FEASIBILITY STUDY OF WATER SAVING MEASURES IN UNIVERSITY CAMPUSES BUILDINGS:
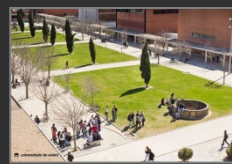## A CASE STUDY OF THE UNIVERSITY OF AVEIRO

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- Sustainable resources management is essential in universities.

- The University of Aveiro already follows several sustainable solutions:
  - irrigation through stored rainwater;
  - concern on the planted species in some garden areas;
  - energy production through alternative sources (solar, geothermal);
  - local water treatment;
  - existence of a green roof;
  - building with rainwater harvesting system is presently in construction.

- However, a focus on restroom water efficiency is lacking, although *EPA (2012)* and *Meireles et al. (2014)* indicate that, in the United States and in Portugal, respectively, the main consumption of water in education facilities takes place in restrooms.

➢ **Santiago Campus of the University of Aveiro**

- 460 000 m^2 ;

- 42 buildings;

- Built infrastructures mainly divided in
    - departments buildings,
    - library,
    - sports pavilion,
    - central administration building,
    - student's dormitory,
    - refectory.

N

Studied buildings

Mathematics Department (MD)

Environment and Planning Department (EPD)

Chemistry Department (CD)

Civil Engineering Department (CED)
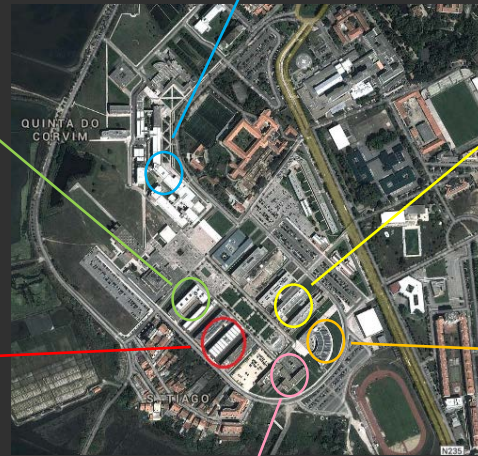
Pedagogic Complex (PC)

Communication and Art Department (CAD)

Construction dates

Mathematics Department (MD)

1993

Environment and Planning Department (EPD)

1979

Chemistry Department (CD)

1993

1997

Civil Engineering Department (CED)

2000

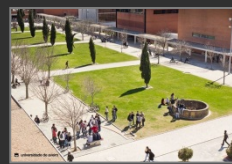Pedagogic Complex (PC)

1996

Communication and Art Department (CAD)
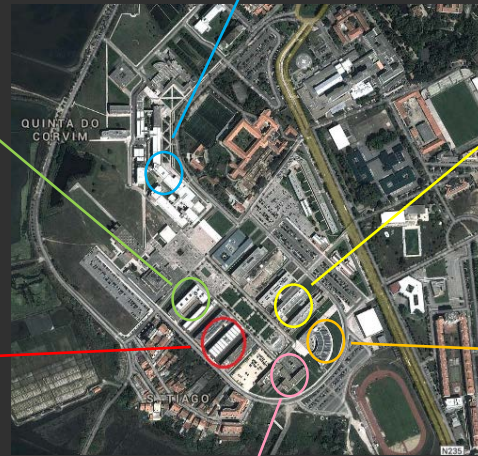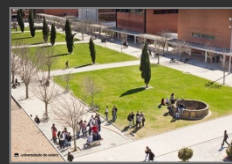
➢ **Studied buildings cover:**

- a wide range of construction dates (from 1979 to 2000);

- the two major groups of programs in the University:

    – exact sciences and engineering;

    – social sciences.

➢ **Audits:**

- Visual inspection to identify the:

    – fixtures characteristics;

    – fixtures conditions.

➤ **Audits:**

- Measurements to determine the discharge/volume of each fixture:
  - taps discharges measured either directly (using a flow meter) or indirectly (by measuring the time to fill a container);

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- Measurements to determine the discharge/volume of each fixture:
  - taps discharges measured either directly (using a flow meter) or indirectly (by measuring the time to fill a container);
  - flushing cisterns water consumption measured by determining the flushed volume;

➤ Audits:

- Measurements to determine the discharge/volume of each fixture:
  - taps discharges measured either directly (using a flow meter) or indirectly (by measuring the time to fill a container);
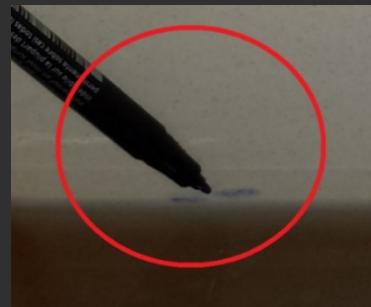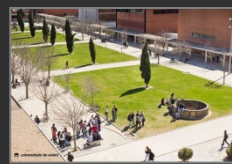 - flushing cisterns water consumption measured by determining the flushed volume;
  - urinal flushing volumes measured directly in the Civil Engineering Department and assumed equal to 2.5 l in the other buildings (corresponding to the average flush volume of 258 urinals of 26 public buildings of the region of Aveiro).

