bigger reduction between 2014 and 2015 than between 2015 and 2016. Water consumption presents seasonality according to the academic calendar, being lower during the months of academic recess.

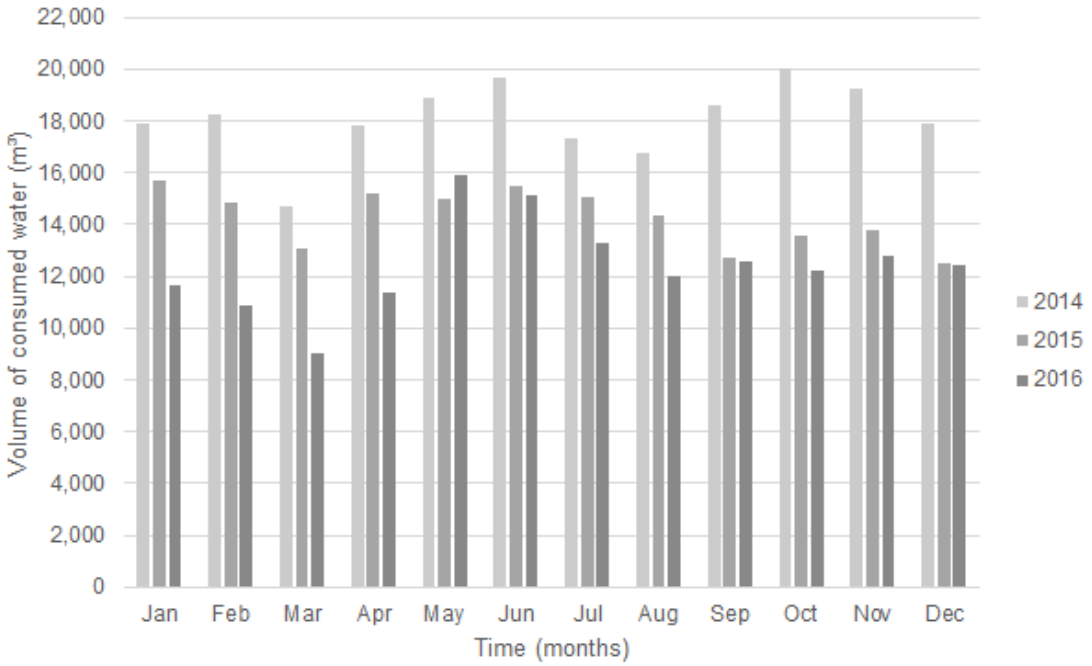



**Figure 1 |** Water consumption at Unifesp between 2014 and 2016.

The almost simultaneous publication of the MPOG Ordinance 23/2015 and management actions led by DGA-Unifesp have encouraged the reduction of water consumption in the university. Table 2 shows the annual average water consumption per *campus*.

**Table 2 |** Water consumption (in m³) at Unifesp's campuses and Rectory between 2014 and 2016

| ***Campus*** | **2014** *(m³/month)* | *2015 (m³/month)* | *2016 (m³/month)* |
|---|---|---|---|
| Baixada Santista | 1,475 ± 497[c] | 832 ± 265[c] | 940 ± 340[c] |
| Diadema | 1,199 ± 276[b] | 624 ± 105[b] | 733 ± 168[b] |
| Guarulhos | 1,097 ± 285[b] | 680 ± 241[c] | 531 ± 277[c] |
| Osasco | 831 ± 170[b] | 397 ± 95[b] | 366 ± 133[c] |
| São José dos Campos | 605 ± 231[c] | 477 ± 82[b] | 503 ± 102[b] |
| São Paulo | 12,438 ± 1,015[a] | 10,903 ± 1,103[a] | 8,988 ± 1,300[a] |
| Rectory | 434 ± 168[c] | 357 ± 64[b] | 381 ± 53[a] |

Average values ± standard deviation

[a] = Variation coefficient lower or equal to 15% - low dispersion

[b] = Variation coefficient between 15 and 30% - average dispersion

[c] = Variation coefficient higher than 30% - high dispersion

The data show that in 2015 and 2016 all *campuses* have reduced their water consumption compared to 2014.

