Planning for Water Resource Management
Assignment 1. Water Consumption Data Analysis of The Ritsumeikan-UBC House

Brigit Haley

University of British Columbia

PLAN 597

October 10, 2014

PLAN 597: Planning for Water Resource Management Assignment 1. Water Consumption Data Analysis of The Ritsumeikan-UBC House

Due Date: October 10, 2014.

Author: Brie Haley

Background

The following report provides a bi-weekly analysis of water consumption (m^3) for the Ritsumeikan-UBC House. As a symbol of UBC's academic partnership with the Ritsumeikan University in Japan this multi-dwelling unit (MDU) was established. Background information on the Ritsumeikan-UBC House is as follows:

- Building is located on the NW side of UBC's Vancouver Campus
- The MDU sits at full occupancy in the Winter Semester, while the Summer Semester occupancy varies as it is open to public and private rental
- The MDU consists of kitchens, bathrooms, 200 beds, along with classrooms and activity areas
- The MDU sleeps a maximum of 308 people (Davies, 2014)
- The Summer Semester of 2012, 80% of the toilets and sinks were upgraded to low-flow models
- Water consumption (m^3) data read daily and is available from September 2011-present
- This report provides bi-weekly data readings, every second Wednesday
- There is one water meter for this MDU.

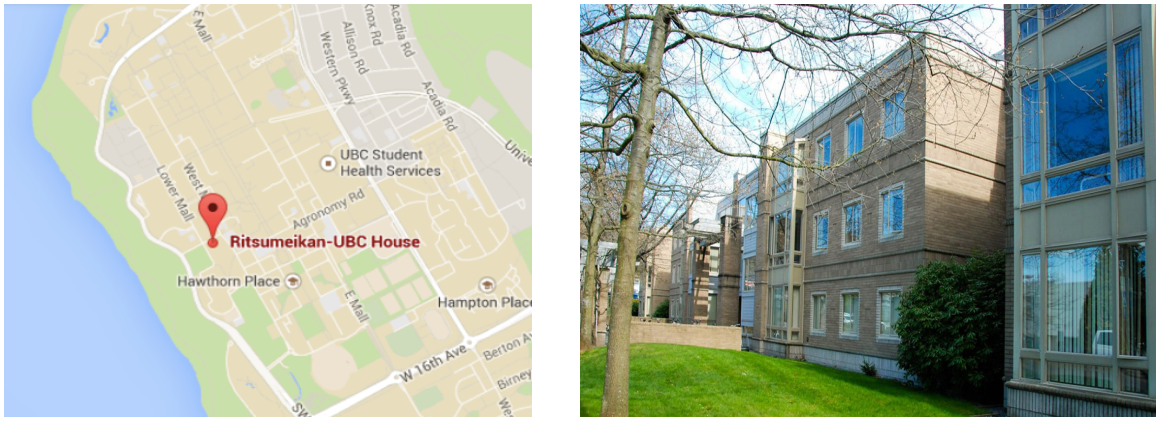

Figure 1. Image on the left pinpoints the location of the building of interest on Google Maps, while the image on the right is an exterior view of the Ritsumeikan-UBC House (UBC, Unknown).

Data Analysis

Data was acquired from David Gill, Project Coordinator for UBC's SEEDS Program to determine if there has been a reduction in water consumption since 80% of the toilets and sinks have been retrofitted to low-flow models. Daily measurements were recorded from the single meter in the Ritsumeikan-UBC House. The data was analyzed using a combination of Excel and StatPlus software. The following section displays the results and the findings will be discussed in further detail in the Discussion section.

Table 1. Depicts the statistical summary of Ritsumeikan-UBC House's bi-weekly water consumption (m^3). Data was available from September 2011 until present. Data was summarized using the StatPlus, Basic Statistics application for Office 2011, on October 7, 2014.

