



# Analysis of Water Usage in Dickinson College by Living Situation on Campus

Irene Tang, Jinglei Liu, Cindy Zheng

# Dickinson

## Objectives

- Compare the amount of water usage per person per year of first year students to those of upperclassmen.
- Examine the water use of Treehouse which focuses on sustainability.
- Use statistical tools to give a better understanding of water usage among different groups of students.

## Introduction

Dickinson College, ambitious to be a leading sustainability college, provides many sustainability courses as graduation requirement. We are curious about if those efforts make a difference on students' behavior by showing differences in water usage per person per year among different classmen and special interest housing. We assume that water usage per person per year of first year students is more than that of upperclassmen because we think that upperclassmen become more conscious of their water usage after some sustainability education.

We also assume that students living in Treehouse use less water because they are committed to support and promote sustainability efforts.

The size of the data sets is large. We use the data of water consumption of different buildings in 5 years (2014-2018). The data was collected by recording the units in water sewer and the “use” was calculated by dividing costs by unit costs. It is categorized by quarters, building types and names, etc., and stored manually by Center of Sustainability Education staffs. We also have data of the number of residents in dormitory, residence and student housing from Office of Residence Life & Housing.

The staffs of the Center for Sustainability Education showed interests in our topic when we asked for data.

## Methods

Reason why we use paired t-test in both tests: We are interested in the difference in mean water usage per person per year of first year and upperclass students. Since the mean water usage is dependent on years, we need to use paired t-test. We think that the sustainability education in Dickinson College may lead to that difference.

### First-years vs. Upperclassmen

Hypothesis: Do we expect that on average, upperclassmen consumed less water than first year students did during 2014-2018? That is, is the difference between the mean water usage per person per year in upperclass housing and that in first year housing positive?

Summary statistics:  $\bar{x}_D = 433.089$ ,  $S_D = 417.813$ ,  $n_D = 5$

Let  $\mu_D$  be the difference in mean water usage of first year students per person per year (gal) and mean water usage of upperclassmen per person per year (gal).

$$H_0: \mu_D = 0$$

$$H_1: \mu_D > 0$$

Assume the population of differences is approximately normal,

$$\text{test-statistic: } t = 2.32$$

$$df = 4$$

$$p\text{-value} = 0.0406 < 0.05$$

### Treehouse vs. Other Residential Halls

Hypothesis: Do we expect that on average, students living in Treehouse consumed less water than students living in other residential halls did during 2014-2018? That is, is the difference between the mean water usage per person per year in Treehouse and that in other housing positive?

Summary statistics:  $\bar{x}_D = 3603.925$ ,  $S_D = 421.227$ ,  $n_D = 5$

Let  $\mu_D$  be the difference in mean water usage in Treehouse per person per year (gal) and mean water usage in other residentials per person per year (gal).

