

IMPROVING EFFICIENCY IN WATER USE AND CONSERVATION IN SPANISH HOTELS

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ABSTRACT: Hotels are a fundamental component within the tourist Spanish sector, and its role in water management turns out more relevant taking into account the fact that tourist areas, in which they are generally located, are water scarce. Trying to go further from the standard ratios and estimations to plan water conservation, this work intends to really measure and quantify water use in rooms. Only by doing this, later conservation actions, now able to be reliably specified for each specific use, could achieve a real success.

1. Introduction

For last three years, a research project devoted to learn in-depth the real composition of final water uses in urban areas has been being carried out at the Institute for Water Technology (Polytechnic University of Valencia, Spain). Further from global figures periodically (monthly, bimonthly...) read at water meters, if proper and accurate studies on water conservation are to be undertaken, it is necessary to know the real percentage that every final specific use takes. For past now, already finished, efforts have been done onto water uses in the residential sector, and results thus obtained have been correspondingly published (Arregui et al., 2002; Cobacho et al., 2003; Gascón et al., 2004).

Current target is now focused onto the use of water by the tourist sector, mainly for the Spanish Mediterranean autonomic regions, and, as a first and main approach, on hotels.

The reason that justifies the study is rather simple:

- These Mediterranean regions are undoubtedly among the most affected in Spain by constant water scarcity and periodical droughts, and this fact gives rise to unavoidable conflicts in uses and pressure on natural resources.
- The weight of tourism in the economy of those regions is quite significant. According to INE (2004), the total number of hotel vacancies for such regions roughly amounts up to 700,000, which would put this single area at a 6th place in the ranking of European countries.

Very good studies have already been carried out and published on water use in hotels, and improvements in efficiency and conservation correspondingly achieved (O'Neill et al., 2002; EA, 2004). Also in Spain some works have become milestones in this field: ECODES (2001 and 2003), and Manchado et al. (2002).

The work presented in this paper intends to reach a different aim by applying an alternative methodology. Considering that a significant part of water consumption in a hotel is demanded by the needs of guests in their rooms, and that those needs are satisfied by standard water uses in the bathroom, the methodology prepared for this study is adapted from that already developed for the residential sector.

The fundamental idea is, in principle, a similar one. Today, great hotels in Spain accurately monitor operation and maintenance parameters by means of remote sensing networks and software analysis in real-time. But, in times, water consumption monitoring lies in daily taking water meter readings. Valuable information is thus obtained, but may be, a bit too general. Modulation curves of hotel water use, like the one shown in Figure 1, and benchmarks like those published by Thames Water as reference guidelines (Table 1) are examples of the kind of results that hotel meter readings can provide.

Figure 1. Modulation curve of hotel water use

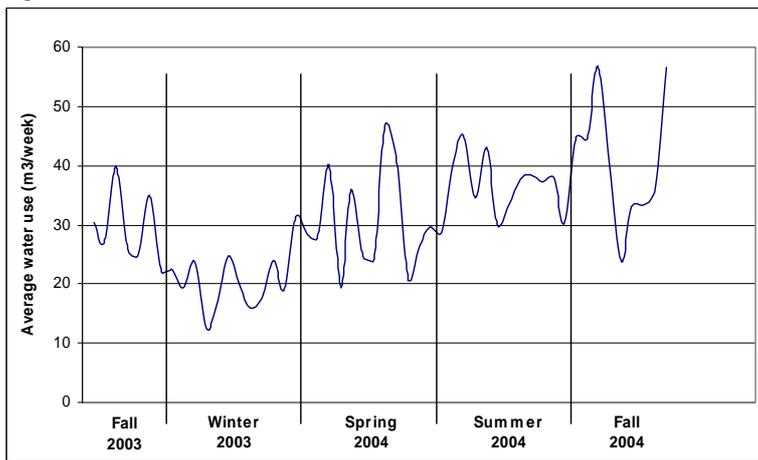


Table 1. Water use benchmarks for hotels (Thames Water)

Hotel star rating	Water use categories (m ³ /bed/year)			
	Low	Average	High	Very high
2* and 3*	0 – 35	35 – 60	60 – 110	110 – 260
4* and 5*	0 – 80	80 – 100	100 – 220	220 – 260

It is clear that all these figures directly depend on factors like occupancy rates, kind of facilities, habits of guests and personnel, etc., and correlation analysis can be performed to identify such relationships. But by doing so, there will always be a gap between the initial total water consumption figure and the resulting estimations *assigned* to guests' needs, hotel running activities and maintenance. And that gap enlarges when trying to go deeply in each of these points.