Statistical Summary of Bi-weekly Water Conusmption(m^3) Data			
Count	79	Skewness	2.30572
Mean	21.28478	Skewness Standard Error	0.2671
Mean LCL	17.67975	Kurtosis	11.79241
Mean UCL	24.88981	Kurtosis Standard Error	0.51455
Variance	182.0022	Alternative Skewness (Fisher's)	2.35059
Standard Deviation	13.49082	Alternative Kurtosis (Fisher's)	9.45534
Mean Standard Error	1.51784	Coefficient of Variation	0.63382
Minimum	1.90039	Mean Deviation	9.04917
Maximum	92.20117	Second Moment	179.69837
Range	90.30078	Third Moment	N/A
Sum	1,681.4975	Fourth Moment	N/A
Sum Standard Error	119.90902	Median	19.2002
Total Sum Squares	49,986.47296	Median Error	0.21403
Adjusted Sum Squares	14,196.17126	Percentile 25% (Q1)	13.49976
Geometric Mean	17.78427	Percentile 75% (Q2)	26.12503
Harmonic Mean	13.73875	IQR	12.62527

To determine the frequency of varying water consumptions a Frequency Histogram was generated (Figure 2).

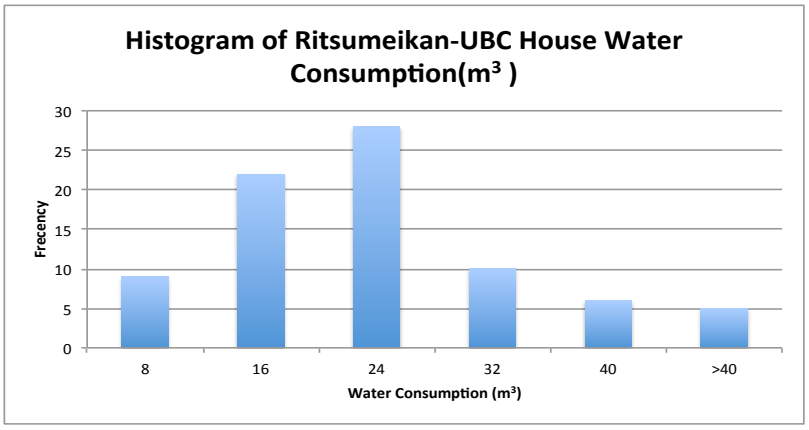

Figure 2. Displays the distribution of bi-weekly water consumption (m^3) during the period of analysis, September 2011-present. The graph suggests that the habitual bi-weekly water consumption falls between 16(m^3) and 24 (m^3), with a bi-weekly average of 21.51(m^3).

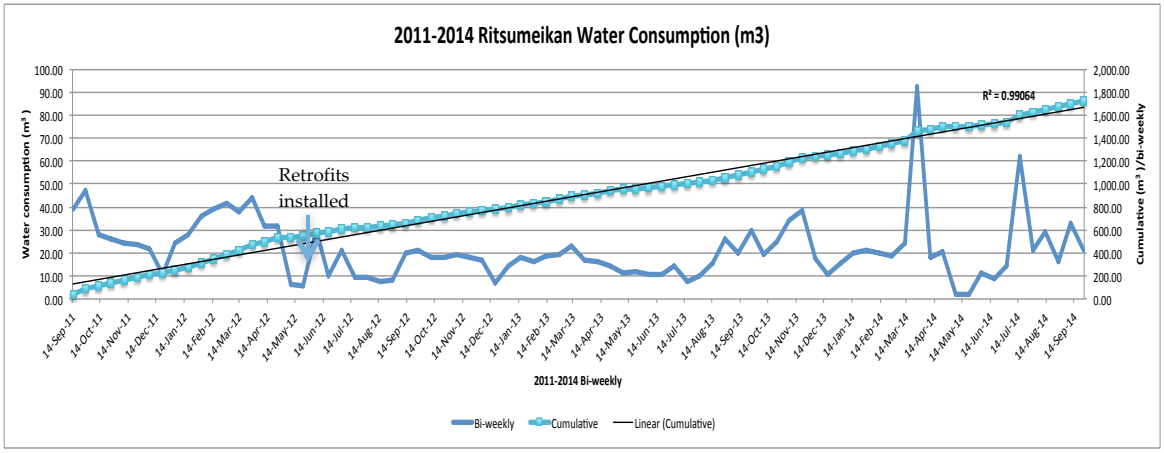

Figure 3. Depicts Ritsumeikan-UBC House's cumulative water consumption (m^3) from 2011 – 2014. Note the Retrofit installation date, June 2012, and the R^2-value of 99.064%.

