Statistical analysis of water efficiency, metering, rainwater and greywater savings
(or how I learned to love looking at toilets)

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Acknowledgements

- Project completed on behalf of water industry collaborative fund

- Project team:
  - Rob Lawson
  - Victoria Ashton
  - Keith Ponsonby
  - Dene Marshallsay
A brief history of me

Age 11: Stood in river

Age 18: started BSc in Physical Geography

Age 21: 1st job: Graduate Hydrologist (did involve poo)

Age 24: MSc thesis in the effect of hydropower releases on salmon

Age 29: Asked to look into toilets…
Water efficiency...the early years (late 90s)

- Dual flush toilet study
- Water butts
- Greywater recycling

Plate 3.3: The Peter Brann Device
The dial selector around the toilet handle determines the size of the flush, based upon the length of three tubes which extend below the device (not visible). The siphon is broken when water level in the cistern falls below the bottom of the tube selected.
Quantification of the savings, costs and benefits of water efficiency

- Principles of research
- Study design
- Introductory statistics

We determine a significance level of 5% for the test. Using the TTEST function in Excel (specifying two tailed test, assuming unequal variances) we obtain a t value of 6.11x10^{-5}. This is extremely small, and enables us to reject the null hypothesis. In retrospect we could have rejected the null hypothesis at the 1% significance level.
Which brings us to the current project...

- Request to water companies for recent projects
  - Fifty projects proposed
    - Nine stand-alone water efficiency projects
    - Nine phases of ESW H2Eco
    - Seven projects from previous phase
    - Three metering projects
    - One RWH/GWR project
Challenge of detecting the signal in the noise

Essex & Suffolk Water
Water Saving Kits

Solutions:
• Test for significant differences between savings and zero
• P value of 0.1

Yay! Someone’s using that stuff I wrote 12 years ago
Study and control groups

OK – I’m using the stuff I wrote ten years ago..
Results of Essex & Suffolk Water’s water saving kit analysis using a side-by-side control

- 11,447 properties were available with complete sets of pre and post meter reads.
- Data exclusion rules stated resulting in the exclusion of 98 records and therefore a final sample number of 11,349.
- Skewness acceptable and close to normal.
- Kurtosis acceptable with median result close to the mean, this finding is robust.
- There was a statistical significant mean saving of 2.8 litres per property per day

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample number used</td>
<td>11,349</td>
<td></td>
</tr>
<tr>
<td>Measurements excluded</td>
<td>98</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>2.8</td>
<td>l/prop/day</td>
</tr>
<tr>
<td>90% CI</td>
<td>1.9, 3.7</td>
<td>l/prop/day</td>
</tr>
<tr>
<td>Lower quartile</td>
<td>-18.9</td>
<td>l/prop/day</td>
</tr>
<tr>
<td>Upper quartile</td>
<td>27.1</td>
<td>l/prop/day</td>
</tr>
<tr>
<td>Median</td>
<td>2.9</td>
<td>l/prop/day</td>
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<tr>
<td>Skewness</td>
<td>-0.2</td>
<td></td>
</tr>
<tr>
<td>Kurtosis</td>
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<tr>
<td>Statistically Significant?</td>
<td>Yes</td>
<td></td>
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</table>
Meta-analysis of results

- ESW ecoBETA study
- SWW Water efficiency trial
- UU Home audit study trial
- YW Water saving trial
- TW Self audit rateable value trial
- TW Measured visit and fix trial
- STW Domestic water efficiency trial
- ESW H2Eco Phase 1
- ESW H2Eco Phase 2
- ESW H2Eco Phase 3
- ESW H2Eco Phase 4
- ESW H2Eco Phase 5
- ESW H2Eco Phase 6
- ESW H2Eco Phase 7
- ESW H2Eco Phase 8
- ESW H2Eco Phase 9
- ESW H2Eco summary of all phases
- SEW Ashford Homes Project
  - AW Retrofit trial
  - NW North Ecofit study
  - ESW Ecofit study
  - ESW Challenge TWENTY 12
  - NW North Water saving kits
  - ESW Bespoke water saving kits
  - ESW Water saving kits
- Average water efficiency savings (Phases 1 & 2)
- AW Metering home display trial
- SEW Customer metering programme

Mean water saving (litres/prop/day)

- Phase 1 report: water efficiency savings
- Phase 2 report: water efficiency savings
- Phase 2 report: metering savings
Summary (water efficiency and metering)

- On average, water efficiency programmes save water!
- Mean saving of 13.5 litres per property per day for water efficiency projects
- South East Water and Southern Water metering savings large and consistent
- Not enough RWH or GWR evidence to make firm conclusions
Conclusions (water efficiency and metering)

- Water efficiency programmes should:
  - Identify the most effective water saving device
  - Target households that will use it most
  - Install it as cost-effectively as possible

- H2Eco has provided valuable insights:
  - Savings appear to stabilize
  - ‘Urban Adversity’ households save most water
  - Properties with an occupancy of three save the most water

- Consumption at unmeasured households needs to be measured before customers transfer from rateable value to a metered tariff

<table>
<thead>
<tr>
<th>Device</th>
<th>Water saving (l/device/day)</th>
<th># properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>ecoBETA</td>
<td>22.6</td>
<td>7,296</td>
</tr>
<tr>
<td>Save-a-flush</td>
<td>6.4</td>
<td>7,296</td>
</tr>
<tr>
<td>Showerhead</td>
<td>10.5</td>
<td>7,296</td>
</tr>
<tr>
<td>Tap insert</td>
<td>6.7</td>
<td>7,296</td>
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</table>

<table>
<thead>
<tr>
<th>Acorn Category</th>
<th>Counts</th>
<th>Actual Savings l/prop/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affluent Achievers</td>
<td>2,120</td>
<td>16.5</td>
</tr>
<tr>
<td>Rising Prosperity</td>
<td>259</td>
<td>18.7</td>
</tr>
<tr>
<td>Comfortable Communities</td>
<td>2,578</td>
<td>19.6</td>
</tr>
<tr>
<td>Financially Stretched</td>
<td>789</td>
<td>23.9</td>
</tr>
<tr>
<td>Urban Adversity</td>
<td>1,310</td>
<td>37.4</td>
</tr>
</tbody>
</table>
Rainwater and greywater findings and conclusions

• We only identified one valid, household-scale study, with water company involvement, with limited data available (at the time of writing).

• This study indicated that grey water recycling could save 11% of potable water supplied to households.

• We know lots has been done in this area, but published empirical evidence is very limited…
Berlin field trip
Evidence of water savings from rainwater and greywater systems installed in real households

Historic and contemporary studies useful
The bigger the sample the better

Reward available...see me afterwards!
Anyway, back to me...

Age 30-45:
Water efficiency on military sites
Disaggregation of savings due to metering
Savings from water efficiency across SE England
Cost effectiveness of demand management
Thames Gateway water neutrality study
Eco-towns and water neutrality
Design standards for water efficiency in London
Government procurement and water efficiency
Update to MTP briefing notes for water
Water and energy efficiency

Age 46: Feel like we’ve come a long way…

Now let’s sort out metering, rainwater and greywater!
Thank you

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Phase 1 report: water efficiency savings
Phase 2 report: water efficiency savings
Phase 2 report: metering savings