A possible way to overcome that gap is given by the chance of *jumping* from indirect estimations to direct measures. Real figures will be thus obtained, and sound subsequent calculations on both use and conservation could be performed. This paper will present the method prepared for this aim, and the results obtained so far.

2. Learning about water use in rooms

The stated method is based on:

- Getting accurate measures of water use by means of the adequate water meters and data-loggers, to obtain, thus, the highest possible amount of information.
- Processing that information in an accurate, detailed and convenient way.

As it will be seen, this way of working turns out complex and time-consuming, that is the reason why it cannot be applied to all the rooms in a hotel. An adequate sample has then to be selected. Parameters of selection should be carefully considered, and they should comprise at least:

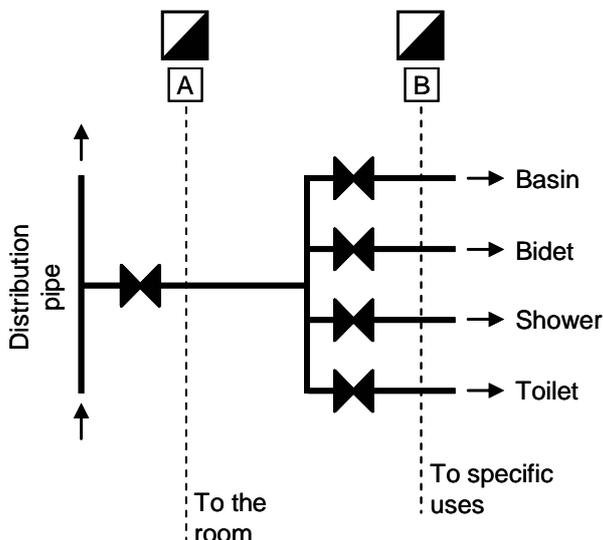
- High occupancy rate.
- High rotation of guests.

These two points can be enough for the former stages of the study. It can now be advanced that for later steps, detailed studies on guests' habits could be done if further information is available.

2.1. Accurate measures

Figure 2 shows a standard cold water inlet of a hotel room. It is as simple as four small diameter pipes, each one for a bathroom specific use (basin, bidet, shower and toilet), branching from the general distribution pipe.

Figure 2. Diagram for a hotel room standard water inlet



Choosing the allocation to install the registering equipments for water use monitoring poses no difficulty, and Figure 2 shows the most convenient ones (correspondingly, a parallel assembly should be done for the hot water inlet):

- Letter B points the inlets of four different specific uses, taking this allocation would entail the need of four different registering equipments. This alternative turns then rather expensive, though later information processing could be easier, since no differentiation between uses is needed. However, a couple of practical drawbacks might make this option nearly impossible when carrying the installation: first, four (accurate) water meters could be too many for the available space in this kind of facilities, and second, avoiding leakage in them all (considering the additional and necessary assembly devices) is not, for sure, a short or light work.
- Letter A, on the contrary, is the cheaper alternative that, in turn, requires a more reasonable installation work. The difficulty in this case could result harder

though: all water uses are absolutely mixed in the records, and unless the data process is accurate enough to be able to distinguish and separate them, the whole work could become almost vain. All in all, this is the allocation selected for the study here presented.

Water meters used in this work are those volumetric (oscillation piston) of C class of accuracy. Automatic data acquisition has been possible by means of pulse-emitters connected to the meters that send information to data-loggers at a rate of 1 pulse per each 0.1 litre accounted. These pulses are finally stored at the logger for later process.

2.2. Accurate data processing

Now, all water uses are stored and ready for analysis. The first step to begin with it is determined by distinguishing different water specific uses, and the way followed to do so is based on a visual direct identification: after data processing, a water ‘consumption profile’ is obtained, and by plotting that profile, particular features of each specific water use become perceptible. Thus, every single use of water is identified and assigned to the appropriate category: faucets, shower and toilet, bearing in mind that advantage for further analysis should be taken from the fact that information is obtained from two different sources: cold and hot water.

The relevant point of the analysis, however, comes after uses identification, because now every single water use is not only identified but fully quantified: duration, flow, volume and time, and they all are gathered in a large table for further study and final results.

3. Results: how water is used in rooms

An initial general study on the processed results yields the overall percentages of water per use, shown in Figure 3. As deepening in the analysis, a second stage would evaluate volumes and flows per specific use, and hence flow-rate histograms shown in Figure 4 are obtained. In turn, all this information about water uses can be combined by occupation rates to produce a new class of water use ratios, correspondingly shown in Table 2.

