Towards a Sustainable University Campus – Water Use and Plastic Generation

Nahid Khalifa[+], Kazi Fattah and Abdallah Al-Alami

Department of Civil Engineering, American University of Sharjah

Abstract. The globe, in its move towards advancement is continuously exhausting earth's valuable and limited resources. Water is an invaluable resource that is currently not available to some, while others are wasting it. Furthermore, in the Middle East, the primary source drinking water is bottled. This bottled water demand lead to higher plastic consumption, which unfortunately resulted in more resources are being used and wasted. This paper hopes to investigate such trend, for both water and plastic, and provides means of minimizing the negative impacts. As a case study, bottled water consumption trends in the American University of Sharjah were analyzed, in hopes of leaving a green and blue footprint on this planet starting with our own community. The results show that 55.1% of students purchased one bottle of water per day, and 26.5% purchased two bottles, while 15.3% reported buying 3 to 4 bottles per day. The remaining 3.1% bought more than 4 bottles per day. These numbers are only the number of bottles bought on campus, during the time spent in the university. Furthermore, 30% of the bottled water was not consumed. Despite the presence of recycling bins on campus only 22.2% were found to be taken for recycling. The survey also yielded that the best alternative to the bottled water is the use of water coolers. The highest incentive to recycle was found to be paying money for recycling as well as spreading awareness.

Keywords: Water, Plastic, Reuse, Sustainability.

1. Introduction

1.1. Water: Use and Trend

Water scarcity can be defined as the lack of access to sufficient supply of clean and safe water. Economic scarcity is when difficulties are faced in locating a reliable water source and extracting it. However, physical scarcity is more profound as the world's resources are limited. With the globe's development tipping the scale in favor of overconsumption, resources in general, and water in particular, is being excessively used. The region already suffers from natural fragility as it is the world driest area. Furthermore, the problem is amplified by the fact that it continues to supply water abundantly despite the undersized water resources available. Approximately 90% of the freshwater resources are already stored in reservoirs. Therefore, it is not surprising that water is the major vulnerability of the region (World Bank, 2010). Also, the lavish living styles and increasing standards of living, combined with the drive to make profits out of supplying water has driven supply irrationally high relative to the water levels available. Not only is the waste in the domestic section relatively high, but the gap between extraction and consumption is still increasing. In other words, the wastage is high and still increasing.

The United Arab Emirates' average per capita consumption is 550 l/day, the third highest in the world, and is growing at an annual average of 8% to 10%. Abu Dhabi alone estimated consumption is 2.49 billion cubic meters (Kisner, 2009). This figure consumption is expected to double by 2020 reaching 5.86 billion cubic meters. The Emirates Industrial Bank conducted a study that revealed that the water consumption in the United Arab Emirates is relatively high compared to western countries, and that is associated with harsh

---

[+] Corresponding author. Tel.: Tel. + (971 50 581 61 33);
E-mail address: (g00032330@aus.edu)

climatic conditions, increasing tourism, and increasing standards of living. Furthermore, for the past 30 years, the groundwater level in the UAE has dropped 1 m per year.

1.2. Plastic

Although plastic is a convenient material for both the consumer and the produces, it is environmentally harmful. After treatment, typically drinkable water in the UAE is bottled in containers of various types and sizes ranging from 0.33, 0.5, 1.5 Litres to 5 and15 gallons. The most common type is Polyethylene Terephthalate bottles, which are non-biodegradable. Usually, the 5 gallons bottles are refilled and reused, while the smaller bottles consume place in landfills. Figure1 below illustrates the distribution of plastic use in Europe by category. No similar data was found for the Middle East.

Plastics Demand by Segment in Europe - 2010

27,3%
39%
5,6%
7,5%
20,6%

■ Packaging
■ Building & Construction
■ Automotive
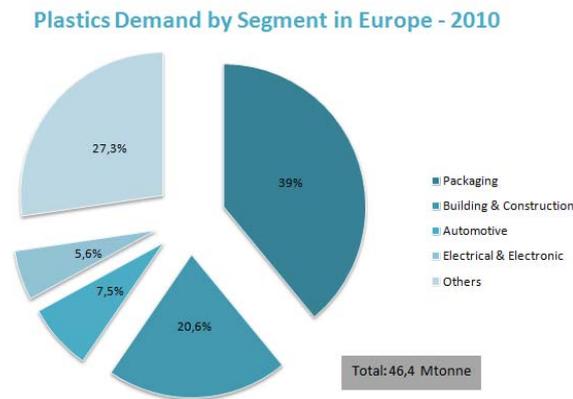■ Electrical & Electronic
■ Others

