

## CHANGING PERCEPTIONS: WATER QUALITY AND DEMAND IN THE UNITED ARAB EMIRATES

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### ABSTRACT

The natural availability of water in the United Arab Emirates (UAE) is low, but due to substantial economic and population expansion in recent years, water consumption has increased dramatically. Groundwater supplies are being rapidly depleted, and reliance upon relatively expensive desalinated water is growing. In spite of the high cost of desalinated water and the natural scarcity of water, usage of water on a per-capita basis in the UAE is among the highest in the world. Agricultural ventures that would be impossible without desalination are subsidized by the low water fees that are charged by governmental water utilities. Public water use is growing as the standard of living rises and the use of non-native plants and grasses expands.

Despite heavy governmental investment in water production and delivery infrastructure, and despite the widespread availability of potable tap water produced in line with international standards, most people in the UAE believe their tap water to be unsuitable for drinking and instead rely on bottled water. In this research, surveys gauging the opinion of UAE residents on the quality of municipally-provided water supplies identified that most water users do not believe desalinated water, in general, is fit for regular drinking. Respondents identified a variety of reasons, including perceptions of mineral imbalances, concern about the sanitation of intermediate water storage tanks, and the cleanliness of the seawater source used for production. Attitudes about water scarcity and tap water drinkability were found to vary significantly by nationality.

It is proposed that by reducing government subsidies on water and by working to improve user perception of tap water quality within the UAE, residents will reduce their reliance upon less environmentally friendly bottled water, and will also use tap water more judiciously and reduce per-capita water consumption to levels that correspond more rationally to the locally high cost and low natural availability of water.

## INTRODUCTION

As a variety of factors – such as population growth, increased standards of living in developing countries, and climate change – put pressure on already stressed global water resources, the ways that people perceive and consume potable water are rapidly changing. It has been estimated that global average consumption of bottled water increased by more than 40% between 2000 and 2005 (Worldwatch Institute, 2007). In some regions with arid climates, where utilization of non-traditional sources of potable water (i.e., desalination) is common, increases in bottled water consumption were even more dramatic, with a reported doubling in bottled water consumption in the Middle East from 2003 – 2008 (Saleem, 2008). The United Arab Emirates (UAE) leads the world in terms of per-capita bottled water consumption, with 68.6 gallons per person, compared to 29.3 gallons per person in the United States, 24.1 gallons per person in nearby Saudi Arabia, and the 7.6 gallons per person global average (Beverage Marketing Corporation, 2008).

Within the United Arab Emirates, demand for tap water is also on the rise; in Dubai, contracts valued at AED 40 billion (USD 10.9 billion) have recently been announced to expand electricity generation and desalinated water production capacity from 1.26 million m<sup>3</sup> per day in 2007 (DEWA, 2007) to 1.90 million m<sup>3</sup> per day in 2010 (Husain, 2008a), and 4.55 million m<sup>3</sup> per day by 2020 (Husain, 2008b). While a booming population within the UAE has contributed to increased water demands, increases in per-capita consumption have also helped fuel the need for expanded desalination capacity. Rising standards of living have propelled many residents from densely populated multi-story apartments into single-family villas, where expansive and water-intensive grassed areas and gardens are the norm. One recently-launched Dubai development billed as green and environmentally friendly is, according to UAE Minister of Cabinet Affairs and Dubai Holdings CEO Abdullah Al Gergawi, aiming to “restrict the usage of power and protect natural resources from being wasted.” However, this development, the Mohammad Bin Rashid Gardens project, will cover more than 8100 hectares and will be 73% greenery (Gulf News, 2008).

The escalating demand for water in the UAE is at stark odds with the average of 11.9 cm of precipitation received annually (UAE National Center of Meteorology & Seismology, 2008). With increased demand upon water resources by individual consumers, combined with the many new housing developments, parks, golf courses, and municipally-irrigated green spaces adjacent to roadway areas, the ability to provide sustainable water resources has long since been exceeded. In the absence of substantial surface water supplies, and as the country’s limited and slow-to-recharge groundwater resources near exhaustion, the UAE is increasingly turning to energy-demanding desalination processes to provide the water that is used for domestic and agricultural use. In Dubai, wells account for only 11.5% of the installed capacity, with desalination accounting for the remaining 88.5% (DEWA, 2007).