To analysis the volume of water consumption (m^3) pre-renovation and post-renovation, descriptive statistical summaries have been tabulated (Table 2).

Table 2. Compares the descriptive statistics of Ritsumeikan-UBC House's bi-weekly pre-renovation with post-renovation water consumption (m^3). It appears that the retrofits were installed June 2012. Data was summarized using the StatPlus, Basic Statistics application for Office 2011, on October 7, 2014.

Descriptive Statistic	Pre-renovations	Post-renovations
Mean	27.3900	19.1758
Median	27.8001	17.8491
Variance	147.8543	182.1657
Minimum	5.5000	1.9004
Maximum	47.1000	92.2012

To determine if the means are statistically significant, a mean comparison between the pre-renovations and post-renovations was generated assuming:

μ_a = Pre-renovation
μ_b = Post-renovation

On the null hypothesis:
$\mu_{a^\circ} = \mu_{b^\circ}$
On the alternative hypothesis:
$\mu_a \neq \mu_b$

Table 3. Depicts a mean comparison through the tabulation of a Two Sample T-test assuming the equal variances. Data was summarized using the StatPlus, Basic Statistics application for Office 2011, on October 7, 2014.

Summary			
Degrees of Freedom	76	Hypthesized Mean Difference	0.00E+00
Test Statistic	2.398	Pooler Variance	173.8975
Two-tailed Distribution			
ρ-level	0.01894	t Critical Value (5%)	1.99167
One-tail Distibution			
ρ-level	0.00947	t Critical Value (5%)	1.66515

Discussion

In June 2012, 80% of the toilets and sinks were retrofitted to low-flow models in the Ritsumeikan-UBC House, UBC Vancouver Campus. Water consumption (m^3) data (2011 – 2014) has been acquired from David Gill, Project Coordinator for UBC's SEEDS

Program. It has been analyzed to determine if the retrofits have decreased the overall consumption of water in the Ritsumeikan-UBC House.

A detailed statistical summary of the water consumption (m^3) has been tabulated (Table 1), however for the intention of this report the majority of the statistical values will not be discussed.

The frequency histogram suggests that the habitual bi-weekly water consumption falls between 16(m^3) and 24 (m^3), with a bi-weekly average of 21.51(m^3). These values are consistent with seasonal fluctuation in temperatures, e.g. November and January's dreary weather exhibits higher water consumption.

Visual evidence from the water consumption data, suggests that the retrofits were installed in June 2012, as a decrease in water consumption is noted after this month (Figure 3). The raw data (Appendix 1) suggests that the highs and lows are consistent with the Winter and Summer Semester occupancy, respectively. Evidence suggests that there were two periods that the water meters were out of commission, the first period was from March 25 – 27, 2014 and the second period was from July 11 – 17, 2014. The next water readings were on March 28, 2014 and July 18, 2014, reading 92.20 m^3 and 62.10 m^3, respectively. It appears that the readings under the periods of question were logged, summed and recorded, in turn producing abnormally high values.

As well, September indicates an increase in water consumption, this could be linked to hygiene behavioural traits, e.g. students are generally more concerned with their appearance in the first month of school and thus an increase in hygiene practices are noted (Miko *et* al., 2012), in turn a higher volume of water is consumed (Figure 3). March also appears to exhibit water consumption spikes (Figure 3). One could postulate that this influx in water consumption could be correlated with another behavioural trait, referred to as "spring fever" (The Calgary Herold, 2008). As well, evidence suggests that with the arrival of spring - people suffering from Seasonal Affective Disorder (SAD) experience an increase in energy and sexual appetite (Lam & Levitt, 1999). One could postulate that this increase in activity leads to an increase in hygiene practices, such as showering, which in turn leads to an increase in water consumption.