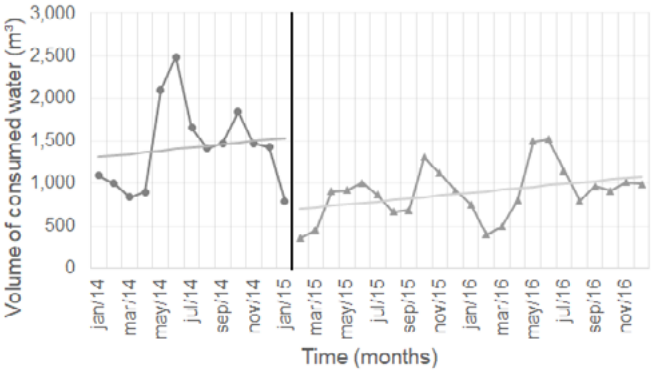
From 2015 to 2016, only the Guarulhos and Osasco *campuses* did not present an increase compared to 2015. There was an increase in the average water consumption at the *campuses* Baixada Santista, Diadema, São José dos Campos and Rectory. However, the increase was less than the scenario in 2014.

Regarding the variation coefficients, it was observed that most *campuses* presented average dispersion in the studied period. During the three studied years, the Baixada Santista *campus* had a high dispersion (heterogeneous data), the Diadema *campus* an average dispersion, and the São Paulo *campus* had low dispersion (homogeneous data). All other *campuses* had different variation coefficients between the analyzed years.

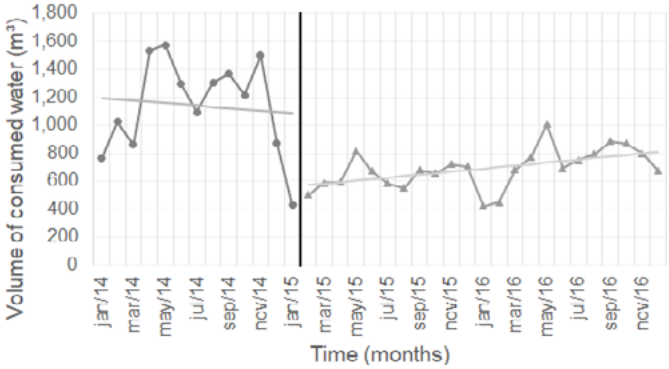
## 4.2 ANALYSIS OF THE INTERVENTION

Figure 2 shows the evolution of water consumption at the *campuses*. It can be seen the consumption observed and the linear regression line adjusted in the period previous to the implementation of saving actions fomented by DGA-Unifesp in parallel with the publication of the MPOG Ordinance. After the mentioned actions, separated by the vertical line in February 2015, we observe the consumption and the regression line until late 2016.

