Every Drop Counts: UC Berkeley Student Water Conservation Behavior

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ABSTRACT

One of the more serious consequences of climate change is the effect on availability and distribution of water resources. The likelihood of water reduction in California's climate associated with climate change will require improved forms of water conservation, including decreased residential water consumption, which offers the largest potential avenue for conservation. There is limited research on pro-environmental behavior, which is the tendency to act in a way that poses the smallest impact on the environment and is influenced by knowledge, attitude, and intention. To examine Pro-environmental behavior I surveyed UC Berkeley undergraduates, assessing: knowledge of water usage, attitudes towards conservation, water use behavior and demographics. The study objective goals included: (1) Understanding student's basic knowledge of water use/water conservation behavior , (2) attitudes towards conservation, (3) the water use and water conservation behavior of current students, and (4) providing a baseline for current knowledge and ways that UC Berkeley can increase students' participation in pro-environmental behavior. I found that the majority of students sampled had some environmental knowledge background in education yet seemed lack the basic knowledge of their water source, the average consumption of a CA resident, and how water is distributed in California. I also found that the majority of the students had pro-environmental attitudes towards water conservation yet very few engaged in water conservation behavior. Understanding student knowledge, attitudes and intentions and how they affect water consumption can help the office of sustainability develop campaigns at UC Berkeley that can motivate students to begin implementing more pro-environmental behavior.

KEYWORDS

water conservation, pro-environmental behavior, education campaigns, sustainability,

INTRODUCTION

Water is critical in California's economy because it supports agriculture, urban life, recreation, and energy supplies (Hanak et al. 2011). One of the more serious consequences of climate change is the effect on availability and distribution of water resources (Shandas et al. 2012). The areas of water use that are both especially critical and vulnerable to climatic change: the energy, agriculture, and urban sectors. Any decrease in the water supply to these sectors can have very important economic and social implications. (Stanton and Fitzgerald 2011, Hanak et al. 2011). The likelihood of water reduction in California's Mediterranean climate associated with climate change will require improved forms of water conservation, including decreased residential water consumption. Changing lifestyles will be crucial for maintaining resources in the long run and recent calls to maintain water supplies suggest that reduced residential consumption offers the largest potential avenue for conservation and understanding why people do or don't engage in water conservation practices is crucial (Adua 2010, Shandas et al. 2012). Residential use conservation requires understanding demand-side behavior that is often difficult to assess at a household scale (Shandas et al. 2012). There is still limited understanding about household water use behavior during changing climate conditions or how future climate change scenarios can impact water demand; so without an explicit understanding of household behavioral patterns, managing water resources in varying climate scenarios will be a challenging proposition (Shandas et al. 2012). Residential water use can be reduced only if the key drivers of water usage are understood (Dolnicar et al. 2012). The limited understanding about consumption behavior can be attributed to the complexity of behavior itself, specifically pro-environmental behavior that is the desired behavior in order to reduce consumption.

Pro-environmental behavior is the tendency to act in a way that poses the smallest impact on the environment. Pro-environmental behavior is influenced by knowledge, attitude, and intention. The theory of reasoned action suggests that attitude influences behavior and is mediated by intention (Kaiser et al. 1999). Attitudes concerning the environment are influenced by factual knowledge about the environment, social and moral values and intention to act in a more pro-environmental way (Kaiser et al. 1999). The factors contributing to pro-environmental behavior are essential to understand. Factual knowledge can be seen as a precondition of

environmental attitude (Kaiser et al. 1999). Social and moral values involve ones subjective norms and social normative beliefs regarding the environment (Kaiser et al. 1999). Moral values influence subjective norms that then, in turn, influence attitudes toward the environment and behavior. Social norms shape attitudes and thus influence behavior (Kaiser et al. 1999). Subjective norms (i.e., person's perceptions of the social pressure to perform a behavior) predict behavioral intentions to behave pro environmentally and in turn influence conservation behavior (Corral-Verdugo and Frias-Armenta 2006). The more someone accepts that this norm applies to everyone, the more they accept that it applies to him or her and the more the person engages in conserving natural resources (Corral-Verdugo and Frias-Armenta 2006). Intention mediates knowledge and social and moral values (Kaiser et al. 1999). Intention is aimed at engaging in a specific behavior with the intention of doing it for pro-environmental purposes (Kaiser et al. 1999). Often this is what distinguishes those who do engage in an environmental behavior and those that do not. Other factors such as socio-demographics can play a role in environmental behavior. The relationship between these variables can be seen in Figure 1.

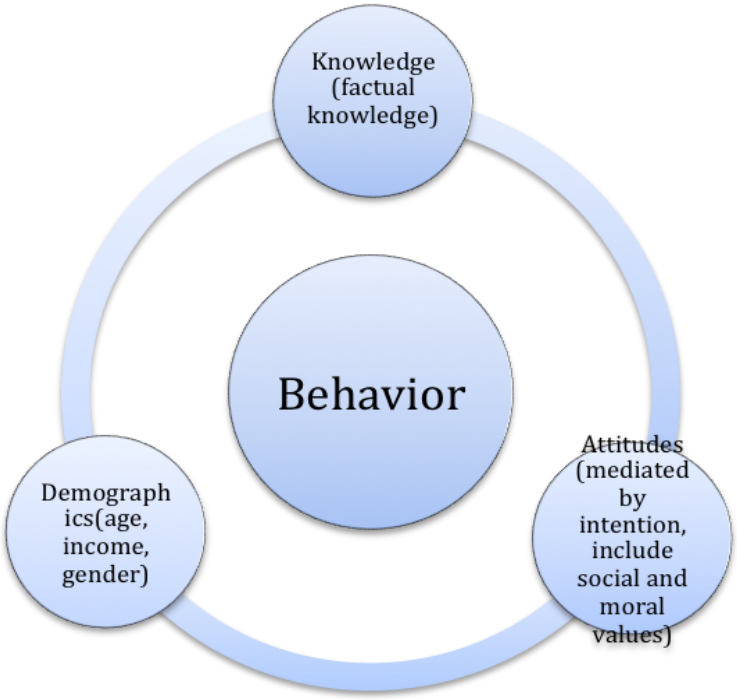

Figure 1. Relationships between knowledge, attitude, demographics which all can influence behavior.

Socio-demographical factors also may influence water conservation behaviors and

attitudes, since the amount of water consumption may be related to the number of people in the house, the age of residents, education levels of residents, size of properties, race and/or ethnicity, and residents' income or gender. (Abrahamse and Steg 2009) Income can influence environmental behavior because it often limits the amount of water that one can consume. The ability to consume is proportionate to income and thus the more income one has, the more one can consume (Lutzenhiser and Hackett 1993). These socio-demographic and behavioral factors may correlate with attitudes influencing behavior. Investigating people's attitudes toward resource conservation is relevant to better understanding the determinants of pro-environmental behavior, including water conservation practices (Corral-Verdugo and Frias-Armenta 2006). If we can understand what influences pro-environmental behavior and how attitudes and socio-demographics correlate with that behavior, we can understand how to approach motivating others to engage in conservation behavior. The institutions and communities in which people reside in can play a big part in influencing pro-environmental behavior, especially places such as UC Berkeley.

UC Berkeley has had a large population of student activist and often influences students to engage in pro-environmental behavior. The activism at UC Berkeley has been around since the 1930's to today and has ranged from the peace strikes to the free speech movement and anti-war protests. The campus seems to foster more of an awareness and active participation towards important issues, including some important environmental issues. Universities play a big role in the increase in consciousness of university students concerning environmental problems. The UC Berkeley Office of Sustainability is an example of how the university influences their community by leading the campus initiatives that focus on climate action.

The goal of the office of sustainability is to foster a culture of sustainability and reach climate neutrality. Currently, the office of sustainability has a goal to reduce potable water use to 10% below 2008 levels by 2020. According to the 2012 Sustainability Report, the campus is currently at 8.2%, below 2008 levels. The goal is almost reached but the office of sustainability should strive to continue to reduce student water consumption, since it accounts for half of the water consumption of the campus, and ways to modify behavior should be targeted to foster a more sustainable community. According to the 2010 CACS report, investment in outreach and education is costing the school approximately $20,000 a year with the benefits being unknown

and estimated at $10,000. In order to understand how to target outreach more efficiently, behavior needs to be understood. Understanding the current knowledge, attitudes and intentions of UC Berkeley students on water use and conservation can help the education and awareness campaigns to find ways to motivate students to conserve more water. Although students are often aware of water issues, their behaviors don't always reflect this awareness and should be targeted since they are responsible for the majority of the University's water consumption. Understanding student knowledge, attitudes and intentions and how they affect water consumption can help the office of sustainability develop campaigns at UC Berkeley that can better motivate students to begin implementing more pro-environmental behavior. If UC Berkeley can influence their community to engage in conservation behavior, they can set an example that can further influence the creation of a social norm of environmental behavior throughout other UC campuses. This can allow for more environmentally conscious generations to be prepared for the potential effects of climate change.

Objectives

My objective for this study is to understand water conservation behavior in UC Berkeley students. By assessing knowledge of water usage, attitudes towards conservation, water use behavior and demographics, I can begin to understand how they play a role in increasing water conservation behavior. Understanding the knowledge, attitudes, and behavior can help the office of sustainability better understand the social influences and factors that play a role in behavior. The goals for my study are to:

- Understand student's basic knowledge of water use and water conservation behavior
- Understand attitudes towards conservation
- Understand the water use and water conservation behavior that current student's are engaging in
- Provide a baseline for current knowledge and ways that UC Berkeley can increase students' participation in pro-environmental behavior, specifically water conservation behavior

METHODS

Study Site and Data Collection

UC Berkeley currently enrolls almost 26,000 undergraduate students. The gender percentages are around 53% female and 47% male. The percent of identified races and ethnicity are as follows: 4% African American /black, 1% American Indian/Alaskan Native, 43% Asian/ Pacific Islander, 13% Hispanic, 33% White, and 6% Race/Ethnicity Unknown. International students make up 9% of the population while California residents comprise 82%. The average age of a UC Berkeley student is 21 and approximately 77% of students live within 1 mile of campus.

Survey

To investigate knowledge of water usage, attitudes towards conservation, demographics and behavior regarding water conservation of UC Berkeley students, I surveyed undergraduate students through class emails, social-media networks such as Facebook, as well as some class email list serves for groups on campus. The survey was constructed with questions about water knowledge, attitudes towards conserving water, water conservation intention, water use and water conservation behavior, and socio-demographic information. See Attachment 1.