While on the whole the UAE possesses abundant petroleum and gas resources, the vast majority of these resources reside within the emirate of Abu Dhabi. Due to a highly-federal structure of government, resources available in one emirate do not always translate into availability for the others. As a result of the uneven distribution of energy resources within the UAE, the other six emirates besides Abu Dhabi are beginning to incorporate less traditional (i.e., natural gas) means of supplying the electricity required to generate desalinated water, including coal gasification / turbine electricity plants, traditional coal-fired electricity power plants, recently announced nuclear power development agreements with France, importation of natural gas from neighboring gulf states such as Qatar, and to a lesser extent, incorporation of renewable energy resources such as solar.

Although demand for tap water in the UAE is increasing, public perception about its quality is generally low: tap water is not available at restaurants, public drinking fountains are very rare, most

people utilize at-home delivery of bottled water, and beyond avoiding tap water for drinking purposes, some UAE residents also avoid it for cooking. Perception about the superior healthfulness of bottled water compared to tap water has been questioned for a number of years in the US, with one study showing that one-third of bottled water samples failed guidelines related to limits on bacteria, inorganic contaminants, and carcinogenic chemicals such as phthalate (Olson, 1999). While tap water in the US is regulated by stringent laws enforced by the Environmental Protection Agency, bottled water is regulated by the Food and Drug Administration, with a different, more lenient, set of regulations being applied. There is also evidence that bottled water in the developing world is not as healthy as sometimes advertised; an analysis of seventeen different brands of bottled water in India found concentrations of essential minerals such as magnesium, potassium, and calcium were generally lower than World Health Organization (WHO) minimums, and that the concentration of lead was exceeded in seven of the seventeen brands tested (Mahajan et al., 2006).

There are four primary water utilities in the UAE: the Dubai Electricity and Water Authority (DEWA); the Sharjah Electricity and Water Authority (SEWA); the Federal Electricity and Water Authority (FEWA), which is responsible for production and delivery of tap water in the emirates of Fujairah, Ajman, Umm al-Quwain, and Ras Al-Khaimah; and the Abu Dhabi Electricity and Water Authority (ADEWA), which oversees a semi-privatized consortium of companies tasked with water production in the Abu Dhabi emirate. UAE water utilities have confirmed that the water they produce is intended for human consumption, is regulated in accordance with World Health Organization (WHO) recommendations, and leaves production facilities in a condition that is safe to drink (ADEWA, 2008; DEWA, 2008; FEWA, 2008).

In order to investigate the apparent contradiction between the public perception of poor water quality and utility assurances that tap water is safe to drink, and in an attempt to understand how perception of water quality may influence the growing demand for water in the UAE, a survey pertaining to perception of water quality was administered to residents of the UAE, including national and non-national residents. Survey questions included those intended to gauge public perception of overall freshwater resource availability, questions pertaining to perception of tap water quality, questions related to water pricing and valuation, questions probing preferences towards bottled water versus tap water, questions investigating attitudes towards water conservation, and demographics questions used to analyze population sub-groups for attitudinal effects related to nationality, gender, education, income, age, etc.

## **METHODS AND MATERIALS**

The survey utilized was available to respondents both in English and in Arabic; while Arabic is the official language of the UAE, English is the language most widely spoken in business, commercial, and educational settings. Less than 20% of the UAE's approximately 4.1 million residents (UAE Ministry of Economy, 2006) are nationals of the UAE, with the remainder being comprised primarily of Asian expatriates, nationals of other Gulf and Middle Eastern countries, and Western expatriates.