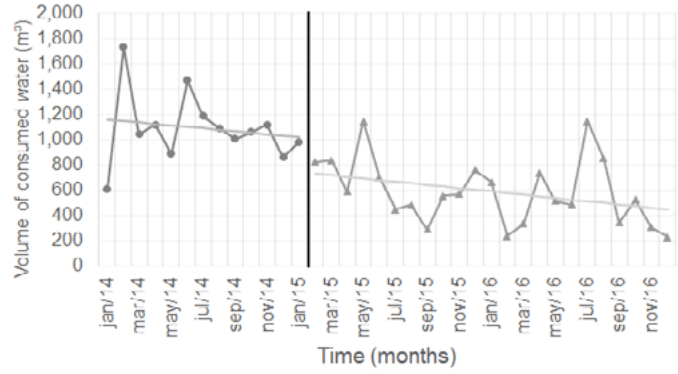
A) Baixada Santista *Campus*



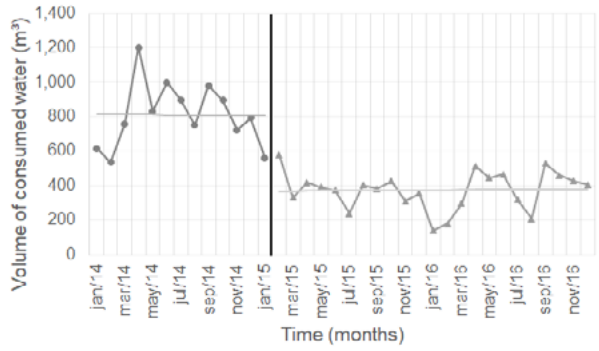

B) Diadema *Campus*



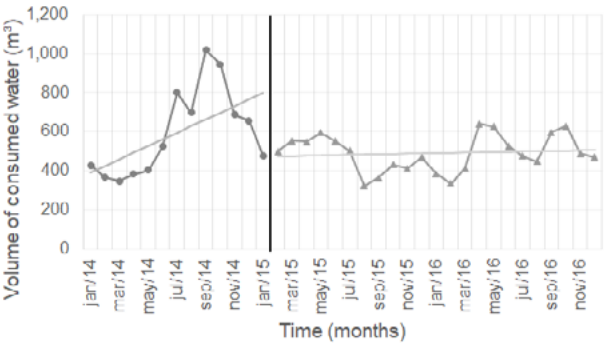

C) Guarulhos *Campus*



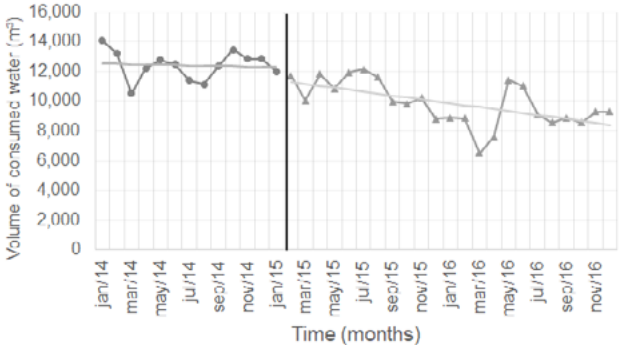
D) Osasco *Campus*




E) São José dos Campos *Campus*




F) São Paulo *Campus*




G) Rectory

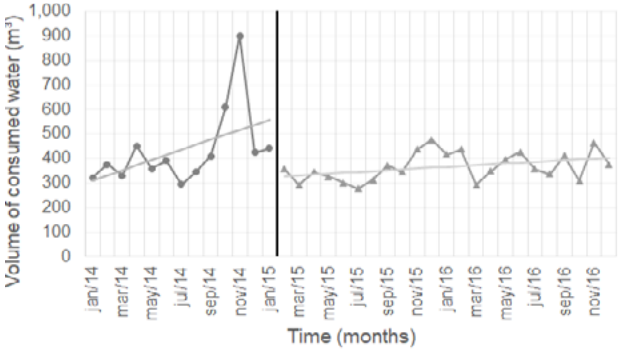



**Figure 2 |** Water consumption at Unifesp's *Campuses* and Rectory pre-intervention (-●-) and post-intervention (-▲-). Diagonal lines: adjusted linear regression lines pre-intervention (dark grey) and post-intervention (light grey). Vertical black line: month of intervention (February 2015)

The actions implemented were on a continuous evaluation monthly, in meetings conducted by DGA-Unifesp with the presence of representatives from each *campus*. These meetings enabled to calibrate the Good Practice Manual orientation. Besides, they permit to evaluate every action and learn from the experience and peculiarities of each *campus*. For instance, the São José dos Campos *campus* adopted a very interesting water reuse system for restrooms discharges. Water storage capacity in *campuses* was compared with estimations of water demand to alert on a need for additional savings' measures.

The Baixada Santista *campus* showed a rising line before and after the intervention, but water consumption decreased after the intervention. The Diadema *campus* before the intervention had a declining consumption, and after the intervention had a growing variation, despite having reduced its water consumption. The Guarulhos *campus* had declining water consumption before and after the intervention. At the Osasco *campus*, the water consumption was reduced after the intervention and was kept stable. The São José dos Campos *campus* and the Rectory had growing water consumption before, and after the intervention, it was reduced and kept stable. At the São Paulo *campus*, the water consumption was constant before intervention and declined after the intervention.

Table 3 shows the segmented regression coefficients, which correspond to the difference between the water consumption before and after the intervention. Thus, all *campuses* had negative coefficients, indicating a reduction. However, not all reductions presented significant differences after the intervention, as for the Guarulhos and São Paulo *campuses*.

**Table 3 |** Segmented regression coefficients (water consumption)

| *Campus* | Coefficient (se) | p-value |
|---|---|---|
| Baixada Santista | - 851.70 (265.29) | 0.003 |
| Diadema | - 526.03 (156.05) | 0.002 |
| Guarulhos | - 274.61 (177.48) | 0.132 |
| Osasco | - 441.03 (99.83) | <0.001 |
| São José dos Campos | - 325.61 (91.87) | 0.001 |
| São Paulo | - 869.71 (793.56) | 0.281 |
| Rectory | - 233.42 (65.28) | 0.001 |

se = standard error

Statistically significant ($p < 0.05$) for the hypothesis that the coefficient equals zero.

Based on this data, *campuses* reduced their consumption: 45,697 $m^3$ of water in 2015 and 21,949 $m^3$ in 2016, equal to the volume of more than 6,765 water tank trucks (10 $m^3$ each). After the water crisis that touched the SPMR in 2014 and 2015, the consumption issue was a determinant factor for changing habits and adapting infrastructure within the *campuses*.