Knowledge

Water knowledge

Knowledge was assessed by asking questions regarding knowledge of water use at a personal/state level and water conservation techniques. Knowledge of water use at a personal and

state level included a binomial system of yes and no answers. The statements included knowledge of personal water use and average California resident water consumption. The students were also asked to estimate the average California resident water consumption. The source of water in Berkeley was also ranked in a binomial system of yes and no answers. Water knowledge of consumption stakeholders in California included a multiple-choice question with the gross percentage of water used for urban, agriculture, and energy.

Water conservation knowledge

Using the same binomial system of yes or no, questions regarding knowledge of water conservation techniques were asked. These included knowledge of low flow showerheads and toilets as well as behavioral conservation techniques like shutting off the water when washing hair or brushing teeth. These questions in water use/water conservation knowledge are intend to be stated as a basic level of water knowledge and aimed at influencing students to believe that typical student would know this information. By establishing this normative feature, students will start to question if other students are aware and engaging in these behaviors that might motivate them to act more pro-environmentally.

Attitudes

Using a likert scale ranging from strongly agree to strongly disagree attitudes are gauged by asking questions regarding attitudes towards environmental education, conservation the environment and intention and willingness to conserve. Environmental education attitudes are intended to understand if students are willing to learn more about this or if any courses they have taken before have helped change their attitudes. A likert scale ranked students perception of environmental education. These questions involved statements that gauge at attitude towards the importance of environmental education and applicability to daily life. Conservation attitudes are included to understand whether students have attitudes that are pro-conservation. These statements include conservation as a moral obligation, importance of conservation, and human

need for water. Intention was assessed with statements about willingness to change behavior, willingness to conserve water, willingness to be more environmentally conscious.

Statements about attitude are intended to reflect those that someone who is pro-environmental would agree with. I provided statements to gauge at students attitudes towards things they had never thought about or things they agree with. These attitudes can help us understand if attitudes influence water conservation practices. Some of the underlying assumptions include ethical concerns that could arise from lack of water. These statements are intended to gauge the students into thinking about environmental problems from an ethical standpoint.

Environmental Education at Cal

A section of the survey served solely for environmental education experiences at UC Berkeley. These questions included previous environmental courses taken at Berkeley, attitude towards requirement of environmental courses, attitude towards environmental issues and previous personal assessed footprint evaluation. These questions are aimed to provide the office of sustainability with current information of access or importance of environmental courses at UC Berkeley, as well as importance of specific environmental issues to students.

Behavior

Water use behavior, water conservation behavior, and other environmental behavior questions were asked by allowing students to check whether they engaged in a certain activity involving water and the frequency at which they engage in it. Questions regarding other environmental behavior include recycling and energy saving habits. Including other

environmental behavior will allow to properly distinguish students that do or don't engage in environmentally conscious behavior.

Socio-demographics

Questions regarding age, gender, income, race/ethnicity and education level were asked as well. This socio-demographic information can help us understand our population and understand how other factors besides knowledge, attitudes and intention effect behavior practices.

Data Analysis

To understand knowledge, attitude, and demographics in water conservation behavior, I used summary statistics to understand the level of water knowledge, the general trend in attitudes and frequency in engagement in water use and water conservation activities. Using graphs and tables, I constructed visual representations of my data to understand UC Berkeley students' water conservation behavior.

RESULTS

Study Site and Data Collection

The sample size of students surveyed was n=59. The sampled population was identified to be 74% female and 26 % male and 2% other (Figure 2). The average age of the population surveyed was approximately 21 years old and of senior class status (Figure 3). The income

distribution consisted of a majority of students with $100,000+, which made up 35.5% of the sample population (Figure 4). The identified race/ethnicity of the sample population were as follows: 48% White, 36% Asian, 9% other, 7% Hispanic, 0% African American /black, 0% American Indian/Alaskan Native, 0% Hawaiian/ Pacific Islander (Figure 5). The majority of the students surveyed lived in dorms or apartments with the percentage being 42% and 32% respectively (Figure 6). The majority of students are California residents making up 87% of the sampled population (Figure 7).

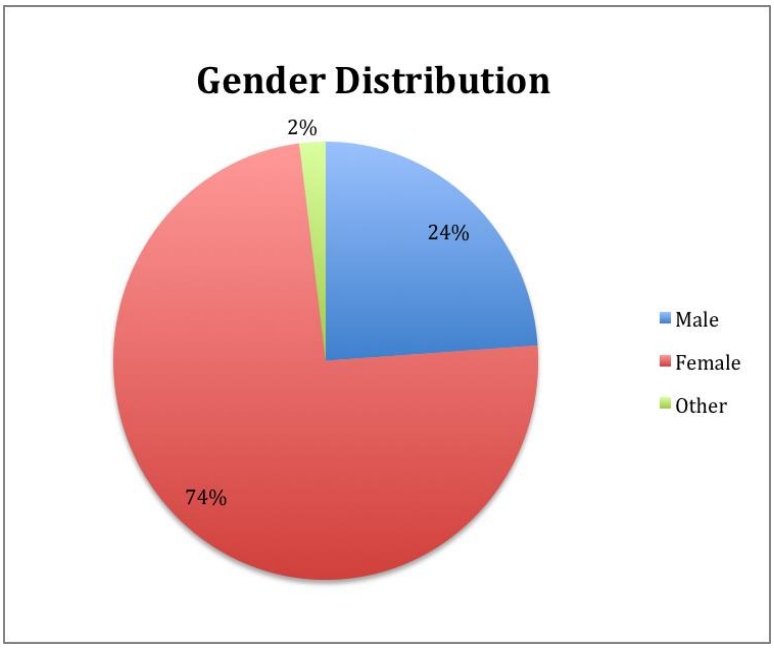

Figure 2. Sampled population of UC Berkeley students' gender distribution.

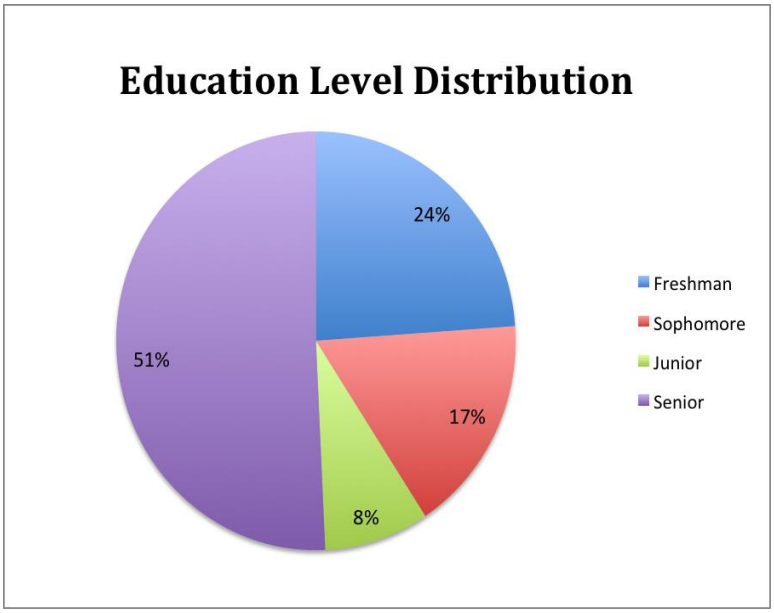

Figure 3. Sampled population of UC Berkeley students' education level distribution.

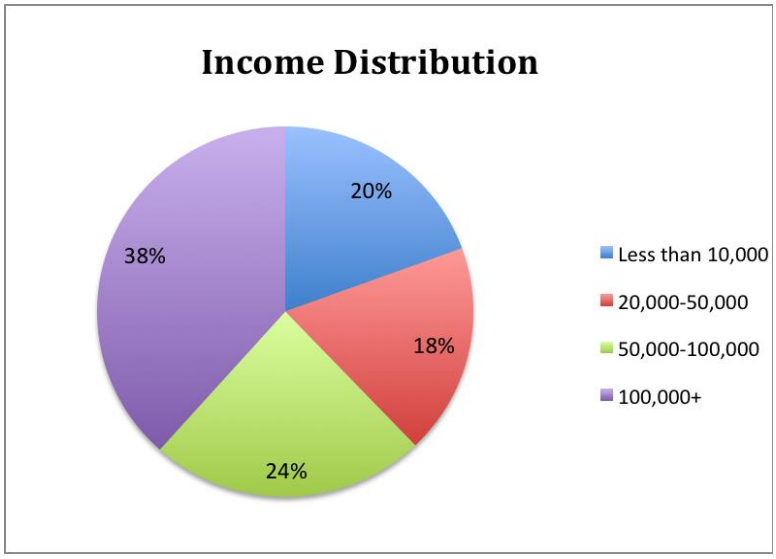

Figure 4. Sampled population of UC Berkeley students' income distribution.

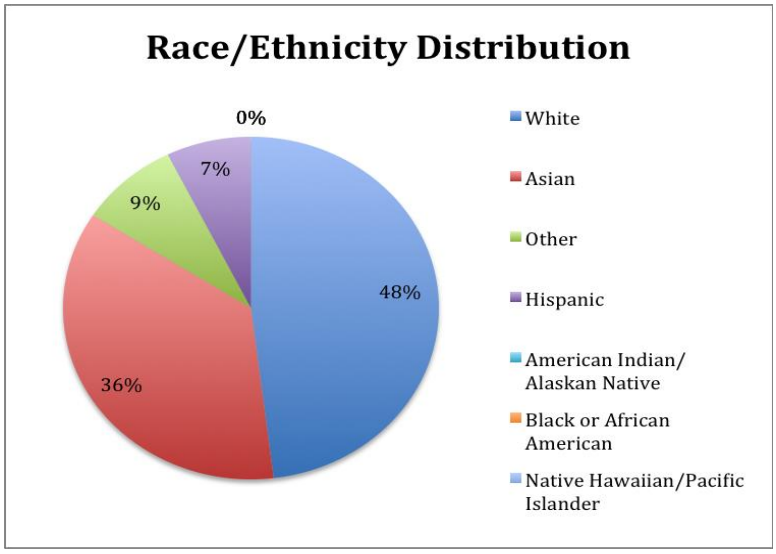

Figure 5. Sampled population of UC Berkeley students' Race/Ethnicity distribution.