Table 2. Volume per specific water use in hotel rooms

	<i>Volume of water use (litres/day/room/guest)</i>				
	<i>Faucets</i>	<i>Shower</i>	<i>Toilet</i>	<i>Leaks</i>	<i>Total</i>
<i>Cold Water</i>	20.73	14.40	19.49	0.03	54.65
<i>Hot Water</i>	15.26	13.03	-	0.20	28.49
<i>Cold + Hot Water</i>	35.99	27.43	19.49	0.23	83.14

And finally, since every single use has been monitored, it is possible to get final statistics about the number of times every device in the bathroom has been used, as shown in Table 3.

Table 3. N° of uses per specific water use in hotel rooms

	<i>Number of uses (n°/day/room/guest)</i>		
	<i>Faucets</i>	<i>Shower</i>	<i>Toilet</i>
<i>Cold Water</i>	6.18	0.48	2.45
<i>Hot Water</i>	5.36	0.45	-

Figure 3. Percentages of water use in rooms

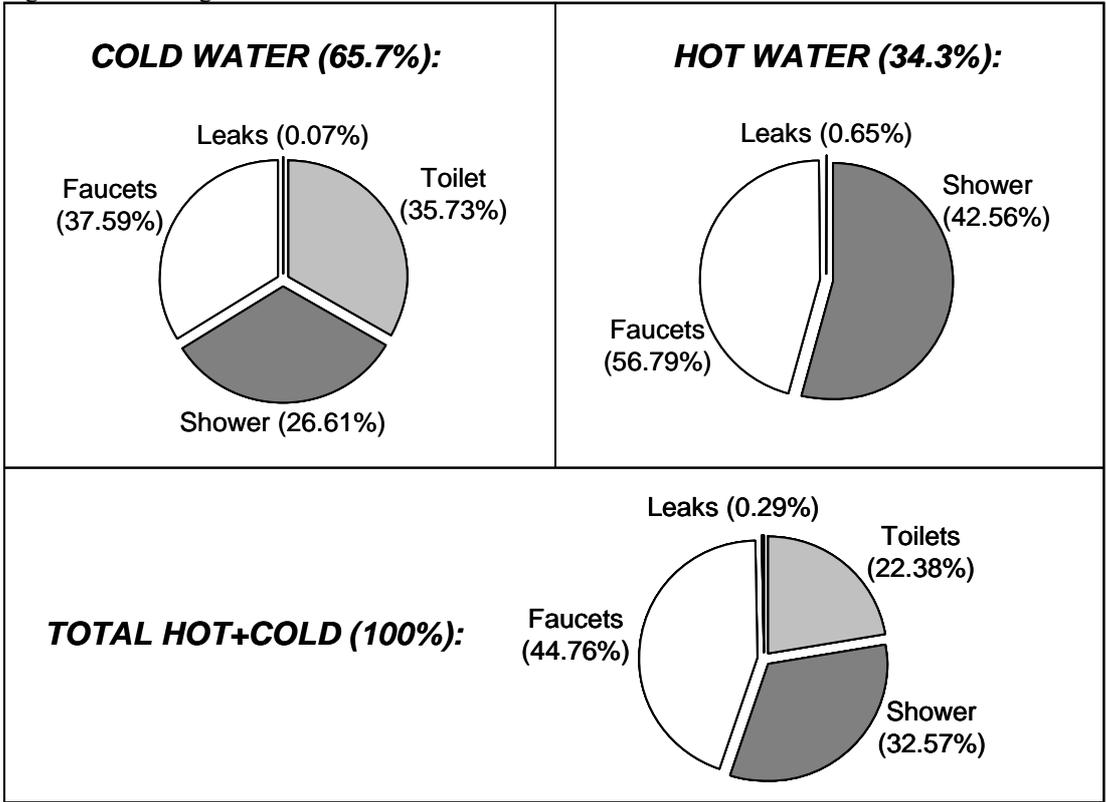
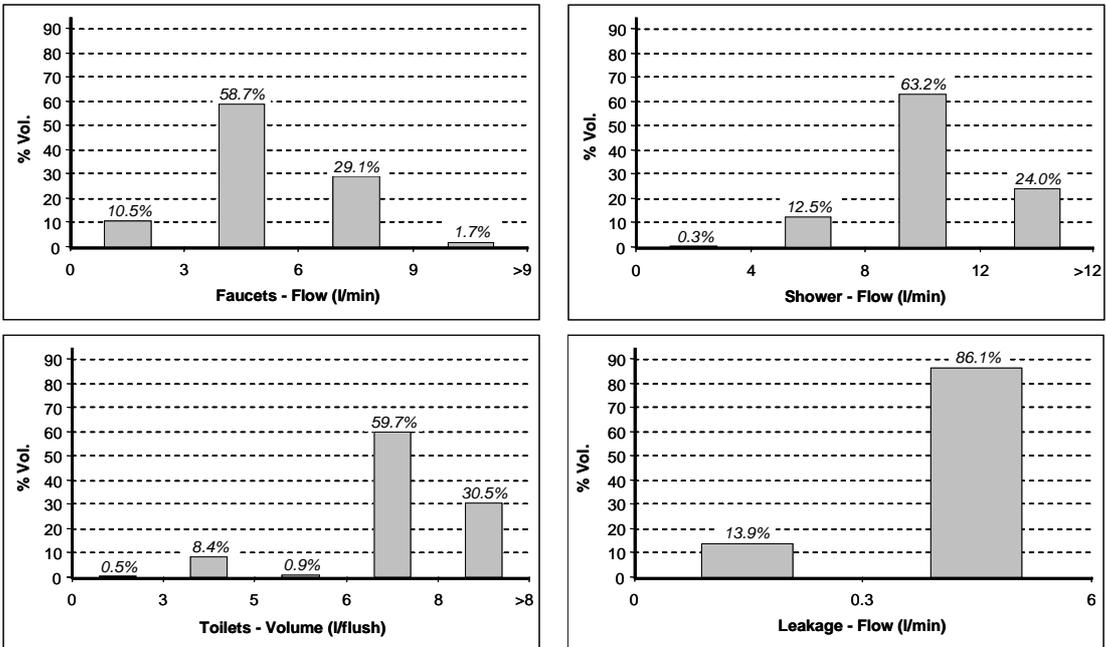