In Table 4, it is observed the *per capita* water consumption (L/person/day) at the *campuses* throughout the studied period and the percentage variation between years.

**Table 4 |** *Per capita* water consumption (L/person/day) at the *campuses* and variation percentage

| *Campus* | *2014* | *2015* | | *2016* | |
|---|---|---|---|---|---|
| | *Water consumption (L/person/day)* | *Water consumption (L/person/day)* | *2015x2014 variation* | *Water consumption (L/person/day)* | *2016x2015 variation* |
| Baixada Santista | 22.0 | 10.5 | -52% | 11.4 | 9% |
| Diadema | 13.2 | 6.7 | -49% | 7.4 | 10% |
| Guarulhos | 9.8 | 5.9 | -40% | 4.3 | -27% |
| Osasco | 21.0 | 7.9 | -62% | 6.6 | -17% |
| São José dos Campos | 15.9 | 10.3 | -35% | 9.7 | -6% |
| São Paulo | 74.3 | 53.4 | -28% | 44.3 | -17% |
| Rectory | * | 27.5 | * | 35.3 | 28% |

* Not estimated, since the data sent were incomplete.

*Per capita* water consumption at Unifesp *campuses* varied from 9.8 to 74.3 L/person/day (average 26 L/person/day) in 2014, from 5.9 to 53.4 L/person/day (average 17.5 L/person/day) in 2015, and from 4.3 to 44.3 L/person/day (average 17 L/person/day) in 2016. This index was lower for all *campuses* than during 2014, showing that the intervention had good results in this first period. While in 2016, the Baixada Santista and Diadema *campuses* and the Rectory presented an increase in consumption comparing to 2015.

The Baixada Santista *campus* was not affected by the water shortage as the other *campuses*. Notably, intervention actions had positive effects on the reduction of water consumption in 2015. Nevertheless, in the following year, an increase was observed. Probably, the opening of a new unit influenced the increase by 9% in water consumption.

The variation in water consumption at the Diadema *campus* followed the changes in the number of undergraduate students during the whole studied period, presenting a reduction in 2015 and a small increase in 2016. The intervention from February 2015 was effective since there was a rupture in the water consumption pattern during those years.

The Guarulhos *campus* reduced water consumption in 2015 and 2016. After the intervention in February 2015, we observe a tendency for water consumption reduction comparing with the previous period. In 2016, there was an increase in the *campus*' academic community. This variation did not reflect an increase in *per capita* water consumption.

Osasco and Guarulhos *campuses* do not have experimental laboratories. Despite this *per capita* water consumption in Osasco *campus* was similar to the *campuses* that have experimental laboratories. There was an inspection of the water network in this *campus*, where the leakage was. The implementation of intervention actions further reduced up to 62% of the water consumption.

There was the opening of the Technological Park Unit at the São José dos Campos *campus*. Despite the increase in the number of students and courses offered, it was observed a reduction of the *per capita* water consumption in 2015 and 2016. This reduction reinforces the importance of using water from the local Rainwater Treatment Plant for flushing toilets.

The São Paulo *campus* has the largest academic population, which associated with the high number of laboratories and assistance services performed in the health area, resulted in a higher *per capita* water consumption. Despite the *campus* having a demand contract with minimum supply among São Paulo's Basic Sanitation Company (Sabesp), we observed a reduction in *per capita* water consumption in 2015 and 2016. Also, it is estimated that the floating population that attends all *campuses* affects the determination of *per capita* water consumption; however, this movement is more intense at the São Paulo *campus*.

For the Rectory, since this unit has different operational characteristics than other *campuses* and conducts only administrative activities, the results were dissonant. The population is low, but water usage higher, resulting in a growth in the *per capita* consumption in 2016, in opposition to the expected one. One possible explanation could be related to the floating population in this building. There are several meetings with members of all *campuses* several times a week in the Rectory. Recently, pressure reducing valves and new toilets were being installed, to improve water use in the building.

## 5 DISCUSSION

The implementation of environmental management in universities is a recent movement in Brazil, and it presents many difficulties due to a lack of awareness about its relevance to the acquisition of resources (BRANDLI et al., 2015).

Effective environmental management systems must be adopted to manage and assess a university environment and education impacts for sustainable development should become common practice in all HEIs (NICOLAIDES, 2006). Moreover, considering the scarce resources in developing countries, the adoption of environmental management systems contribute to important economic savings in university budgets.