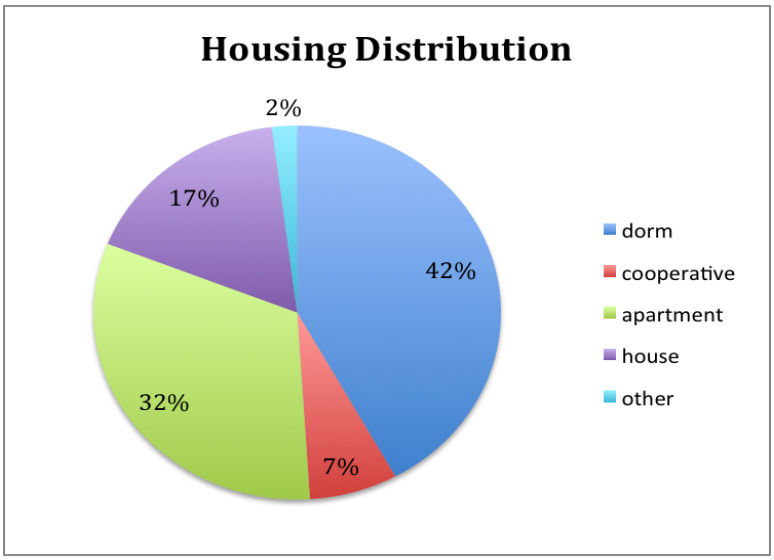

Figure 6. Sampled population of UC Berkeley students' housing distribution.

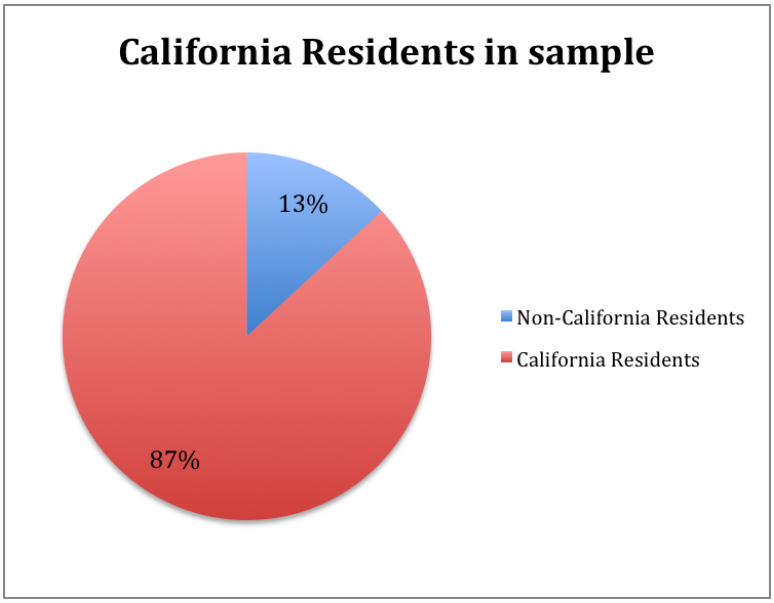

Figure 7. Percentage of UC Berkeley students that are California Residents.

Knowledge

The sampled population of UC Berkeley student's water use knowledge varied throughout the different questions asked (Table 1). About 2 in 5 students knew approximately how much water they used per day and had knowledge of Berkeley's water source. About 1 in 5 students correctly identified gross percent usage of water in CA agriculture, energy, and urban sectors. The average estimated personal water usage per day was about 140 gallons/day and the estimated California Resident water usage was about 74 gallons/day (Figure 8 and 9).

Table 1. UC Berkeley students' water use knowledge.

Water Use Knowledge	% students that knew approximately how much water they used per day	Estimated personal water usage per day (gallons/day)	Estimated California Resident water usage (gallons/day)	% students who had knowledge of water source	% that identified gross percent of usage in Agriculture, Energy, and Urban sectors
	42%	140.64	73.7	42%	19%

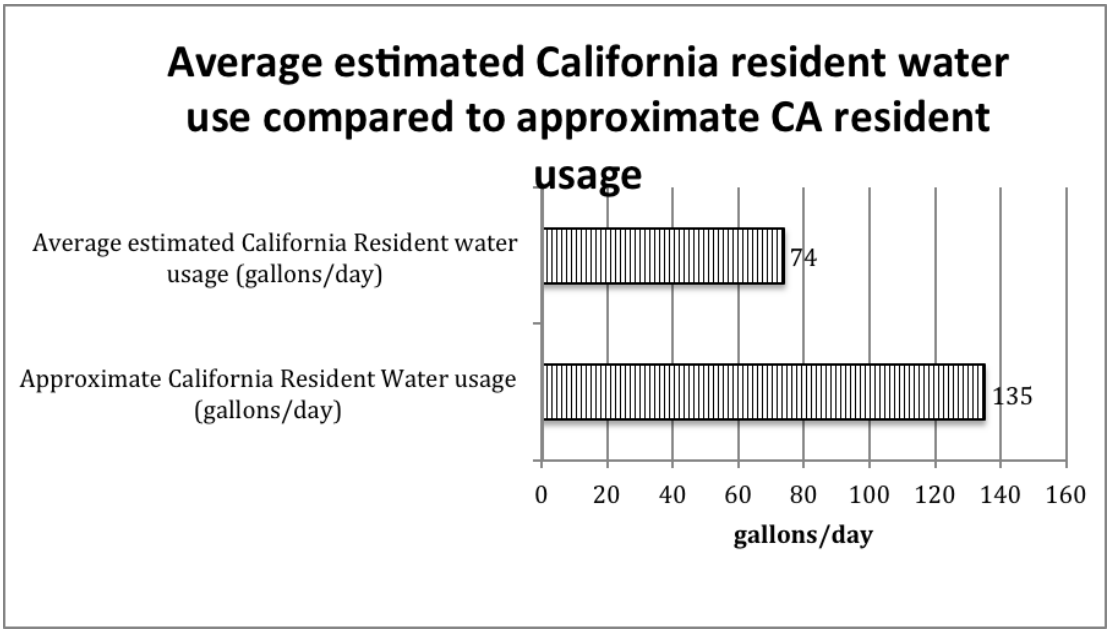

Figure 8. Average California resident water use estimated by students and the approximate California resident water usage

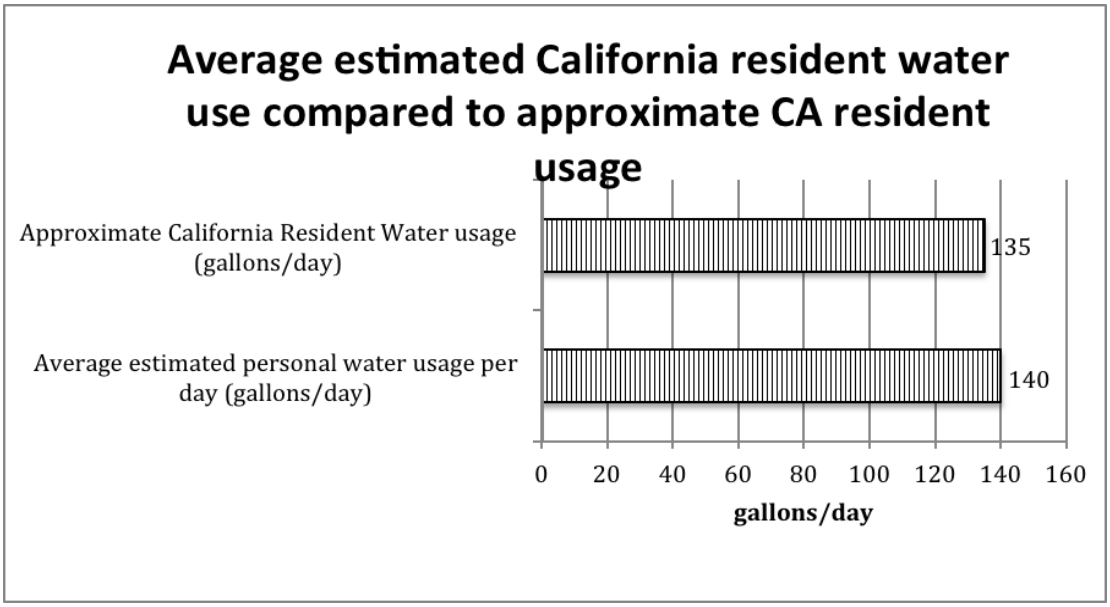

Figure 9. Comparison of the estimated personal water usage estimated by students and the actual approximate usage by a typical California resident.

Water Conservation Knowledge	% that knew efficient showerheads as water conservation measure	% that knew EBMUD supplies free low-flow showerheads	% that knew running a full dishwasher could save water	% that knew that valve flappers, displacement bags, and high efficiency models could save water	% that had knowledge of water saving behavior: turning off water when brushing teeth or washing hair/body	% that had knowledge that EBMUD provides free faucet aerators
	52%	31%	78%	47.50%	73%	51%

Table 2. UC Berkeley student's knowledge on water conservation practices and savings.

Water conservation knowledge also varied much like water use knowledge as summarized in Table 2. About 1 in 2 students knew that efficient showerheads could save 15 gallons of water per day and that valve flappers, displacement bags, and high efficiency models could save up to 30 gallons/day. About 1 in 3 knew that EBMUD provided free low-flow showerheads (2 gallons/min). About 4 in 5 students knew that running a full dishwasher rather than washing by hand could save up to 4gallons/day of water. About 3 in 4 knew that you can save up to 20 gallons/day by turning off the faucet when you brush your teeth and wash your hair/body.

Attitudes

UC Berkeley student's attitudes towards the water conservation statements asked were varied with a majority of the students answering towards one extreme end. The different percentages of students that answered these questions can be seen in Figure 10. About 4 out of 5 Strongly Agreed that water conservation is important and Strongly Disagreed on the opposing statement that water conservation is not important. Approximately 3 out of 4 stated that they believed water conservation was crucial for the survival of humans. About 2 out of 3 Strongly Agreed that environmental education is important, while approximately half of the students Strongly Agreed that environmental courses were worthwhile and applicable. About 6 out of 10 students Strongly Agreed that it is their moral duty to conserve resources and are willing to be more environmentally conscious. About half of the students Strongly Agreed and the other half Agreed that water conservation was something they strived to do when possible. About 97% of the students either Strongly Agreed or Agreed that they would be willing to change for the better of future generations. Approximately 81% of students either Strongly Agreed or Agreed that they were willing to change their behavior to conserve water.