- Number of consumption points and consumption per use in each building:

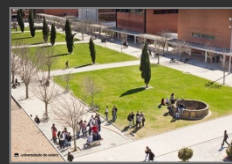| DATA	BUILDINGS					
	PC	EPD	CAD	CD	MD	CED
Number of consumption points						
Restrooms						
Washbasins	21	15	43	15	22	22
Toilets	23	15	32	17	31	17
Urinals	12	12	18	6	7	14
Laboratories						
Sinks				39		
Water consumption per use						
Restrooms (l)						
Washbasins	1.7	4.3	1.5	5.0	3.6	2.4
Toilets	6.0	7.8	9.3	12.0	5.8	7.2
Urinals	2.5	2.5	2.5	2.5	2.5	1.5
Laboratories (l/min)						
Sinks				15		

➢ **Consumption in each building:**

- The buildings are equipped with a **telemetry system** which consists of:
  - i) a water meter;
  - ii) a radio transmitter;
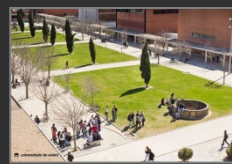 - iii) a data logger;
  - iv) a computer.

radio transmitter

data logger

➢ **Consumption pattern in the Civil Engineering Department:**

● The consumption pattern in the Civil Engineering Department (CED) was monitored (*Meireles et al. 2014)*:

    i) in selected 9 Tuesdays and Fridays;

    ii) during the classes' period, between February and May, 2014;

    iii) from 8:30 am to 6:30 pm.
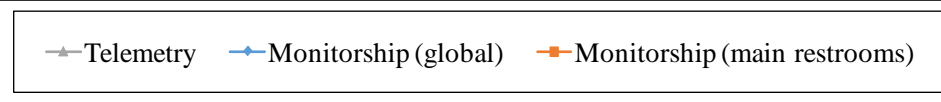
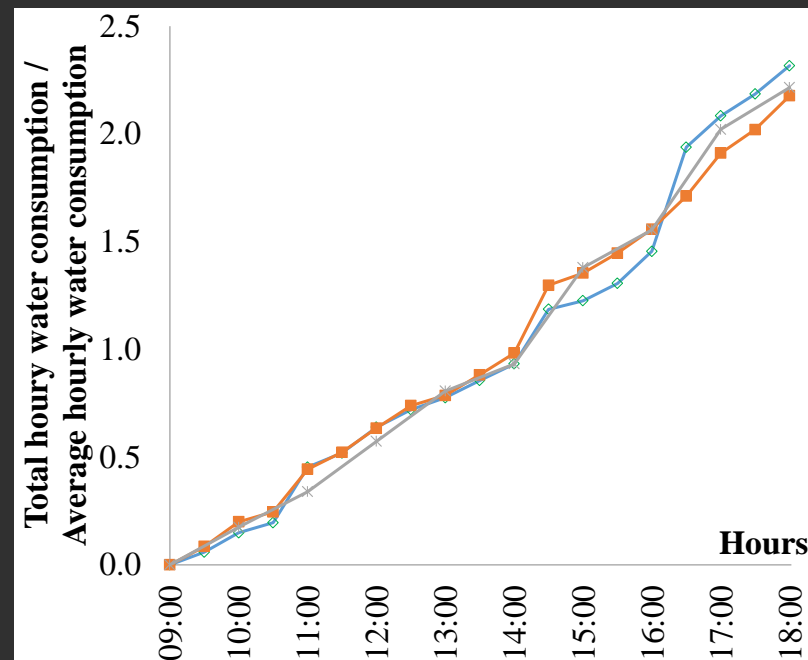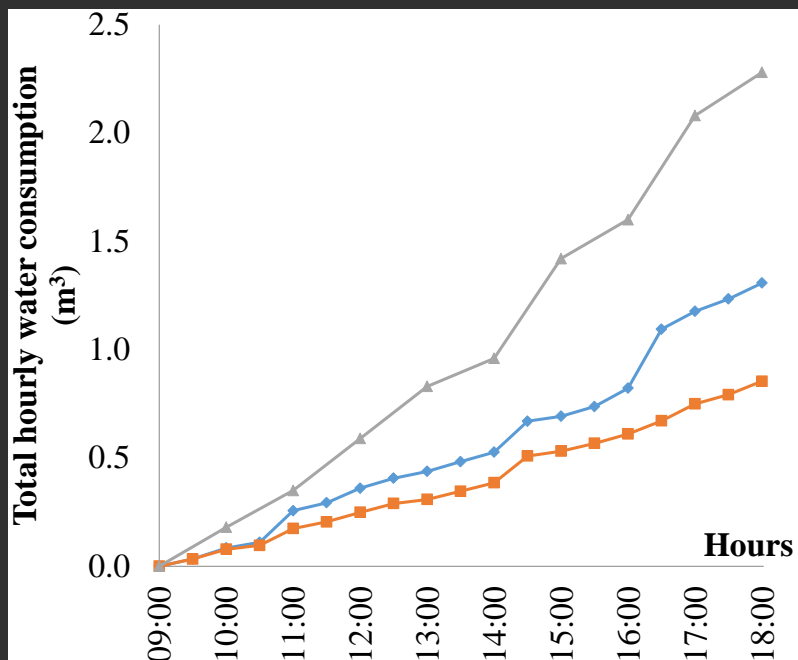➢ **Consumption pattern in the Civil Engineering Department :**

