Understanding the influence of smart sensors on domestic water use behaviour

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WATER INFRASTRUCTURE AND RESILIENCE
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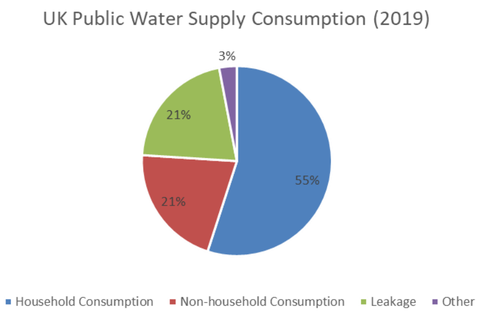

Figure 1 (*Meeting our future water needs, EA, 2020)*

Household consumption comprises over 50% of public water demand in the UK

Implications of excessive water demand:

Ecological damage
- Wetland degradation
- Riverbeds run dry

Increased supply costs
- Need to dig deeper wells
- Need for more water treatment

Health risks
- Increased concentration of contaminants
- Possible use of unsafe water resources

Social upheaval
- Increased inequality
- Conflicts if water bans are enforced

Background

Despite the availability of more efficient appliances, household water demand has stuck at 140 l/p/d

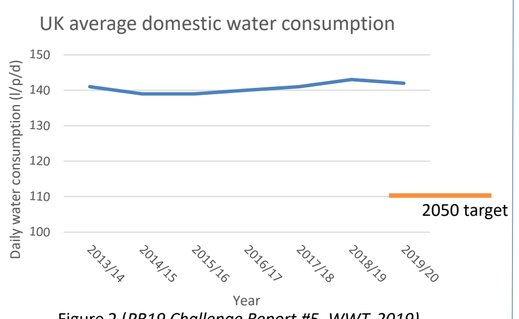

Figure 2 (*PR19 Challenge Report #5, WWT, 2019)*

Why?
- Gap between perceived and actual consumption
- Little incentive to reduce consumption
- Lack of knowledge on how to reduce consumption

Goal: Increase public water availability by 4,000ML per day by 2050

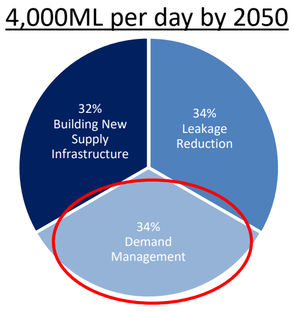

Figure 3 *(Preparing for a drier future, NIC, 2018)*

Demand management is a key pillar of the strategy for increasing water supply and improving drought resilience

Smart sensors, which instantly collect and transmit water use data, can empower water users and influence them to consume less water at home

How?

Inform people of their actual water use

Challenge people to reduce water use

Improve communication between users and suppliers

How can smart sensors influence households to use less water and improve societal resilience to droughts?

Research Objectives

Table 1

Objective	Method
1. Explore how smart water use sensors have already been used to generate behavioural change and water consumption reductions	
2. Understand how smart water use sensors open doors for better water governance and water company-customer relationships	
3. Investigate users perception of smart water use sensors and engagement with data	
4. Collect empirical evidence on the impacts of behavioural interventions on water consumption	

Methods

Literature review
- *How do smart sensors influence water use behaviour and improve engagement in water governance*

Surveys
- *Qualtrics, multiple choice format*
- *Demographic data pre-intervention, attitudes towards water sensors post-intervention*

Interviews
- *Industry experts in smart sensors and demand management*

Aguardio sensors (500+)
- *Installed in each bathroom*
- *Sensors display shower timer and QR code with daily shower data*

Waterfall sensors (10)
- *Installed in building blocks*
- *App for users to view data*

Experimental Design

500 Aguardio water use sensors installed in shower cabins of single-occupation campus residences

Treatment groups:
Control: no timer display
T1: Timer display
T2: Timer display + education message
T3: Timer display + water saving incentive

Timeline:
Devices installed over summer 2021
Data collection will begin in October 2021
Interventions introduced in January 2022

Waterfall water use sensors to be installed underneath 10 campus residence buildings

** Treatment groups yet to be finalised*

Early Findings

Average water savings of 5-20% from installing smart sensors and providing households with water use feedback

Instant feedback provided at the same time of water use yields greater water savings

Behavioural interventions like gamification and incentives for saving water are promising strategies