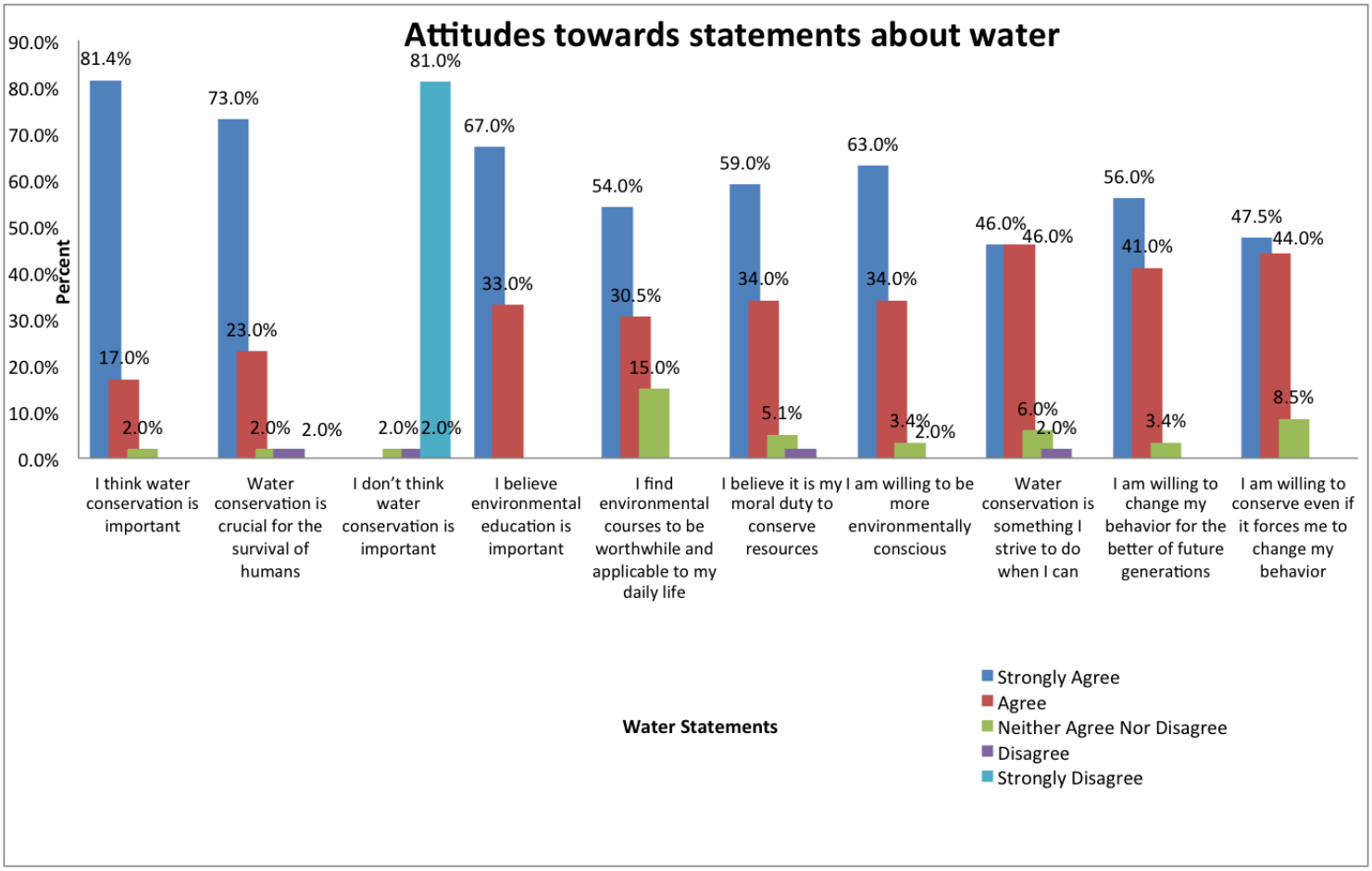

Figure 10. Attitudes towards statements about water by percentages for given answers.

Attitudes regarding recycled water, water use prioritization and important environmental issues all varied in the answers and most students responded to the questions. The given the definition of recycled water given to students was: "water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefore considered a valuable resource (includes both treated agricultural wastewater and treated municipal wastewater)". The students responded with the following activities where recycled water should be used ranked from highest percentage of students who chose activity to least respectively: irrigation (recreational areas), irrigation (food crop), showering, didn't know enough about recycled water, drinking, and none of the above (Figure 11). About 1 in 4 students stated they didn't know enough about recycled water. Attitudes towards water use prioritization were asked and students' response from most important to least important respectively: ecosystem maintenance, agriculture, groundwater recharge, urban-household use, recreation, and

aesthetic purposes (Figure 12). Attitudes towards important environmental problems from most important to least important were: climate change, water quality, pollution, air quality, water security, wildlife and biodiversity, waste, lack of environmental education, biodiversity, deforestation, ocean acidification, and flood control (Figure 13). Attitudes towards environmental problems were asked in two separate questions and the average score is shown in Figure 13 for all the combined environmental problems.

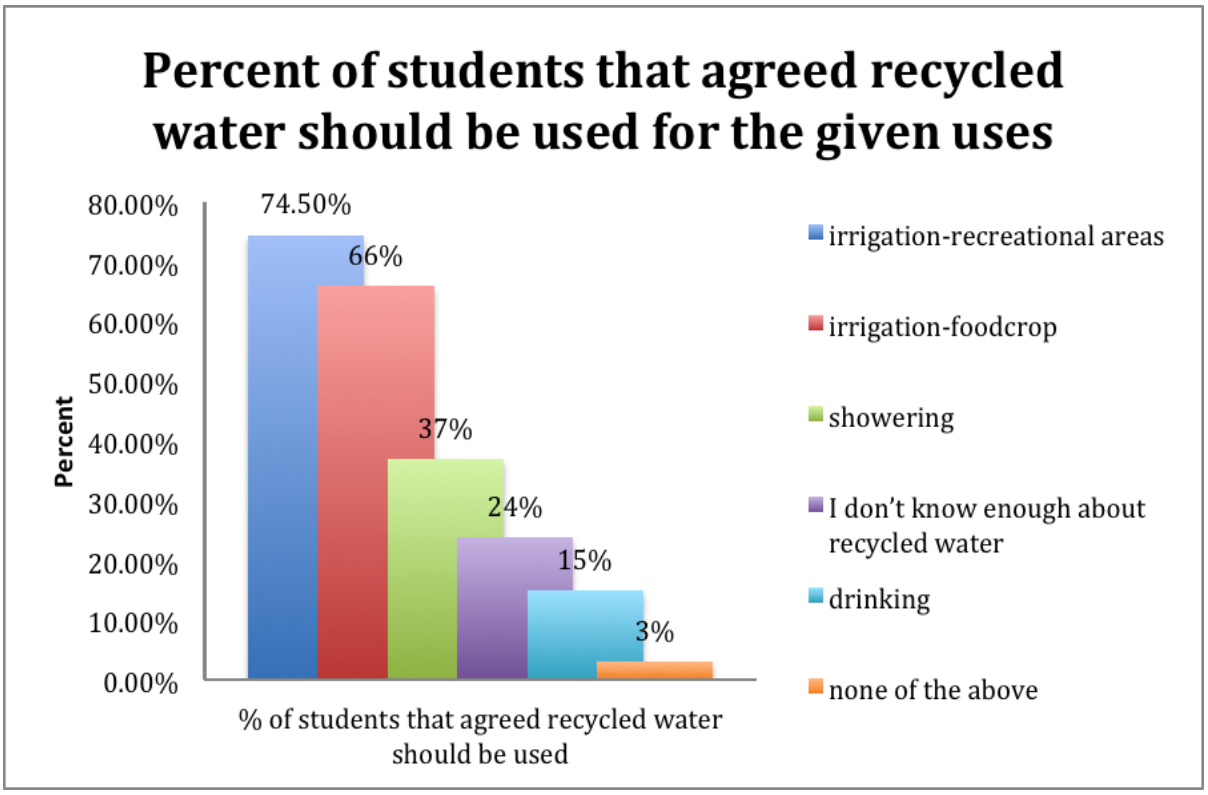

Figure 11. Percent of students that chose the given activity they believed recycled water should be used for.

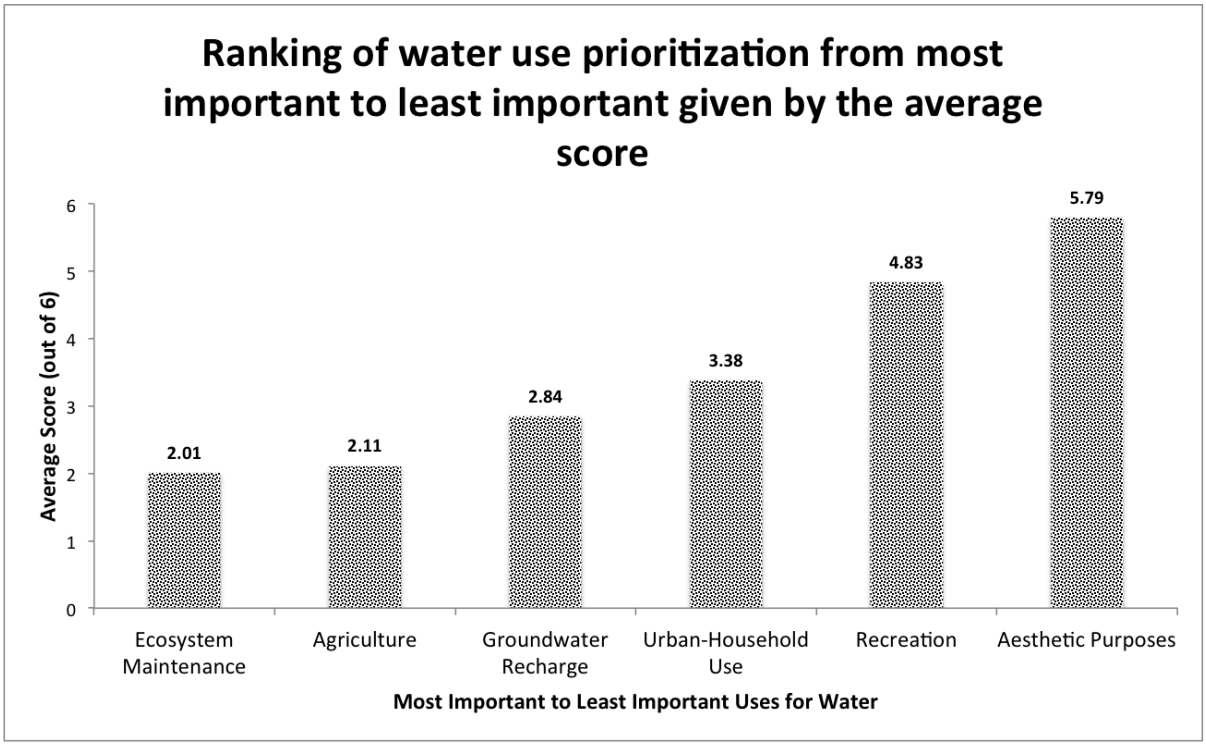

Figure 12. Ranking of water use prioritization from most important to least important.