● The monitoring program consisted of **direct and indirect inquiries** to the users in the main restrooms of the building:

    i) The **direct monitoring** consisted on inquiries by a questioner at the entrance of the restrooms

    ii) The **indirect monitoring** consisted on a questionnaire located inside the restroom to be filled by the users.

➢ **Consumption pattern in the Civil Engineering Department :**

● distribution of water per type of use (the consumption in the main restrooms corresponds to 70% of the total water consumed in the building, on average)

Legend: ▲ Telemetry ◆ Monitorship (global) ■ Monitorship (main restrooms)

➢ **Consumption pattern in the Civil Engineering Department :**

- Consumption by volume/number of uses per type of fixture

Legend:
- ■ Toilet
- ■ Washbasin
- ■ Urinal

by volume: 72%, 17%, 11%

by number of uses: 25%, 54%, 21%
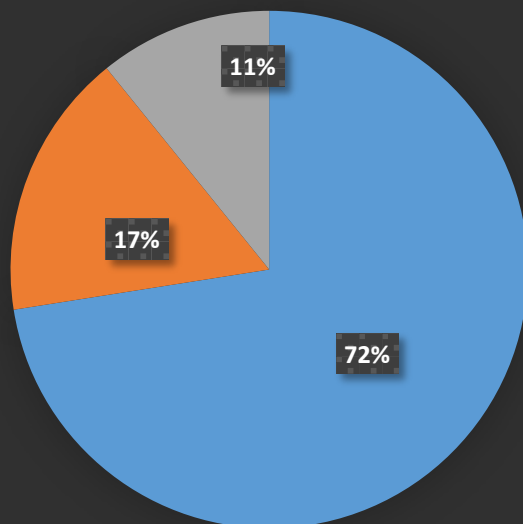
by volume
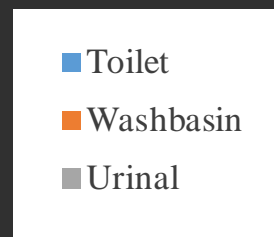
by number of uses

➢ **Consumption pattern in each other building:**

● The consumption pattern in the other buildings was determined using a hybrid approach:

– the distribution of water consumption per type of use of CED was used as a basis;
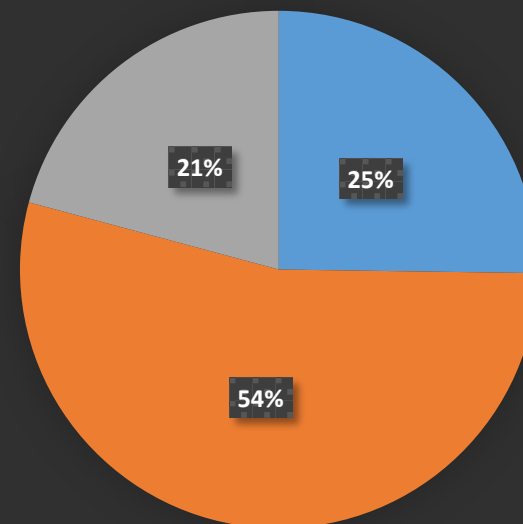
– the number of uses per type of fixture in CED was used as a basis;

– the number of uses in each building was calculated as function of each building total water use;

– the extrapolation of the results was complemented with limited direct observation and information from hourly water consumption records, users and managers.