Finally, a statistical mean comparison of pre-renovation and post-renovation water consumption has been tabulated (Table 2). Evidence suggests that the means and variances from pre-renovation and post-renovation, 27.3900, 147.8543 and 19.1758, 182.1657, respectively, are different. To determine if the means were significantly

different, a mean comparison was calculated using a Two Sample Distribution T-test, assuming equal variances (Table 3). The results indicate that $\rho > 0.05$, therefore the means are not statistically significant. However, evidence suggests (Table 2.) that the pre-renovation and post-renovation means are different, and thus an overall reduction in water consumption has been noted.

Conclusion/Recommendations

After analyzing the results, it is evident that the retrofits installed in June 2012 on 80% of the toilets and sinks have led to an overall reduction in water consumption at the Ritsumeikan-UBC House, on the Vancouver Campus. Additional efforts to conserve water in this MDU should be applied, e.g. install low-flow models on remaining 20% of the sinks and toilets. As well, water timers could be installed on the showerheads, ensuring that users only receive pre-determined amount of time in the shower.

Further strategies to reduce water consumption could focus on behavioural norms i.e. daily hygiene routines e.g. shower times. The UBC Sustainability Department could host water conservation campaigns paired with incentives for participants. E.g. The 30 Second Shower Challenge for 30 days, or a more recent campaign "Go With The Flow" which is being promoted at the University of East Anglia in Norwich, England (Appendix II). This campaign promotes shower urination as it saves a significant amount of water (Off, 2014). Finally, yet controversially, if "spring fever" is leading to an influx in personal hygiene practices, the university might want to suggest to sexually active students to shower with that significant other to conserve water (Off, 2014). Incentives to participate in these campaigns would have to be enticing to students e.g. food gift cards or discounts at the UBC Book Store. Participation in these campaigns will optimistically create new habits, and in turn create a cascading effect of water conservation both on and off campus for today, tomorrow and future generations.

References

Davies, S. (2014, October 8). Totem Park Front Desk Clerk. (B. Haley, Interviewer) Vancouver, BC.

Herold, T. C. (2008, June). *Spring Fever*. Retrieved October 9, 2014, from The Calgary Herold: http://www.canada.com/topics/lifestyle/relationships/story.html?id=101f9880-9fe1-4efa-ae70-e3236696d732&__federated=1

Low, K., & Feissner, J. (1998). Seasonal affective disorder in college students: prevalence and latitude. *Journal Of American College Health: J Of ACH*, *47*(3), 135-137.

Lam, R. W., & Levitt, A. J. (1999). *Canadian Concensus Guidelines for the Treatment of Seasonal Depression*. Canadian Consunsus Group on SAD. Clinical and Academic Publishing.

Miko, B. A., Cohen, B., Conway, L., Gilman, A., Seward Jr., S. L., & Larson, E. (2012). Determinants of personal and household hygiene among college students in New York City, 2011. *American Journal of Infection Control*, *40*(10), 940–945. doi:http://dx.doi.org/10.1016/j.ajic.2011.12.015

Off, C. (2014, October 9). UK student study reveals a morning pee in the shower is good for the environment. *CBC*. (C. Dobson, Interviewer) CBC.

UBC. (Unknown). *Ritsumeikan-UBC House* . Retrieved October 8, 2014, from Student Residence-Vancouver: http://vancouver.housing.ubc.ca/residences/ritsumeikan-ubc-house/

Appendix I

Represents the data used to generate the results. The red highlighted cell designates to estimated date that the retrofits were installed.