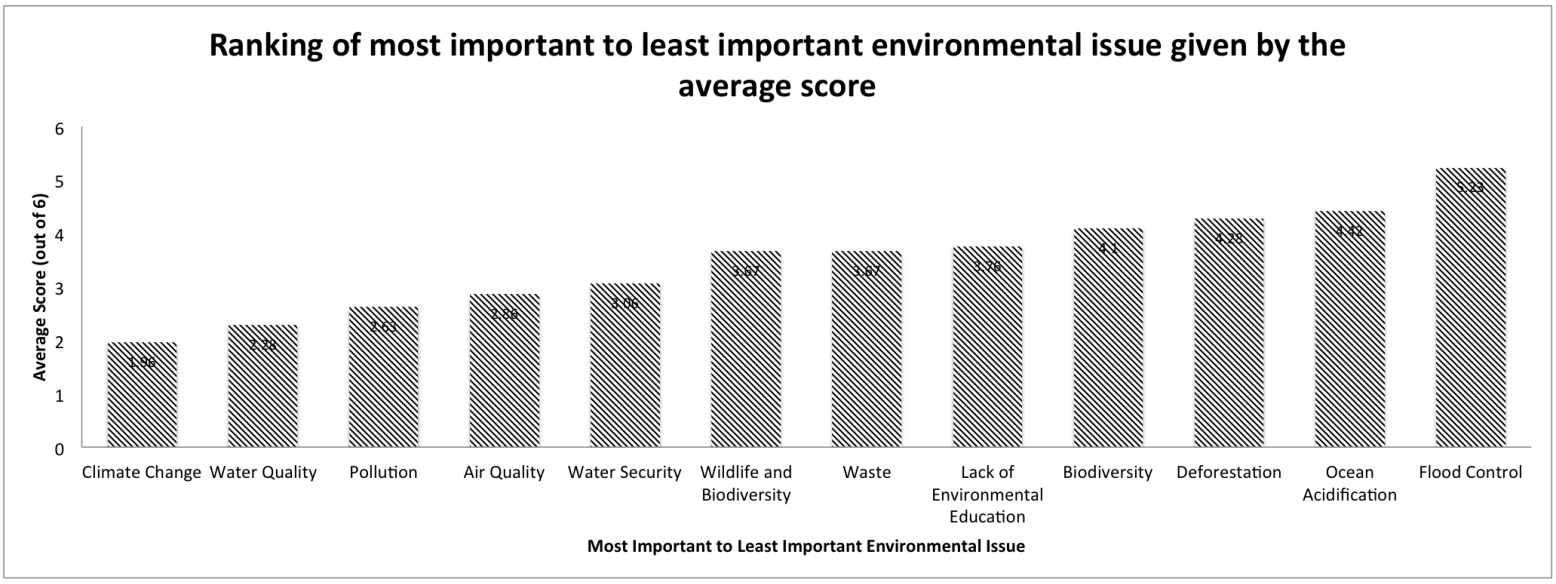

Figure 13. Ranking of environmental issues from most important to least important.

Environmental Education at Cal

Environmental education seemed to be present for the majority of the students who participated. About 93% of students had taken a high school or college level environmental class and the list of courses given by the students can be seen in Table 3. Approximately 86%, or roughly 4.5 students out of 5, believed environmental courses should be required to be taken by undergraduate students at UC Berkeley. About half of the students (54%) volunteer for an environmental organization/club/project and have taken an environmental footprint test (56%). The majority of students who have taken an environmental footprint test did so because of a class obligation, curiosity or personal edification.

Table 3. Environmental Courses students have taken in high school or at UC Berkeley.

Courses students have taken	
High School	College
AP Environmental Science	ES:10; ESPM: 50AC,150AC,168,165,167,114,110,44,163,169,163AC, 90; ERG:100, 101,102,190;EPS 8, 50, 80,180; CEE:107; LA:130

Behavior

The UC Berkeley students surveyed showed a wide range of behaviors regarding water use, water conservation and other pro-environmental behaviors. For water use behavior, students engaged in activities from most engaged in to least respectively: showering, brushing teeth, flushing the toilet, washing hands, washing their face, washing dishes, using the dishwasher and watering a lawn/garden. The average frequency in min/day of these activities ranging from

highest frequency to lowest respectively: washing face, brushing teeth, flushing toilet, washing hands, showering, washing dishes, watering lawn/garden, and using the dishwasher (Figure 14).

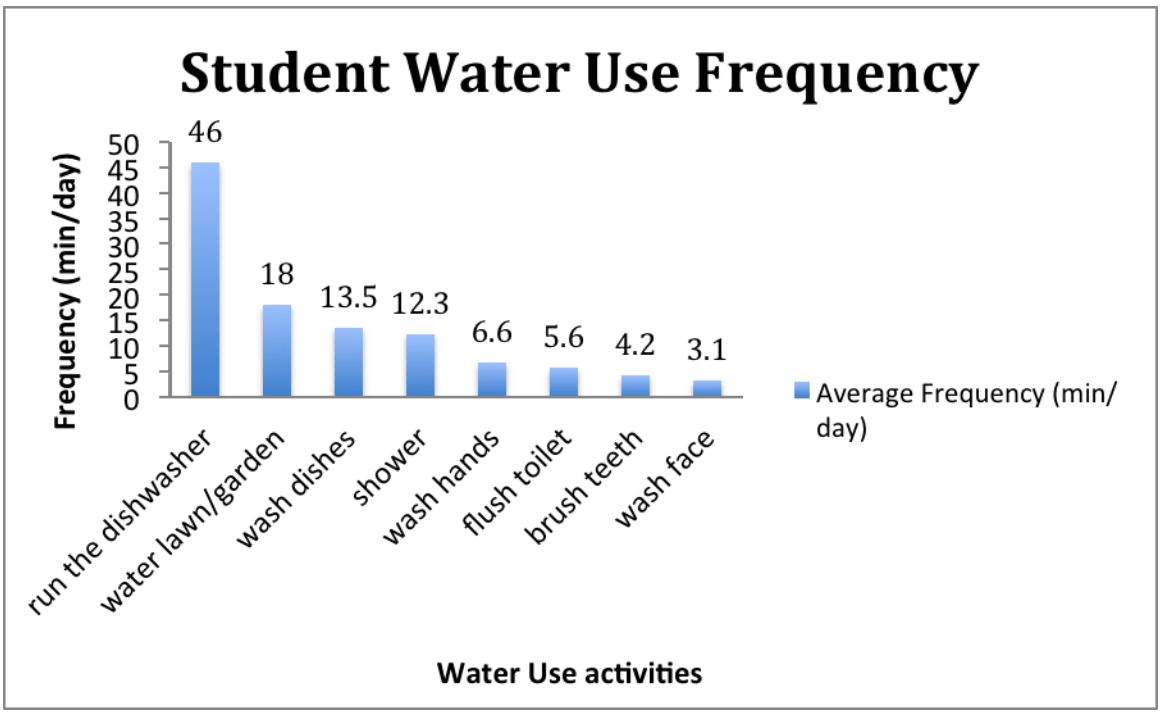

Figure 14. Average frequency that students engage in certain water use activities

Water conservation behavior varied less than water use behavior but a less percentage of students stated they engaged in water conservation activities than they did for water use behaviors. For water conservation, students engaged in the following activities from most engaged to least respectively: turning off water when brushing teeth, turning off water when washing dishes, only running the dishwasher when full, using a water efficient shower head, using a water efficient toilet, following the "yellow mellow, brown down", and turning off the water when washing body (Figure 15). About 9 out of10 students engage in turning off the water when brushing their teeth, 2 out of 3 of the students turn off the water when washing dishes. Approximately 2 out of 5 students run the dishwasher only when full and use water efficient showerhead. About 1 out of 3 use a water efficient toilet and about 1 in 5 follow the "yellow mellow, brown down" and turn off water when washing body.