➢ **Consumption pattern in each building:**

● According to the type of use of each building, the percentage of water consumed in the restrooms was not constant for the 6 buildings:

  – in the Civil Engineering, and Environmental and Planning Departments and Pedagogic Complex 70%-80% of the total consumed water is used in the restrooms, due to their similar uses;

  – in the Communication and Art, and Mathematics Departments, virtually all the water is used in the restrooms, due to the inexistent laboratory activity;

  – in the Chemistry Department, only 30% of the total consumed water is used in the restrooms, due to the high intensity of the laboratories.

➢ **Consumption pattern in each building:**

● The annual number of uses per type of fixture in each building was determined as:

NUMBER OF USES (x 1000)	BUILDINGS					
	PC	EPD	CAD	CD	MD	CED
Restrooms						
Washbasins	217	45	142	203	71	71
Toilets	100	21	66	94	33	33
Urinals	84	17	55	79	27	27
Laboratories						
Sinks				156		
Average total consumption (m^3)	1679	497	1007	7784	535	636

● Due to the large amount of water consumed in the laboratories of the Chemistry Department building, this study also focused on the water consumed in that particular activity.

➢ **Water efficient solutions:**

- Considered the water efficiency labelling scheme developed by ANQIP (the *Portuguese Association for Quality and Efficiency in Building Services*).

- Since most consumption takes place at faucets and toilets, only water efficient solutions for these fixtures were evaluated:
  – installation of discharge reducers in the faucets;
  – toilet flushing volume reducer bags in the toilets cisterns.

➢ **Water savings potential:**

● Considering the previous water efficient solutions, was estimated a water saving potential of about 200 m^3 per building per year, with exception of the Chemistry Department, which has a higher saving potential due to its intensive water consuming activities.

WATER SAVINGS	BUILDINGS					
(m^3/per year)	PC	EPD	CAD	CD	MD	CED
Restrooms						
Washbasins	145	149	76	810	185	96
Toilets	0	36	218	563	0	40
Urinals	0	0	0	0	0	0
Laboratories						
Sinks				1401		
Total	145	185	294	2774	185	137

➤ **Water savings potential:**

● Water saving potential ranged from 9% to 37%, with an average of 30%:

DATA	BUILDINGS					
	PC	EPD	CAD	CD	MD	CED
Year of construction	2000	1979	1996	1993	1993	1997
Water savings estimate [%]	9	37	29	36	35	22

   – the most recent building has the lowest saving potential;

   – the oldest building has the highest saving potential;

   – between the other buildings, the Civil Engineering Department has the lowest saving potential, which may be due to some awareness on water efficiency of its users.

➢ **Financial appraisal potential:**

● Due to the low investment cost of the water efficient measures (less than 600€ in each building), they are also highly viable in financial terms:

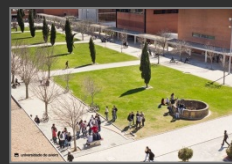| FINANCIAL APPRAISAL	BUILDINGS					
	PC	EPD	CAD	CD	MD	CED
Investment (€)						
Restrooms						
Washbasins	200	143	409	143	209	209
Toilets		75	160	85		85
Urinals						
Laboratories						
Sinks				371		

➢ **Financial appraisal potential:**

● The yearly saved amount is not very significant in most cases, but the low payback period (less than 7 months for every building) and the low investment makes it a very attractive investment in terms of relative performance:

FINANCIAL APPRAISAL	BUILDINGS					
	PC	EPD	CAD	CD	MD	CED
Savings (€/per year)						
Restrooms						
Washbasins	542	559	283	3038	695	361
Toilets		136	819	2110		152
Urinals						
Laboratories						
Sinks				5253		
Payback period (months)	4.4	3.8	6.2	0.7	3.6	6.9
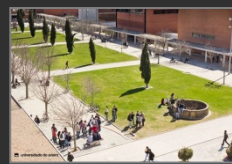
- This communication reports the findings of a study on the water efficiency potential of Portuguese university buildings.

- For the presented case:

  - the average water savings potential is of 30%

  - The payback period is very low (less than 7 months for every building).

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