Unifesp completed 25 years in 2019, however not until very recently it developed specific issues on environmental administration, especially concerning waste management. The creation of DGA-Unifesp in 2013 boosted the institutional commitment with the consolidation of environmental sustainability at the university. Unfortunately, many Brazilian universities, although concerned with environmental issues, are not implementing measures quickly enough.

Unifesp's initiative in controlling water consumption occurred due to the water crisis. We have to consider pressures in the media due to meteorological occurrences or catastrophic events, usually motivate the initiatives for sustainable use of environmental resources (HAASNOOT et al., 2011; LINNENLUECKE et al., 2012). In this sense, the water crisis that affected the SPMR in 2014 and 2015 led water supply companies to exert pressure on consumption reduction to avoid a shortage, even with fines for those who exceeded the average. The same happens when there is contamination, leakage, rupture of adductors, or other supply problems. Unifesp experienced this situation due to the long drought that affected the SPMR and led to water rotation and the risk of shortage, with the possibility of affecting academic activities and the operation of the university hospital.

Besides the publication of the MPOG Ordinance 23/2015, other measures conducted by DGA-Unifesp were the publication of the Policies and Good Practices for water and electricity savings, and the Sustainable Logistics Management Plan, which was positive as the results showed. Moreover, the *campuses*' directors have equally started to mobilize and support initiatives for consumption reduction

to prevent shortages. Thus, the management actions carried out in 2015 were effective in consumption reduction for all *campuses*, saving up more than 65,000 $m^3$ of water. According to Levy and Marans (2012), the academic community becomes involved with changing habits if institutional efforts related to saving water and electricity are being carried out.

There is still no consensus of a single index to adopt for measuring sustainable development in scientific and political communities. Wilson et al. (2007) have made a comparative review of six types of sustainability indexes and concluded that there is a lack of a global direction to achieve sustainable development. Therefore, initiatives with simplified indexes such as water consumption, as performed in this study, energy consumption, waste generation, and emission of greenhouse gases consist of an important phase in the process of institutional evaluation for Brazilian universities.

Regarding the *per capita* water consumption, most HEIs do not disclose this index (MARINHO et al., 2014). This index is estimated through data on monthly water consumption and academic population, which could be easily calculated if the university compiles and disseminates this data. The average *per capita* water consumption at Unifesp reduced every year and was similar to University of Brasília (21 L/person/day), Federal University of Bahia (26.8 L/person/day) (MARINHO et al., 2014), and Federal University of Rio Grande do Sul (21 L/person/day) (MENDES, 2006). There are large differences due to the sizes and types of laboratories present on *campuses* (MENDES, 2006) and *per capita* water consumption at the São Paulo *campus* was similar to the University of São Paulo (70 L/person/day) (SILVA; GONÇALVES, 2005). Some actions that promoted water consumption reduction were, and still are applied, at Unifesp's *campuses*, such as water-saving campaign, leakage elimination, installation of equipment for water reuse.

Corroborating our study, Hoque et al. (2017) list many North-American, Australian and European universities that adopted actions aiming to reduce the impacts related to their activities. In Brazil, in 2004, the Federal University of Bahia implemented the Project Aquapura and the reduced *per capita* water use by half. The main actions were: students training from various courses, increase in the network of volunteer collaborators and development of projects along with external institutions (MARINHO et al., 2014). The Permanent Water Conservation Program (Pura), implemented in the University of São Paulo, reduced by 36% *per capita* water consumption (SILVA; GONÇALVES, 2005), very similar to results described here (33% in 2015 and 35% in 2016). Pura projected changes in water supply systems, administrative and building maintenance routines, technological development, alternative water sources, and users' behaviour (SILVA; GONÇALVES, 2005).

Wright (2010) identified that financial restrictions can limit the implementation of initiatives for environmental sustainability at universities. An example happens in periods of crisis, while universities are forced to manage their economic resources more strictly, this is also the perfect justification for suspending any financial support to sustainability. At Unifesp, there is no financial subsidy directed to actions for the implementation and promotion of environmental management actions, nor for the creation of technologies to save environmental resources or energy with alternative sources. This difficulty is also observed in other universities around the world and it can be highlighted as one of the main barriers, besides internal political aspects and technical capacitation (LEAL FILHO et al., 2019). In Brazil, the federal government has reduced the transfer of resources to universities continuously during the past years. The reduction of expenses with water and electricity bills, more than an issue for environmental sustainability goal, is a matter of financial balance for universities, a way of survival with resources below the amount needed for the full development of academic activities.