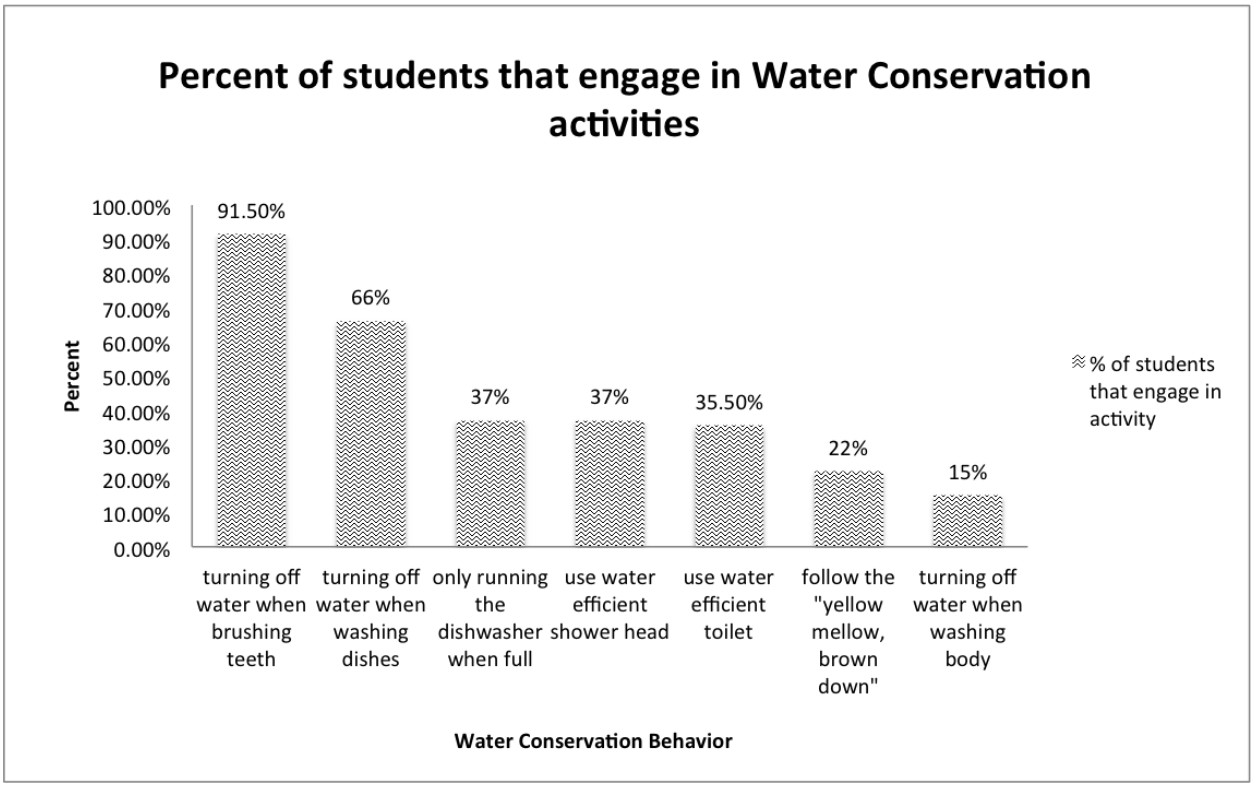

Figure 15. Percentage of students that engage in certain water conservation activities from most engaged to least engaged.

Other Pro-Environmental behavior showed was similar to water conservation behavior in that it was less varied but more students engaged in these activities than in water conservation activities. For Pro-Environmental behavior, students engaged in the following activities from most engaged in to least respectively: turning off the lights when not in use, recycling, riding bike or walking instead of driving, using public transportation instead of driving, using energy efficient light bulbs, and buying food from farmers markets (Figure 16). All students turned off the lights when not in use and most recycle. About 4 in 5 ride their bike or walk or take public transportation and 3 in 4 use energy efficient light bulbs. Only about 1 in 3 purchase food from farmers markets.

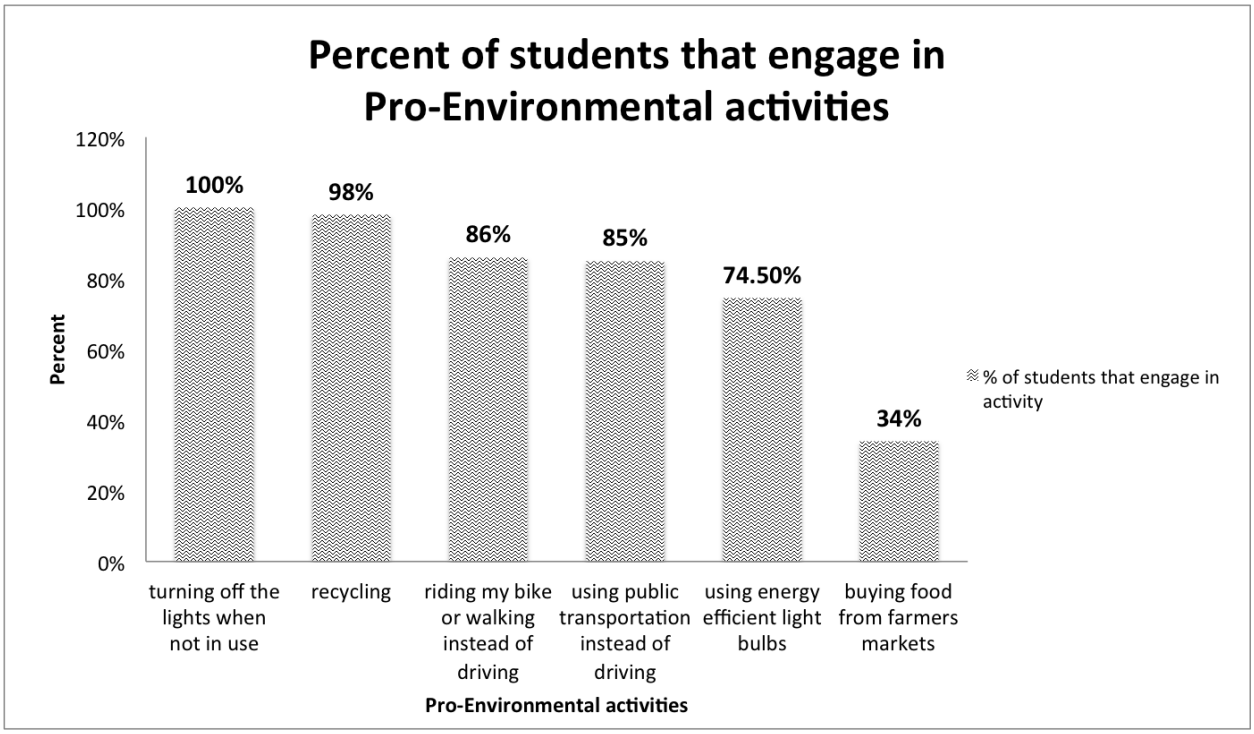

Figure 16. This figure shows the percentage of students that engage in pro-environmental behavior.

DISCUSSION

My study surveyed the water use/water conservation knowledge, attitudes towards conservation, water use/water conservation behavior and demographics of UC Berkeley students. Although the sampled population was not representative of all UC Berkeley undergraduates, I sought to understand students that I believed engaged more frequently in water conservation behavior in order to understand the factors that influence the desired behavior that we want to encourage students to engage in. My results focused on the student's answers to understand the basic level of water conservation knowledge, attitudes and practices that students engage in. I found that the majority of students sampled had some environmental knowledge background in their education yet seemed lack the basic knowledge of their water source, the average consumption of a typical CA resident, and how water is distributed in California. I also found that the majority of the students had pro-environmental attitudes towards water conservation yet very few engaged in water conservation behavior. I will discuss further what the data shows and

how we can begin to understand how we can implement these findings in order to create water conservation campaigns to motivate students.

Study Site and Data Collection

Although the sample size of students surveyed was n=59, the findings of this study is significant to explore further. Figure 2 showed the gender distribution in which the majority of the participants were female. This is significant to discuss, since gender can influence how much water a student consumes per day and water conservation practices that can be applicable. Women tend to have longer hair than men, and thus the average shower time could account for this difference in gender and could be slightly higher than if more males had been surveyed. Often the amount that one engages in water use can be reflective of the lifestyle of the individual and the preferences that they have for specific activities (Wilhite and Lutzenheiser 1999). With showering, many women do not wash their hair everyday so the average reflected per day in Figure 14 does not take this into account. Although age and ethnicity may not necessarily influence water conservation behavior, income and housing choice can be important factors because income often limits the amount one can consume and housing choices limits the accessibility to knowing how much one consumes (Wilhite and Lutzenheiser 1999). My results showed that the majority of the students were of income of $100,000+ comprising of about 1 out of 3 students surveyed and that most of the students lived in dorms or apartments. For those living in dorms, income may not necessarily matter since all students pay a flat fee but instead the lack of connection with their water use and the payment for the water could contribute to whether the student uses more water (Harland et al. 1999). But despite this lack of connection, dorms also facilitate a community within the students living in the dorms and from experience; students often value the opinions of others. If students felt that others were engaging in water conservation practices, whether it was taking shorter showers or making sure the water is not wasted, can increase the feelings of personal obligation, which might be beneficial in encouraging environmentally conscious behavior (Corral-Verdugo and Frias-Armenta 2006). For the students who live in apartments and pay their own water bill, the connection between

consumption and the amount spent on water may be a bit more obvious. Although water is a relatively cheap resource, students also tend to have less income or have their parents pay their bill and thus could be more of a strain if they're consuming more than they can afford. It is possible that these students are more aware and thus would engage more frequently in water conservation behavior (Kaiser et al. 1999). These students would benefit from knowing the resources for acquiring the free devices supplied by EBMUD so that they can begin conserving water. Students in dorms should be encouraged to engage more in water conservation behavior through their Resident Assistant to foster more of a social norm that students can take with them and eventually implement in their future years at UC Berkeley.

Knowledge

The level of water knowledge of the sampled population of UC Berkeley students varied significantly and is of great importance since factual knowledge is often a pre-condition of pro-environmental attitudes (Kaiser et al. 1999). Besides the relationship between knowledge and attitudes, it is important to just understand what the students know and don't know and establish what can be incorporated in future educational campaigns. For knowledge of students' water use, about 2 in 5 students knew approximately how much water they used per day. The students who know how much water they use could most likely be those who pay their own water bill or those who understand how to read their water meter. The average value of personal water use was 140 gallons/day, which was very close to the actual average usage of a typical California resident shown in Figure 9. This shows that the students who know how much water they use actually do have a good knowledge of how much water they consume. But 3 out of 5 students don't know how much water they use and facilitating this information could be worthwhile in increasing student's awareness about their personal water consumption. Similarly, 2 out of 5 students had knowledge of Berkeley's water source. It is possible that knowing where your water comes from can have an impact on whether you conserve water or not. Knowing the water source could give you a connection to the way in which we acquire water and the consequences of such supply. Often the feeling of guilt from engaging in an act where you are aware of any negative

consequences can lead individuals to engage in more pro-environmental behavior (Gazquez-Abad et al. 2011). The results show that 3 out of 5 students are unaware of where their water comes from. If students were aware of where their water came from and the variability in supplies due to the general knowledge of the hydrologic cycle, students could be more aware of the consequences of their actions and thus may be motivated to engage more in water conservation behavior (Gazquez-Abad et al. 2011). But despite this, often environmental decisions that exceeds one's ability to tolerate change will be rejected, which could mean that those who cannot tolerate a change in behavior may choose to not engage in water conservation (Arbuthnot 1977). For water uses in California, about 1 in 5 students correctly identified gross percent usage of water in CA agriculture, energy, and urban sectors and the estimated average CA residents' water use was 74 gallons/day. The majority of the students surveyed were unaware of how water was distributed between the economic sectors in CA and greatly underestimated the amount of consumption of a typical resident by a little over half of the actual value shown in Figure 8. Being more aware of how water is used and approximately how much can be accounted for by an individual could greatly enhance students' ability to see their consumption in the bigger scope. The average amount of water use by a typical CA resident is 135 gallons/day and visually representing that to students can have a great impact on how students' begin to perceive their water usage (Hegedus et al. 2009).