Total: 46,4 Mtonne

Fig. 1: Plastic Demand by Segment in Europe

As previously mentioned, the United Arab Emirates suffer from harsh climatic conditions which lead to higher water consumption. Due to the living styles, increased drinking water consumption is associated with higher bottle consumption. However, it should be noted that in addition to the previously mentioned factors, high disposable income and easy market access to suppliers also contributed to building up the storm that lead to the heavy increase in the number of bottled water in the market. Euromonitor International has reported that the market for bottled water is increasing globally, and is flooding the Middle East area. The key areas are GCC countries: United Arab Emirates, Saudi Arabia, and Bahrain, with an increase in bottled water of more than 30% over the past five years (Hotelier, 2011). It is estimated that at least 250 liters of bottled water is consumed per capita annually. With the capital Abu Dhabi attracting more business visitors, and Dubai being an international tourist hub, imported mineral water is becoming more widespread. The UAE market is being described as a dynamic market due to the several variables aspects involved in the major leap in the thirst for bottled water. OanaVremes, marketing and brand manager of International Hotel Supplies does not doubt that 50% of the demand for bottled water stems from five stars hotels and restaurants. The following graph shows trends of plastic use and reuse in the United States. According to the US Environmental Protection Agency only 8% of plastic waste was recycled in 2010. This is equivalent to 2.4 million tons, which is only a small amount of the plastic that can be recycled. Figure 2 shows the difference between the plastic generation and plastic recovery in the United States.

Plastics generation
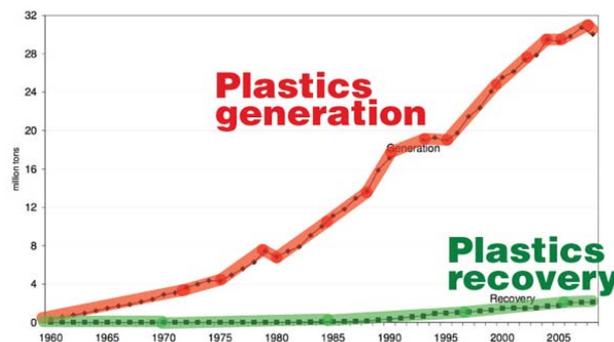
Plastics recovery

Fig. 2: Plastic Generation and Recovery

Plastic bottles and containers provide themselves as an attractive packaging material due to its properties. After the early 1960s, the introduction of high density polyethylene lead to relatively low plastic costs relative to glass bottles. Both the producers and the consumers found it to their advantage. Not only is plastic an economic choice, but it is also more convenient for the user. It is lightweight in nature, impact resistant and is a good moisture barrier. Furthermore, it is resistant to degradation by sunlight, bacteria, and is a thermal and electrical insulator (The Environmental Literacy Council, 2008). According to the Science Institute in Society, in 2005 the world consumed 100 million tons of plastic. Despite the fact that paper is usually the major constituent of trash, when buried (ie in volume) plastic accounts for 25%. The globe, in its move towards technological advancement, is producing temperature resistant, durable and easy to use, without considering the negative implications of such materials. Plastic is one such material, and it is a synthetic material that does not decompose in soil with moisture and air easily. It remains in the environment for a long time, some leach harmful materials and some get transported to unimaginable locations. Ocean currents contribute to this transportation process. For example, a "Texas sized island" collection of plastic trash is observed floating in the North Pacific gyre. It affects the natural life of organisms on soil, water and air. Any plastic that enters the ocean is broken down into smaller pieces. Marine animals confuse these smaller pieces of plastic with food. An expedition by the Algalita Marine Research Foundation and the 5 Gyres Institute (Hoare, 2012) revealed that in remote areas of the Pacific Ocean there is as much as six times by weight of plastic, as there is food. He has also found that populations of ducks on remote islands have died due to consuming plastic instead of food (2012). In addition, incineration of plastic also has undesirable effects. When burnt, carbon monoxide, dioxins, and furans are produced. Toxic gases released in the process of burning plastic have been associated with a variety of health issues such as: cancer, impotence, asthma, hormonal imbalance, sex behavioural orientation newborn babies, and a series of other allergies to human beings.