Frequency (bi-monthly)	Water usage (m^3)	Cumulative (m^3)	Frequency (bi-monthly)	Water usage (m^3)	Cumulative (m^3)	Frequency (bi-monthly)	Water usage (m^3)	Cumulative (m^3)
14-Sep-11	39.4000	39.4000	02-Jan-13	14.2998	796.496	23-Apr-14	20.5000	1,500.8994
28-Sep-11	47.1000	86.5000	16-Jan-13	18.0000	814.496	07-May-14	1.9004	1,502.7998
12-Oct-11	27.7001	114.2001	30-Jan-13	16.2002	830.696	21-May-14	1.9004	1,504.7002
26-Oct-11	26.1000	140.3001	13-Feb-13	18.5000	849.196	04-Jun-14	11.1992	1,515.8994
09-Nov-11	24.2000	164.5000	27-Feb-13	19.2998	868.496	18-Jun-14	8.5996	1,524.4991
23-Nov-11	23.8000	188.3001	13-Mar-13	22.9004	891.397	02-Jul-14	14.5996	1,539.0987
07-Dec-11	21.8999	210.2000	27-Mar-13	16.7998	908.196	16-Jul-14	62.0996	1,601.1983
21-Dec-11	10.7002	220.9002	10-Apr-13	16.2998	924.496	30-Jul-14	20.9004	1,622.0987
04-Jan-12	24.2002	245.1004	24-Apr-13	14.2002	938.696	13-Aug-14	29.0996	1,651.1983
18-Jan-12	27.9001	273.0005	08-May-13	11.5000	950.196	27-Aug-14	16.0996	1,667.2979
01-Feb-12	36.0996	309.1001	22-May-13	11.7002	961.897	10-Sep-14	32.6992	1,699.9971
15-Feb-12	39.2998	348.3999	05-Jun-13	10.8994	972.796	24-Sep-14	20.9004	1,720.8975
29-Feb-12	41.8999	390.2998	19-Jun-13	10.8008	983.597			
14-Mar-12	37.7998	428.0996	03-Jul-13	14.0996	997.696	**Average**	23.0058	1760.2975
28-Mar-12	43.9004	472.0000	17-Jul-13	7.8008	1,005.497			
11-Apr-12	31.6997	503.6997	31-Jul-13	10.0000	1,015.497			
25-Apr-12	31.6001	535.2998	14-Aug-13	15.5000	1,030.997			
09-May-12	6.1001	541.3999	28-Aug-13	26.2002	1,057.197			
23-May-12	5.5000	546.8999	11-Sep-13	19.8994	1,077.097			
06-Jun-12	30.0000	576.8999	25-Sep-13	29.9004	1,106.997			
20-Jun-12	10.3003	587.2002	09-Oct-13	19.2002	1,126.197			
04-Jul-12	21.5000	608.7002	23-Oct-13	24.6006	1,150.798			
18-Jul-12	9.2998	618.0000	06-Nov-13	34.0000	1,184.798			
01-Aug-12	9.2998	627.2998	20-Nov-13	38.5000	1,223.298			
15-Aug-12	7.6992	634.9991	04-Dec-13	17.5996	1,240.897			
29-Aug-12	8.0996	643.0987	18-Dec-13	10.4004	1,251.298			
12-Sep-12	19.7998	662.8985	01-Jan-14	15.5996	1,266.897			
26-Sep-12	21.3994	684.2979	15-Jan-14	19.9004	1,286.798			
10-Oct-12	18.3994	702.6973	29-Jan-14	21.0000	1,307.798			
24-Oct-12	18.2002	720.8975	12-Feb-14	19.7012	1,327.499			
07-Nov-12	19.5000	740.3975	26-Feb-14	18.5000	1,345.999			
21-Nov-12	17.8994	758.2969	12-Mar-14	24.4004	1,370.399			
05-Dec-12	16.7998	775.0967	26-Mar-14	92.2012	1,462.601			
19-Dec-12	7.0996	782.1963	09-Apr-14	17.7988	1,480.399			

Appendix II

A recent campaign “Go With The Flow” which is being promoted at the University of East Anglia in Norwich, England. This campaign promotes shower urination as it saves a significant amount of water (Off, 2014).