$$H_0: \mu_D = 0$$

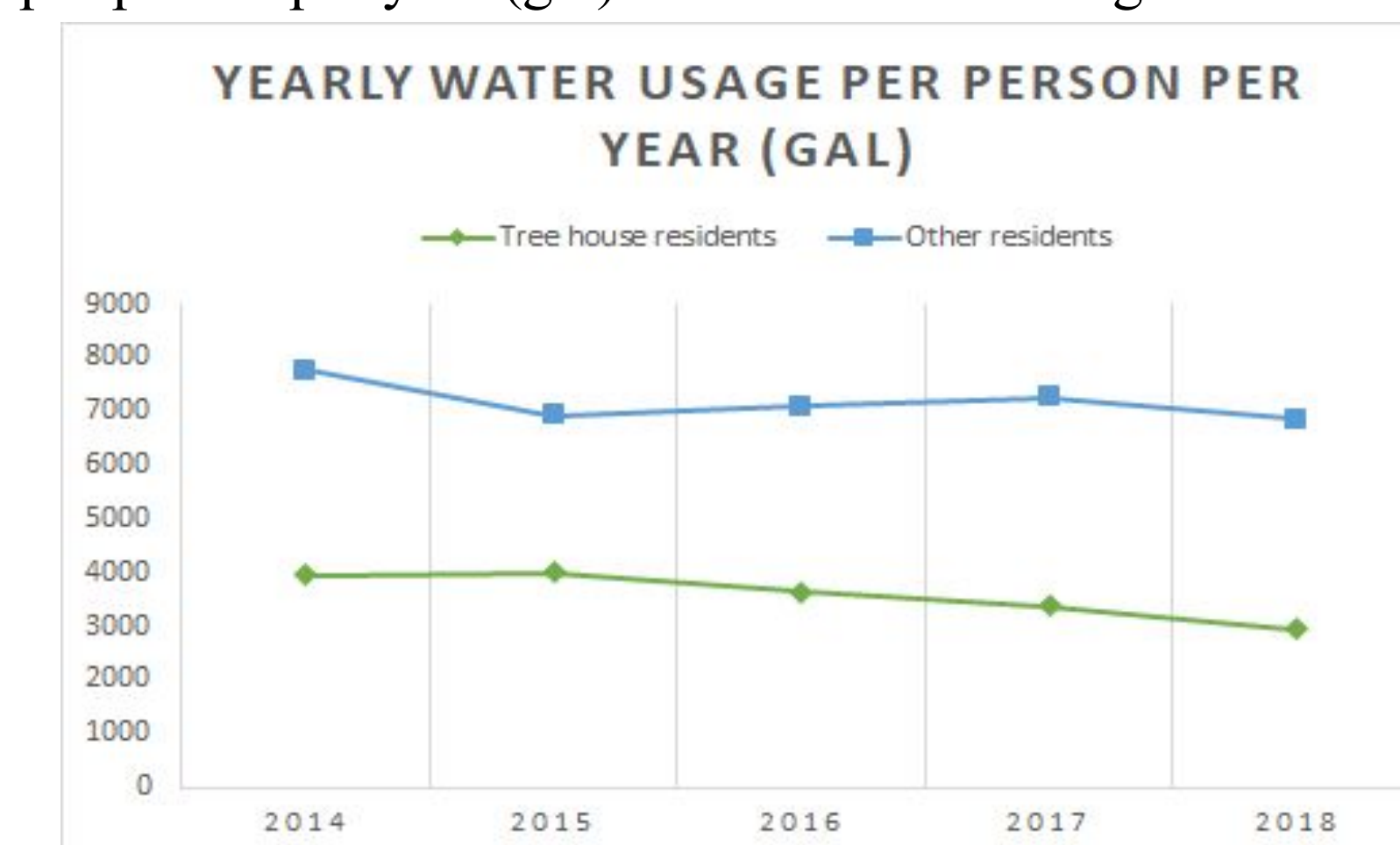
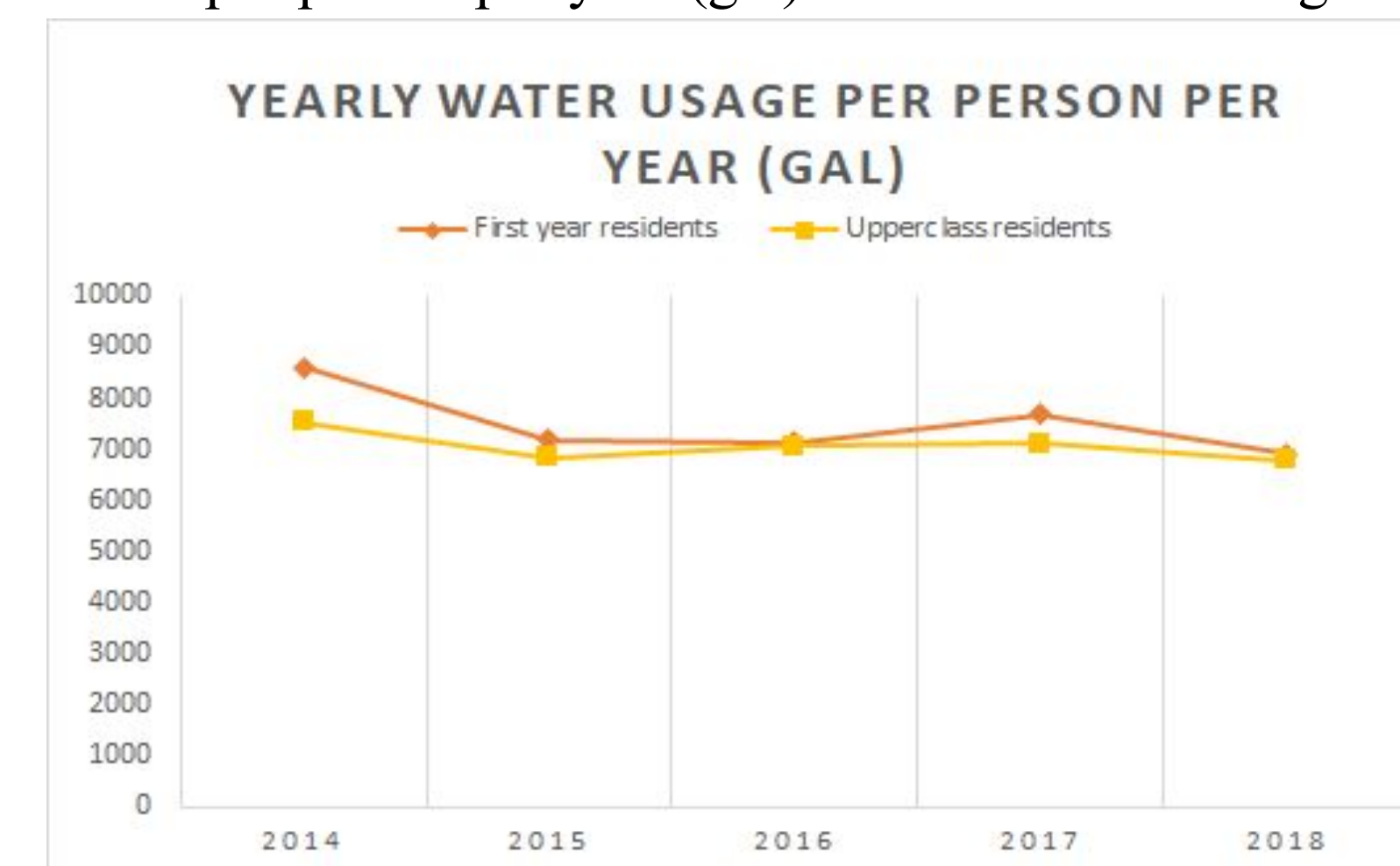
$$H_1: \mu_D > 0$$