Figure 4. Flow-rate histograms for specific water use in rooms (total cold + hot water)



4. Discussion and future works

These results could face this case-study with ratios like those presented in Table 1, getting thus an idea on this hotel compared to an international reference. And so, it would be qualified within the category of (real) LOW water consumption hotels, for hotel's features are 4* and 28 m³/bed/year. Of course, this represents the fundamental first stage of any analysis, but at this same point it would have to finish, since particular conditions (urban hotel, new construction, efficient water use facilities...) drop out from that single number.

This work intends to highlight the fact that a detail-study on water consumption like the one presented yields wider and far more accurate results than standard ratios calculation. Apart from the information displayed in the previous graphs on volumes, flows and number of uses, some other points could be remarked:

- All the toilets in the hotel are dual-flush type. However, the use percentages for each kind of flush look surprising: 90% total flush vs 10% partial flush. In principle and according to common guests needs, the difference between such figures should not be so great, but worse, from a sensible view, those two figures should have resulted just switched. Hence, an initial conclusion would state that guests' perception and habits do not look very much concerned about efficiency when using the toilet.
- Average duration for shower uses is 4.5 minutes, though further work is needed here since we cannot still compound one whole shower from its different shower uses.
- Having tested the flows for bidet faucets (maximum flow of 8.3 l/min for either hot, cold or mixed water), regular bidet uses have not been clearly identified. This would also be an interesting point about water use habits, but in this case further work is needed before stating any sort of conclusion.

Now, a second strength of the study relies on the next step: if that ratio is wished to be improved by implementing water efficiency measures, the information to get the work is already available. And by both measuring pressure at consumption points (that ranges between 2 and 3 bars, depending on pumps working) and considering technical low-flow performances for faucets and showers (Cobacho et al., 2003), sound estimates can be advanced:

- New efficient flow-rates under these conditions would be: 6 l/min for faucets and 8 l/min for showers.
- Only current flows above those figures would be significantly reduced, so by performing volume efficiency calculations, expectable (and conservative) reduction percentages turn out to be: 7% for faucets and 23% for showers.

Apart from the chance to improve current knowledge about water use in rooms, upcoming stages of this work will now focus on:

- Extending the analysis to other water uses in kitchen, irrigation, pool...
- Developing a pilot test to confirm or correct, if necessary, estimates on conservation presented above; and hence preparing an appropriate cost-effectiveness study to schedule the implementation of efficiency actions.

In mid-term, reductions in water use will be oriented towards their energy conservation aspects, revealing thus a second field of possibilities this kind of accuracy-study of water

use may retrieve for both the tourist sector, and the sustainable management of water resources, within the framework of the Mediterranean Spanish coast.

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