The survey included questions to ascertain respondent nationality and emirate of current residence in order to assess variations in perception of water availability and quality by national background, and by which of the seven emirates respondents live in. During some aspects of analysis, geographic / nationality sub-groups were formed for comparative analysis, during which nationals of countries in the Middle East and North Africa were grouped together into one group representing the Middle East, nationals of India and Pakistan were combined into another group representing the Indian sub-continent, nationals of North America, Australia, and European countries were classified into another group, and nationals of Asian countries were classified into another group.

The survey was completed using an online collection system, and results gathered from online means (n=364) were compared to a previously-administered paper survey (n=41) to order to check the consistency of results with respect to survey administration method. Two-way cross-tabulation Chi squared analysis was applied to questions related to bottled water versus tap water preference, and showed that no significant differences in response existed between the online and paper surveys.

Survey results were analyzed overall and by demographic subgroups using summaries of descriptive statistics, Chi squared analyses, analyses of variation.  $\alpha=.05$  was utilized for purposes of defining statistical significance.

## RESULTS AND DISCUSSION

### Water Quantity Perception

In general, responses to questions related to water quantity indicated that while some people in the UAE have concerns about the potential of future shortages of fresh water, the level of concern varies significantly by national background. Concerns about the potential for water shortages are, to a degree, contradicted by the widespread view among survey respondents that the availability of freshwater in the UAE is either abundant or not-scarce.

When asked, “Do you ever worry that in the future there may be a water shortage where you live”, 61% of survey respondents overall answered “yes” and 39% answered “no”. When separating respondents by national background, 83% of Western respondents (n=54) expressed concern about the potential for water shortage, compared to only 55% of respondents with a Middle Eastern background (n=205). A two-way cross-tabulation Chi squared analysis of these responses identified the difference in response to be statistically significant at  $p < .01$ .

These results are at first counter-intuitive: one could reasonably expect that residents of the UAE who have a Middle Eastern background would, because of their experience of living in an arid region with a low availability of freshwater resources, tend to have a greater level of concern about the potential for future water shortages than respondents originally from western countries where water resources are generally less scarce. There are, however, a number of possible explanations for these significant attitudinal variations. First, a greater number of western survey respondents may originally come from areas where the amount of available water depends on precipitation patterns that vary widely from year to year. Although the amount of precipitation in the Middle Eastern countries (e.g., the UAE) is less than the average amount of precipitation in many western countries (e.g., the US), surface water resources – which are those most prone to seasonal and year-to-year variations due to drought – are an important source of drinking water in many western locations, but do not account for an appreciable quantity of the available water in most Middle Eastern countries. Thus, since scarcity of water may be more common to those in the Middle East, “water shortages” may be considered as a normal condition for people from the Middle East, and something less prone to generate “worry”. Likewise, since UAE residents originally from a western country are more likely to have been affected by a water shortage, they appear to have transferred concern about these experiences to their new location.

A second explanation as to why westerners living in the UAE may have a higher degree of worry about the potential for water shortages than residents of Middle Eastern origin is that residents of Middle Eastern origin are likely to have lived longer in locations where desalination is a primary water resource technique. One illustration of the general lack of renewable freshwater resources in the Middle East, relative to the amount of water actually used, is the withdrawals-to-availability ratio (WTA). This ratio measures freshwater consumption relative to a country’s annual renewable water resources; whereas in the US the WTA ratio is 16%, in the UK the WTA ratio is 6%, and in Canada the WTA ratio is 2%, in the UAE the WTA is 1533%, second in the world only to Kuwait’s 2200% (WWF, 2006). The annual consumption of fresh water of more than 15 times greater than the renewable water resources available in the UAE highlights that consumption within the UAE is not presently tied to natural water availability, but is rather tied to non-traditional water resources such as desalination that are essentially unaffected by events like drought (though disruption to desalination is, potentially, threatened by other events, such as seawater pollution, fuel shortages, economic disruptions, etc.).

The perception that additional water resources are infinite, and can be ‘manufactured’, in the form of new desalination facilities, when needed may help explain why UAE residents with a Middle Eastern background have a reduced level of concern about water shortages than residents with a Western background. While Western residents of the UAE may have a period of residency in the UAE of only a few months or just a few years, Middle Eastern residents of the UAE are more likely to settle permanently in the UAE, and grow accustomed to the idea of water resources being infinitely expandable and not prone to disruption.