2. Methodology and Study Area

With the intention of determining the bottled water consumption at the American University of Sharjah (AUS) campus, the number of water bottles left behind in different locations on campus was calculated. The first sampling point was the university's library study area. This area was chosen as a large number of students end up taking their bottles to this location and leave it on the tables. The second sampling area was the engineering building. In addition to the number of bottles used and left behind in the two locations, the amount of water wasted – water left behind in the bottles – was measured. The number of bottles left behind by library users was counted for a period of one week. It should be noted that these bottles were collected from the morning opening hours till 9 p.m. The library is also open between 9 p.m and 12 a.m, however, no data collection was possible for that period. In addition, the number of bottles left behind in the engineering building was counted. The average number of users for that period was also documented. In order to obtain a student-water bottle usage data, the head count carried out by the library staff every 2 hours was also obtained.

3. Results and Discussion

3.1. AUS Statistics

A summary of the number of bottles used in the different locations as well as number of users is presented in Table 1. As mentioned earlier, it was not possible to calculate the number of water bottles in the library between the 9pm-12am periods. However, it was learnt that roughly similar amounts of bottled water are left behind during the 9pm -12am period (pers. comm. cleaning personnel).Figure 3 below shows a group of water bottles left behind.

Variation in data can be observed in Table 1 that a higher than average number of bottles of water were collected on the first sampling day (Tuesday). This may be due to students having a common exam in the basement, which is located right next to the library. This may have lead to the high number of users, and in turn the high number of bottles consumed. The number of bottles per user roughly average around 1, however, for Friday it was 0.76 which is relatively less than the average. Typically, the operating hours of the library on Saturdays are less than week days. In order to determine the amount of water being wasted, the

water from the left bottles was collected in a water container. It was found that, on an average, 158 water bottles from the library were needed to fill a 5gallon of water container. This shows that, on average 5 gallons of water is wasted every day from the library, which is equivalent to wasting 19 liters per day of clean water only from the library. Table 2 below shows the calculation of estimations for the quantity of bottled water wasted from the campus per week.

The approximate quantity of the wasted water is 20.04% of the water bottles from the bottles collected from the library over one week. A parallel study carried out at the university student centre found a water loss waste rate of 18%. Despite the location difference, the percentages of water wasted from bottles are close to each other.

Table 1: American University of Sharjah water bottle use study results

Description of bottles collected	No of bottles	Average no of users	Bottles per user
6/3/2012 Tuesday	250	187	1.333
7/3/2012 Wednesday	143	160	0.894
8/3/2012 Thursday	150	160	0.938
9/3/2012 Friday	110	56	1.964
10/3/2012 Saturday	117	154	0.760
11/3/2012 Sunday	170	160	1.063
Library Average	156	146	1.068
Engineering Building (Total one week)	600	-	

Table 2: Total number of water bottles and water quantity wasted per week

Location	No of bottles/d	Water Quantity Wasted (mL/d/bottle)
Engineering Building 1 & 2	600	160.32
Library	400	80.16

Table 3 below provides the quantities of bottled water sold at different locations on the campus, which in turn give an indication of the amount of water wasted. The data was obtained from the vending machine operators who are responsible for refilling the vending machine twice per day. The values above are the total number of bottles sold per day. Based on the previous data, the approximate quantity of bottled water wasted from AUS campus is 278.96 L/day

Table 3: Number of water bottles sold at different locations on campus

Location of vending machines	Number of bottles sold/d
EB1	240
EB2	240
Library	400
Chemistry	240
Physics	240
Old SMB	240
New SBM	480
Student Center	240

3.2. Possible Use of Discarded Water

Although the amount of water wasted may seem insignificant, when multiplied by the number of days the water is wasted, the quantity of clean water wasted may be put to other beneficial uses. For example, each month the amount of water wasted from the AUS buildings is at least 8370 L. Possible uses may include university vehicles washing, watering of indoor plants, or cooling down the artificial turf in the

playground. It may also be further treated for drinking purpose. However, due to public perception towards wastewater, the last use may not be a socially acceptable option at the moment.