Results from previous trials on campus show that visible timers cause a 26% reduction in shower durations

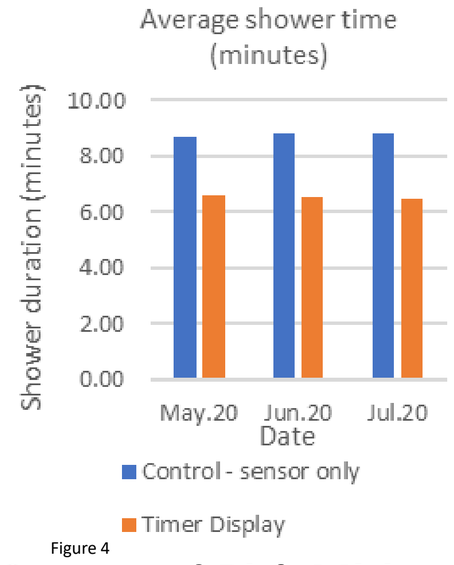

Figure 4

Experimental Setup and Risk Mitigation

12 Aguardio shower sensors installed in Cranfield University halls (2/12 sensors regularly collected data in July 2021)

Figure 5

Figure 6

Sensors being tested and data cleaning process is being established
- Checking the sensors only measure shower flows and do not activate when taps and toilets are used
- Manually cleaning data to ensure that only actual shower events are being analysed

July - Average shower times before data cleaning
Sensor 1 average: 4 minutes 44 seconds
Sensor 2 average: 2 minutes 33 seconds

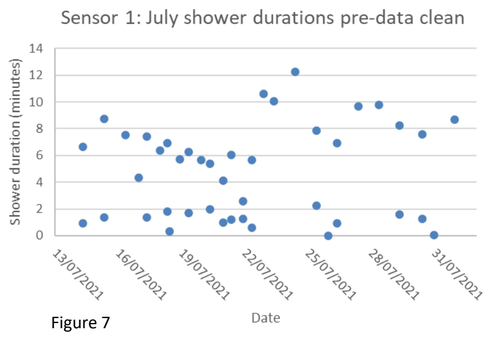

Figure 7

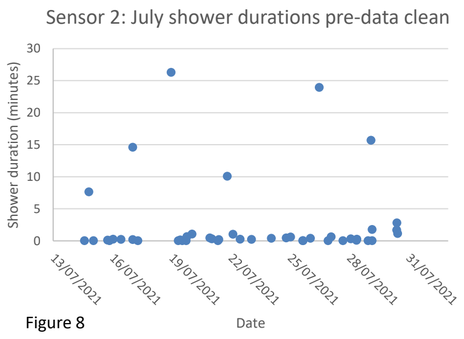

Figure 8

July - Average shower times after data cleaning
Sensor 1 average: 7 minutes 59 seconds
Sensor 2 average: 11 minutes 9 seconds

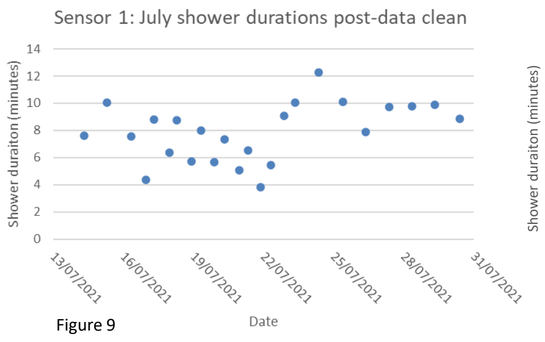

Figure 9

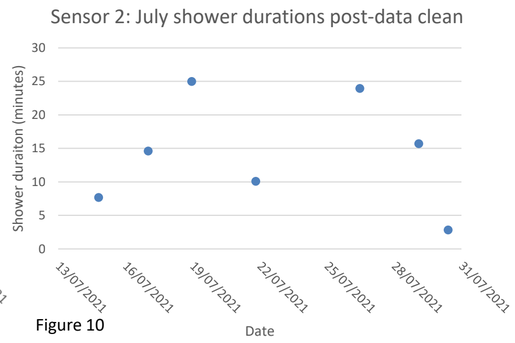

Figure 10

Future Work

- Continued installations of Aguardio and Waterfall sensors and testing of behavioural interventions on household water use
- Investigation of dishwashing behaviour and how smart sensors can generate more sustainable dishwashing habits

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