Water conservation knowledge also varied much like water use knowledge and is of great importance in this discussion as being an important factor in water conservation behavior. Regarding the knowledge of efficient showerheads saving 15 gallons/day, about 1 in 2 students knew that efficient showerheads and about 1 in 3 knew that EBMUD provided free low-flow showerheads of 2 gallons/min (EBMUD 2013). Half of the students knew of water conservation through efficient devices, yet only about 1 out of 3 actually used a water efficient showerhead (Figure 15). It could be that these students are lacking the proper devices due to an economic barrier or lack of incentive to buy an efficient one. I'm hoping that providing the information to the 2 out of 3 students regarding EBMUD's program for free showerheads will lower this economic barrier and provide an incentive for students to switch their showerhead. Harland (1999) evaluated their population with the category of the individual's conviction about whether the required skills and resources to perform the behavior are at one's disposal and my study

incorporated that category to facilitate the skill and resource to the student in order to hopefully motivate that individual to engage in the desired behavior. As a normative feature, most of the section on water conservation knowledge served to set a normative standard in which student's would potentially start to believe that water conservation is something everyone else is doing and thus they should too (Harland et al 1999). For the rest of the water conservation knowledge, the majority of the students had a good sense of water conservation practices and savings such as running the dishwasher when full and turning off the water when brushing their teeth and washing their hair/body. The majority of these students could still benefit from the free resources such as faucet aerators that are provided by EBMUD and providing this information could incentivize students to get them and start saving more water (EBMUD 2013).

Attitudes

For the majority of the students surveyed, the majority showed to have pro-environmental attitudes towards water conservation. For the purposes of this part of the discussion, I will focus on the discrepancies in the students that did not have pro-environmental attitudes as well as the important issues that UC Berkeley students' identified. For the attitudes towards the statements asked about water, the statements that I will focus on will be "I find environmental courses to be worthwhile and applicable to my daily life", " I believe it is my moral duty to conserve resources", "water conservation is something I strive to do when I can", and "I am willing to conserve even if it forces me to change my behavior". The statement about environmental courses and their applicability showed 15% of students neither agreeing nor disagreeing and 30% agreeing. Interestingly, 87% of the students stated that undergraduates should be required to take an environmental course. Considering 15% is almost 1 out of 4 students, I want to address this further. This indifference by some students could be reflective of the academic experiences that they have had with environmentally related courses. Some theoretical courses may not necessarily feel worthwhile to students or may not affect the attitudes they have towards water conservation. With 30% agreeing rather than strongly agreeing, it could be that students do not strongly feel that environmental courses are worthwhile or applicable to their daily life but do

serve a purpose. As an environmental science student I find it odd to take an environmental course and not see the connection to your daily life, but it could be that these students have had an experience with a course that did not make this connection clear. Academia in environmental courses, besides teaching the material that is required for the course, should help try to make these connections for students in order to instill some values towards the environment (Syme et al. 2000). If students find environmental courses worthwhile and applicable, it could foster more of an awareness on a daily basis and could help in the change in lifestyle that is much needed in our society. The statement about moral duty seems to reflect this a bit. The variation included about 5% that neither agreed nor disagreed with the statement and 2% that disagreed. This was similar for the statement about the intention to conserve water. Although the majority strongly agreed or agreed on those statements, there are a few students that felt indifferent towards them or disagreed. These two statements I believe go together in a sense. Those who believe it is their moral duty to conserve water would strive to conserve water as reflective with their values. The opposite I believe would hold true for someone who doesn't find water conservation to be a moral obligation. These morals and values should be incorporated in educational campaigns because of the relationship between values and intent (Harland et al. 1999). The more someone wants to be consistent with their morals and reflect them, the more they will conserve water (Kaiser et al. 1999). Morals and values can be influenced by society and the culture that one lives in and thus incorporating this can influence more pro-environmental attitudes that can facilitate pro-environmental behavior (Kaiser et al. 1999). The last statement about willingness to change behavior, 8% of students were indifferent which I believe is a reflection of the students who believe they are already doing as much as they can to change or those that feel that they don't need to change.

The lack of knowledge surrounding water supply in California and the state of drought could greatly influence the attitudes towards change and should be incorporated in educational campaigns (Syme et al. 2000). The reality of the situation is needed to surface in order to give students a greater urgency to begin to implement this lifestyle change. I believe these attitudes were to change if students were more aware of the water situation in California, specifically the state of drought. According to the California Water Plan, one of the considerations for the Action Plan for Sustainable Communities in California states that they recommend: Encouraging laws and policies that will better reflect the value of water resources to the State and its residents

(Hegedus et al. 2009). This section states that: **"**Steps should be taken to recognize the value of our State's waters by appropriately setting the price of water to all users in the State, following beneficiary pays principles. Increase the focus on conservation, reuse and reclamation measures at all governmental and non-governmental levels while recognizing the water-energy nexus. Steps should also be taken to remove the legal and policy constraints that inhibit the creation of a sustainable financing structure for water quality and resource planning, as well as remove the reliance on public bonds to support critical infrastructure. Further tangible means should be identified to better coordinate multi-jurisdictional planning, oversight, and funding of integrated water resource management between federal, state, regional, county and local entities using a more land-based approach to sustainability as opposed to a jurisdictional approach (Hegedus et al. 2009). With this recommendation, I hope the office of Sustainability will try to bring these values and incorporate them into educational and outreach campaigns.

Attitudes regarding recycled water, water use prioritization and important environmental issues all varied in the answers. For the purpose of this section, I will focus on the important issues that can be addressed on the UC Berkeley campus. The results showed that most students believed recycled water should be used for irrigating recreational areas and 15% didn't know enough about recycled water. According to the Sustainability Water Plan, UC Berkeley does not used recycled water. Providing educational material on the use of recycled water could further enhance the student's ability to understand water as a valuable resource that can be used and should be used efficiently (Daniels 2005). UC Berkeley should implement the use of recycled water and educational campaigns could bring this awareness to light and establish a normative feature (Kaiser et al. 1999). For water use prioritization students' response from most important to least important respectively: ecosystem maintenance, agriculture, groundwater recharge, urban-household use, recreation, and aesthetic purposes (Figure 12). Aestetic purposes was ranked the least important in terms of water use prioritization, showing that students would prefer water be allocated to other sources. Tying this in with recycled water, UC Berkeley uses a significant amount of water for irrigating recreation activities and considering that students don't value drinking water being used for these activities, the school should consider using recycled water for these activities (Daniels 2005). Attitudes towards important environmental problems from most important to least important were: climate change, water quality, pollution, air quality, water security, wildlife and biodiversity, waste, lack of environmental education, biodiversity,

deforestation, ocean acidification, and flood control (Figure 13). For these environmental problems, the average score placed water quality second and water security fifth most important. Students are concerned about water quality and water security. Since the amount of water you use for a given activity influences the amount of pollution one that one emits through the means of water, information about pollution prevention should also be included in educational material (Syme et al. 2000). Pollution was ranked third most important and thus encouraging pollution prevention can target the individual.

Environmental Education at Cal

Environmental education seemed to be present for the majority of the students who participated. About 93% of students had taken a high school or college level environmental class and the list of courses given by the students can be seen in Table 3. Most of the students who participated had some background of environmental knowledge and attitudes and behavior as seen by the amount of students who recycle and turn of the lights (Figure 16). Approximate 86%, or roughly 4.5 students out of 5 believed environmental courses should be required by undergraduate students at UC Berkeley. This is significant because this means that most students value environmental courses. This was contrasted with the worthwhile and applicability of environmental courses attitudes in Figure 10. About half of the students (54%) volunteer for an environmental organization/club/project and have taken an environmental footprint test (56%). The majority of students who have taken an environmental footprint test did so because of a class obligation, curiosity or personal edification. Half of the students had an understanding of their environmental impact, which can be significant when viewing pro-environmental behavior and the tendencies of students to engage in certain activities. These environmental footprints could be great to incorporate into educational campaigns because it gives students a sense of how much impact they make and gives them an incentive to try to better themselves (Barr and Gilg 2007).

Behavior

The UC Berkeley students surveyed showed a wide range of behaviors regarding water use, water conservation and other pro-environmental behaviors. These behavior practices are important to discuss in order to understand how to target water conservation behavior more efficiently. For water use behavior, students engaged in activities from most engaged in to least respectively: showering, brushing teeth, flushing the toilet, washing hands, washing their face, washing dishes, using the dishwasher and watering a lawn/garden. The average frequency in min/day of these activities ranging from highest frequency to lowest respectively: washing face, brushing teeth, flushing toilet, washing hands, showering, washing dishes, watering lawn/garden, and using the dishwasher (Figure 14). Most students seem to shower, brush their teeth, and flush the toilet more frequently than other activities. Understanding these activities that students engage in more frequently is important to know in order to understand what behaviors we are attempting to target to increase water conservation. The average shower time was 12 min/day, which without an efficient showerhead, could add up to more than 36 gallons/day. The savings could be significant in these areas if students implemented water efficient devices or behavioral water conservation practices. I'm hoping that by asking these questions to students they can start to quantify how much water they use per day (Barr and Gilg 2007).