3.3. Public Perception to Reuse of Treated Water

The bottled water wasted is of high quality. Most of that water is desalinated water, and much energy was been invested in its production. Slowly, this is being appreciated by the society. Although most people find some difficulties in accepting the use of recycled water, when presented with the cost difference associated and assured of the quality, this social barrier disintegrates. It is awareness and environmental responsibility that affects the choices consumers make. A survey was conducted at the American University of Sharjah to get a better sense of public perception regarding the reuse of bottled water and the following is a summary of the major findings. The results show that 55.1% of students purchased one bottle of water per day, and 26.5% purchased two bottles, while 15.3% reported buying 3 to 4 bottles per day. The remaining 3.1% bought more than 4 bottles per day. These numbers are only the number of bottles bought on campus, during the time spent in the university. These values are only average values on a typical day at the university, and do not account for other special occasions or events where extra bottles are purchased. Furthermore, 30% of the users stated that they did not completely consume the bottled water. This implies that an amount of perfectly drinkable water is wasted. In addition, 40% of the users answered that they refill the water bottle after use. While this may be a form of reusing resources, it presents its own complications such as leaching of chemicals from the bottle into the water, which may have health effects. Despite the presence of recycling bins on campus only 22.2% were found to be taken for recycling.

3.4. Possible Solution Scenarios

As indicated earlier, large amount of both water and plastic bottles are being consumed and wasted on campus. The following survey question in figure 3 below shows how people rated the incentives that will encourage them to recycle. In the comments, most people suggested using more recycling bins on campus.
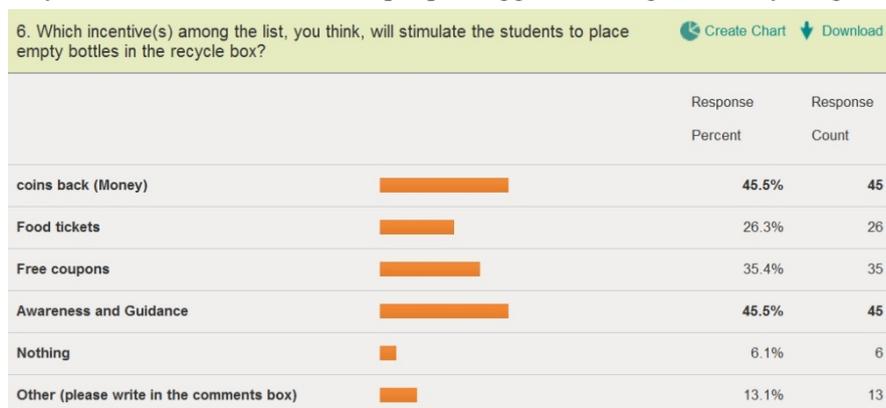

Fig. 3: Incentives for Recycling

Already, there are recycling bins with sorted materials placed around the campus and they are being put to use. However, in order to give people incentives to recycle, perhaps vending machines that pay people for every bottle they recycle could be implemented. These are all suggestions that will incrementally reduce the amount of water wasted on campus, and it is only a small step. However, the main aspect that will decide how much water can be saved is the social one. Social acceptance and environmental responsibility is the most significant factor that affects our consumption patterns.

4. Acknowledgements

5. References

[1] Algalita Marine Research Foundation. Synthetic Sea: Plastic in the Open Ocean. Produced by Mr. McDonald, Bill. Retrieved from http://www.youtube.com/watch?v=QJvifVrGi8o

[2] Environmental Literacy Council, (2008). *Plastics*. Retrieved from
     http://www.enviroliteracy.org/article.php/1188.html

[3] Hoare, R. (2012). CNN: *Research ship finds the world's oceans are 'plasticized'*. Retrieved from
     http://edition.cnn.com/2012/05/21/world/asia/algalita-eco-solutions/index.html

[4] Hotelier Middle East. *The region's bottled water market is exploding*. Retrieved from
     http://www.hoteliermiddleeast.com/12378-the-regions-bottled-water-market-is-exploding/

[5] Kisner, C. (2009). *Sustainable Solutions for Energy and Water Security in the United Arab Emirates*. Climate
     Institute. Retrieved from http://www.climate.org/publications/Climate%20Alerts/Winter2009/UAE.html

[6] Oceans, Waves and Beaches. *The massive gap between plastics generation and recovery*. Retrieved from
     http://oceanswavesbeaches.surfrider.org/the-massive-gap-between-plastics-generation-and-recovery

[7] ReportLinker. *Plastic Industry: Market Research Reports, Statistics and Analysis*. Retrieved from
     http://www.reportlinker.com/ci02375/Plastic.html

[8] U.S. Environmental Protection Agency, (2012). *Plastics.* Retrieved from
     http://www.epa.gov/osw/conserve/materials/plastics.htm

[9] Wan Ho, (2005). Institute of Science and Society. *Redemption from the Plastics Wasteland*. Retrieved from
     http://www.i-sis.org.uk/RFTPW.php