Assume the population of differences is approximately normal,

$$\text{test-statistic: } t = 19.13$$

$$df = 4$$

$$p\text{-value} = 2.199 \times 10^{-5} < 0.001 < 0.05$$



## Results

### First-years vs. Upperclassmen

At  $\alpha = 0.05$  significance level, since  $p\text{-value} = 0.0406 < 0.05$ , we reject  $H_0$ . There is moderate evidence that the difference in mean water usage of first year students per person per year (gal) and mean water usage of upperclassmen per person per year (gal) is greater than 0.

### Treehouse vs. Other Residential Halls

At  $\alpha = 0.05$  significance level, since  $p\text{-value} = 2.199 \times 10^{-5} < 0.001 < 0.05$ , we reject  $H_0$ . There is very strong evidence that the difference in mean water usage in Treehouse per person per year (gal) and mean water usage in other residential per person per year (gal) is greater than 0.

## Conclusion

We reject both hypotheses, but we still need to consider the mean differences in practice.

In the comparison between first-years and upperclassmen, the mean difference of about 433 gals of water is not practically large, even though there is moderate evidence that the mean difference between water usage per person per year among first-years and upperclassmen is statistically significant. Comparing Treehouse residents with other Dickinson students, we found the mean difference to be significant both statistically and practically.

There is a lurking variable that could potentially explain the low water usage in Treehouse. It is a LEED gold certified building which installs green technology like dual flush water closets, low flow faucets and showerheads that might save additional water.

We still believe that sustainability education has influence on difference though we didn't measure it, which leads to further steps.

## Reference

Dickinson Sustainability Dashboard  
Dickinson Sustainability Building Treehouse Website