Water conservation behavior varied less than water use behavior but a less percentage of students stated they engaged in water conservation activities than they did for water use behaviors. For water conservation I will focus on the activities that students could benefit learning how to conserve water. Students engaged in the following activities from most engaged to least respectively: turning off water when brushing teeth, turning off water when washing dishes, only running the dishwasher when full, using a water efficient shower head, using a water efficient toilet, following the "yellow mellow, brown down", and turning off the water when washing body (Figure 15). Since about 9 out of 10 students engage in turning off the water when brushing their teeth, I can conclude that students are engaging in a certain behavioral water conservation practice that seem to be the most convenient and most widely known. This can be seen in activities that are feasible to students such as turning off the water so that it is not wasted,

seen also when students wash their dishes. Having given them the knowledge of free devices that EBMUD gives, I'm hoping these students can implement some valve flappers and faucet aerators in order to continue to conserve water through efficient devices, as well as behavioral practices (Lutzenhiser and Hackett 1993, EBMUD 2013). Approximately 2 out of 5 students run the dishwasher only when full and use water efficient showerhead. Since there are about 3 out of 5 students not using a water efficient showerhead, there are very big water savings that can be beneficial to students. Providing the information about free low-flow showerheads to students served as a reduction of an economic barrier and served as an incentive to encourage students to start conserving water (Harland et al. 1999). About 2 out 3 do not use a water efficient toilet and these students can benefit from free displacement bags that are also provided by EBMUD (EBMUD 2013). Lastly, about 1 in 5 turn off water when washing body. This water conservation practice is least engaged by students and is the most inconvenient of all activities. From my peers, I have understood that this inconvenience is due to the unwillingness of individuals to be cold from the lack of warm water hitting their body. This inconvenience is important to understand, since it seems to reflect an activity that exceeds one's ability to tolerate change and thus is rejected, which could mean that those who cannot tolerate a change in behavior are choosing to not engage in this specific water conservation practice (Arbuthnot 1977). This activity paired with low-flow showerheads can further conserve as much water during the time student's shower and can provide significant water savings. Making it more acceptable could help more students engage in it. Often this activity has been targeted through social means with messages stating "save water, shower with your partner" as a way to incentivize this activity of using the water that otherwise would go to waste for something valuable (Syme et al 2000). Using current day knowledge of students and the culture that they live in can provide valuable resources to target students to foster a more sustainable community.

Other Pro-Environmental behavior showed was similar to water conservation behavior in that it was less varied but more students engaged in these activities than in water conservation activities. Pro-Environmental behavior served as a basis for distinguishing students who engaged in a pro-environmental manner to those whom did not. Students engaged in the following activities from most engaged in to least respectively: turning off the lights when not in use, recycling, riding bike or walking instead of driving, using public transportation instead of driving,

using energy efficient light bulbs, and buying food from farmers markets (Figure 16). All students turned off the lights when not in use and most recycle which reflects the activities that are least inconvenient and more feasible for students to engage in (Kaiser et al. 1999). A majority of the students ride their bike or walk or take public transportation use energy efficient light bulbs. These activities varied slightly but showed that students are willing to engage in pro-environmental behavior, even if it doesn't involve water conservation behavior. Many of these activities are well known and have been popular among students who engage pro-environmentally. Besides the importance of energy efficiency, pollution, and waste that are reflected by the activities most engaged in, fewer people buy food from farmers markets. In the larger scheme of engaging pro-environmentally, farmers markets serve as an avenue where pollution, waste, and energy use is minimized since the food is locally grown. Providing students with a holistic perspective of the overall environmental relationships can serve useful for students to actively choose to behave more pro-environmentally.

Limitations and Future Research

My findings are very limited in scope due my study design. I applied a snowball and convenience sample to gather most of my information, making my findings applicable only to group I sampled, rather than to all students at UC Berkeley. The method I used to assess the various study measures is questionable because all of the tests are different and measure different variables (Barr and Gilg 2007). I could have developed my own scale for all the study measures to better compare the study measures rather than using a percentage system and could have benefited from interviews that would have added a qualitative aspect to the overall project. My research contributes to the limited literature on the understanding knowledge, attitudes and intentions and how they influence Pro-Environmental behavior. The information can be implemented for educational and outreach campaigns, specifically at UC Berkeley, that can better motivate students to begin behaving more pro-environmentally. There is a growing literature on the effectiveness of educational and outreach campaigns in motivating pro-environmental behavior but it is still limited because of the complexity of behavior itself. I

contribute to filling the gap in knowledge about pro-environmental behavior and the factors that contribute to it. Pro-Environmental behavior and applying it to educational campaigns haven't been studied often and my project can play a role in understanding how these two can work well together to create an effective program. Finally, my research creates a baseline for knowledge, attitudes and behavior that can be important for the office of sustainability's future undertakings with water conservation.

Broader Implications

Understanding student knowledge, attitudes and intentions and how they affect water consumption can help the office of sustainability develop campaigns at UC Berkeley that can better motivate students to begin implementing more pro-environmental behavior. If UC Berkeley can influence their community to engage in conservation behavior, they can set an example that can further influence the creation of a social norm of environmental behavior throughout other UC campuses. This can allow for more environmentally conscious generations to be prepared for the potential effects of climate change. It is important to introduce moral environmental ideas that allows students to understand the importance of the environment, so they can develop appreciation for the natural world. This research suggests the need in advocating for increased participation in pro-environmental behavior that will serve as a tool for future generations to deal with the potential effects of climate change.

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APPENDIX 1:
Survey

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My name is Mayra Estrada. For my senior research thesis in Environmental Sciences I am assessing UC Berkeley students' knowledge, attitude, and behavior regarding water conservation. Information will be kept anonymous for the purpose of my research and will be used for research purposes only. *Your name will not be associated with your responses.* Please fill out the survey to the best of your knowledge. If you have any questions or concerns you can contact me at mayra_estrada@berkeley.edu. Thank you for your time and participation :)

For this first section, please answer the questions to the best of your knowledge.

I know approximately how much water I use per day

- yes
- No

If yes, approximately how much water do you use?

How much water do you believe an average California resident uses(gallons/day)?

Water in Berkeley is acquired from the Mokelumne River

- Yes
- No

Water in California is used for energy, agriculture, residents and recreation. Which of the following percentages approximately represent the gross percentage of water used for each sector?

- 20% Energy, 30% Agriculture, 50% Urban
- 33% Energy, 53% Agriculture, 14% Urban
- 20% Energy, 60% Agriculture, 20% Urban

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qualtrics.com

The purpose of this section is to understand the prevalence of water conservation awareness practices of UC Berkeley Students. Please indicate if you were aware of these practices prior to taking this survey.

You can save around 15 gallons/day of water per use by using a flow efficient shower head

- Yes
- No

EBMUD provides free low flow (2 gallons/min) shower heads

- Yes
- No

You can save up to 4 gallons/day of water by using the dishwasher with a full load instead of washing dishes by hand

- Yes
- No

Water displacement bags, quick closing flapper valves, and using high efficiency models can save up to 30 gallons of water per day.

- Yes
- No

You can save up to 20 gallons/day by turning off the faucet when you brush your teeth and wash your hair/body.

- Yes
- No

EBMUD provides free faucet aerators to reduce water use (1gallon/min)

- Yes
- No

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qualtrics.com

For the next section, please check each activity that you engage in and state the frequency per day and the minutes for each activity. ***I use water for the following activities (min/day):***

- ☐ shower
- ☐ run the dishwasher
- ☐ wash dishes
- ☐ wash face
- ☐ flush toilet
- ☐ brush teeth
- ☐ wash hands
- ☐ water lawn/garden

Please check the following ways that you conserve water (check all that apply):

- ☐ turn off water when washing body
- ☐ only run the dishwasher when full
- ☐ turn off water when washing dishes
- ☐ turn off water when brushing teeth
- ☐ follow the "yellow mellow, brown down"
- ☐ use water efficient shower head
- ☐ use water efficient toilet

Other activities you engage in (check all that apply)

- ☐ recycling
- ☐ riding my bike or walking instead of driving
- ☐ using energy efficient light bulbs
- ☐ turning off the lights when not in use
- ☐ buying food from farmers markets
- ☐ using public transportation instead of driving

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qualtrics.com

The purpose of this section is to understand students' attitudes towards different environmental issues.

Rank environmental issue from most important (1) to least important (6)

- flood control
- water security
- pollution 3
- climate change
- wildlife and biodiversity
- ocean acidification

Rank how you think water use should be prioritized from most important (1) to least important (6)

- agriculture
- ecosystem maintenance
- recreation
- urban/household use
- groundwater recharge
- aesthetic purposes (lawns and landscaping)

Recycled water: water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefore considered a valuable resource (includes both treated agricultural wastewater and treated municipal wastewater)

Which uses should recycled water be used for:

- [ ] showering
- [ ] drinking
- [ ] irrigation-food crop
- [ ] irrigation-recreational areas
- [ ] none of the above
- [ ] I do not know enough about recycled water

The purpose of this section is to understand student' opinions concerning water use and conservation. Please state whether you agree or disagree with the following statements:

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I think water conservation is important.	O	O	O	O	O
Water conservation is crucial for the survival of humans	O	O	O	O	O
I dont think water conservation is important	O	O	O	O	O
I believe environmental education is important	O	O	O	O	O
I find environmental courses to be worthwhile and applicable to my daily life.	O	O	O	O	O
I believe it is my moral duty to conserve resources	O	O	O	O	O
I am willing to be more environmentally conscious	O	O	O	O	O
Water conservation is something I strive to do when I can	O	O	O	O	O
I am willing to change my behavior for the better of future generations	O	O	O	O	O
I am willing to conserve water even if it forces me to change my behavior	O	O	O	O	O

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qualtrics.com

The purpose of this next section is to understand the prominence of environmental education at Cal.

Have you ever taken any high school or college level environmental sciences, planning, or sustainability courses? If so, please list all if possible.

- ○ No
- ○ Yes

Do you volunteer at any environmental organizations/clubs/projects? If so, please list all if possible.

- ○ No
- ○ Yes

Do you think environmental courses should be required for undergrads?

- ○ Yes
- ○ No

Which of the following environmental issues do you find to be the most important (1) to least important (6)

- water quality
- air quality
- biodiversity
- deforestation
- lack of environmental education
- waste

Have you ever taken an online environmental footprint test? If yes, please state the reason.

- ○ No
- ○ Yes

>>

What year were you born?

Gender

- male
- female
- other

Are you an international student?

- Yes
- No

Major

College:

Housing

- dorm
- cooperative
- aparment
- house
- other

Do you pay your water bill?

- Yes
- No

What is your household income? If you have no income, please state that of your parents.

- Less than $10,000
- $20,00-$50,000
- $50,000-$100,000
- $100,000+

Original residence outside of Berkeley (if from California, please state the city)

Education level/Class status based on units taken.

- freshman
- sophomore
- junior
- senior

Are you Hispanic or Latino?

- Yes
- No

The above part of the question is about ethnicity, not race. No matter what you selected above, please answer the following, if applicable, by marking one or more boxes to indicate what you consider your race to be.
How would you describe yourself? (Choose one or more from the following racial groups)

- American Indian or Alaska Native
- Asian
- Black or African American
- Native Hawaiian or Other Pacific Islander
- White
- Other

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