At the frontline of environmentally sustainable initiatives, the University of Michigan has invested US$ 14 million in 2011 in actions aiming to reduce its environmental impacts. In 2015, the President of the university invested US$ 100 million to reinforce the actions related to climate changes, healthy environments, and raising awareness in the community.

On their website, the university presents the percentage of compliance to established goals up to now. They achieved almost 70% of the goals in some of their priority items (UNIVERSITY OF MICHIGAN, 2020).

Knowledge of environmental consequences should be fostered urgently by universities and there should be a firm commitment on the part of the hierarchies in a university to assume more responsible approaches to the management of environmental performance enhancement (NICOLAIDES, 2006). Emphasizing the adverse consequences and linking to the potential economic prejudice could be a way to sensitize the stakeholders towards a sustainable balance.

A limitation of the study was the great difficulty in obtaining data information not available at institutional websites. On this aspect, Yáñez et al. (2019) have shown that the adoption of institutional sustainability reports, which, among other information, cover the development of water and electricity, is essential for the definition and execution of strategic management plans. According to those authors, these documents could contribute to transmitting the values of environmental sustainability for HEI. Regarding the practice of environmental management at the university, limitations are observed regarding the reduced number of employees exclusively dedicated to working with environmental management, the trivial involvement of the internal community and its resistance to adopting new attitudes and procedures or the lack of commitment with the performance of long-lasting actions that do not present immediate results. When analyzing 70 universities globally, Leal Filho et al. (2019) reported barriers to the operation of management structures for sustainability, similar to those observed at Unifesp. Most of these management structures take care of waste management, sustainability campaigns, and specific actions for the promotion of environmental sustainability goals. The improvement of the integration between the development of environmental sustainability and students' curriculum remains a challenge to be overcome by the universities (RAMOS et al., 2015).

Strezov et al. (2017) have made a normalized sustainability ranking applied to many countries. Brazil ranked 14$^{th}$, considering the three dimensions of sustainable development. This may be a path for institutions to adopt a reference of how to measure their dimensions of environmental, social and economic sustainability.

Stafford-Smith et al. (2017) recommended seven implementation categories to achieve the 17$^{th}$ Sustainable Development Goals: finance, technology, capacitation, political coherence, partnerships, data and monitoring, and accountability. In this sense, Unifesp may use these categories as a reference for its actions towards sustainability.

For further studies, we suggest the analysis of water consumption behaviour for longer periods and the application of surveys to the academic community. It is also recommended to conduct investigations considering other aspects of environmental management in universities, such as electricity consumption, emission of greenhouse gases, solid waste management and materials consumption.

## 6 CONCLUSIONS

The analyzed study ratifies the concept of sustainability in the researched context, confirming that the efforts must happen equally in all three dimensions: environmental, economic and social, for environmental sustainability to be achieved within an institution.

Through data gathering on water consumption at Unifesp *campuses* and intervention, we observed that institutional water consumption was reduced from 2015 when there were higher reductions at the Baixada Santista, Diadema and Osasco *campuses*. Consequently, the reduction in water consumption resulted in an economic dimension of sustainability gain, having led to an expressive saving in the expenses with water bills at these units that achieved the consumption reduction goals.

The main aspects that led to the best results in the water consumption reduction were the frequent monitoring, the adoption of sensitizing campaigns, the implementation of devices concerning the water reduction usage through the implementation of physical instruments and leak repairs.

Given the relative water consumption indicator in the first analysed period, all *campuses* had expressive reductions. However, there was an increase in the Baixada Santista and Diadema *campuses*, and at the Rectory, in the last analysed period, compared to the previous year. The differences observed may be due to awareness campaigns initially implemented. Through the analysis of relative indicators, it was possible to observe the consumption behaviour from a macro point of view (*campus*) to a micro point of view (individuals), allowing the observation of changes in attitudes – social dimension. Besides, through the reduction of water consumption, the university allowed for greater availability of the water storage in the reservoirs for other uses by the population, especially the most vulnerable ones without alternative options.

Sustainability in higher education needs to be perceived as a work in progress, and this article opens perspectives for similar studies in other HEIs and reinforces the sustainable management approach.

This article points out the importance of actions that could positively affect the three dimensions towards more sustainable institutions. As far as the levels of implementation of sustainability in university systems are concerned, HEIs may pursue different stages of evolution by focusing on a balance in their activities and increasing their degree of engagement and commitment.

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