When asked, “How would you classify the availability of fresh water where you live,” 43.3% of respondents overall answered “abundant,” 36.9% answered “scarce”, and 19.8% answered “neither”. Again, significant variations existed with respect to respondents’ national origin: 61.1% of Western respondents classified freshwater availability in the UAE as scarce, compared to only 26.8% of Middle Eastern respondents. Many of the above-listed factors related to worry about water shortages may also explain the significant difference in perception of freshwater resources in the UAE by national background.

Regardless of variations between different population sub-groups in the UAE, it is clear that a substantial fraction of the population carries the view that water is abundant, and that the risk of water shortages are low. From an environmental standpoint, these attitudes may be troubling because:

1. Even if the governments of the UAE are able to continually add desalination capacity to meet public demand, desalination is an energy-intensive process that leads to a considerable quantity of fossil fuel consumption.
2. The brackish, concentrated by-products of desalination can be harmful to aquatic life.
3. People who believe that water is abundant may also believe that there is no need to conserve water. Such people may be likely to engage in commonly-observed activities such as: planting non-native grasses, plants, and crops (e.g., corn) that consume a large amount of water, particularly in a hot, arid climate; frequent washing of automobiles; spraying water onto porch, driveway, and roadway areas in order to remove dust; and not using low-flow household plumbing fixtures.
4. Excessive water use is tied to heavy wastewater flow rates, and the consequential water pollution and electricity demands associated with wastewater treatment.

### Tap Water Quality Perception

When asked to rate the quality of tap water where they live, 40.1% responded “poor” or “below average”, 33.5% responded “average”, and 26.4% responded “good” or “excellent”. There was correlation between perception of tap water quality and willingness to drink tap water: of those who rated their tap water “poor” or “below average”, 89.7% later reported that they “never” drink tap water. Of those who rated their tap water quality as “good” or “excellent”, only 52.5% reported that they “never” drink tap water.

Overall, when asked to quantify how frequently they drink tap water, 76.9% responded that they “never” drink tap water, 10.5% responded that they drink tap water at least once per month, 10.4%

indicated drinking tap water on a daily basis, and the remaining 2.2% responded that they exclusively drink tap water.

When asked to select all of the reasons that they avoid tap water, bad taste was the top choice among respondents (55.6% selecting), followed by concerns about bacteria, viruses, or other pathogens (49.7%), the “wrong blend of minerals” (34.2%), bad temperature (26.0%), bad color (23.7%), bad smell (21.6%), pollution with harmful chemicals (19.3%), other (19.6%), and too expensive for drinking (<1%).

Among the respondent-provided explanations for avoiding tap water included in the category of “other” was the prevalence of externally-located water storage tanks, an example of which is shown in Figure 1. It is probable that concerns related to external water storage tanks may have also contributed to the avoidance of drinking tap water by people who identified concerns with the presence of pathogens and their water’s bad temperature. These external water storage tanks, which in a separate question 59.2% of respondents reported utilizing at their home (with 22.2% answering that they did not know whether such storage tanks were in use, and 18.6% indicating that these tanks were not in use), were of concern to many respondents because of infrequent cleaning and inspection. Additionally, these tanks may be in a location where disinfection residual (i.e., free chlorine) becomes depleted and where the water stored could come into contact with bacterial or chemical contaminants.



Figure 1 – Example of a user-serviced exterior water storage tank.

When asked to select all of the uses that their tap water has good enough quality for, washing dishes was the top choice (with 94.2% selecting), followed by washing clothes (93.6%), showering (90.8%), brushing teeth (86.7%), watering grass (83.6%), watering crops (67.8%), drinking by animals (60.8%), for use in cooking (51.1%), and drinking by humans (20.6%). In view of the very low rate of respondents who believe tap water is suitable for drinking and water utility assertions that the tap water generated is, in fact, potable, there is a clear disconnect between public perception and physical reality.

Although the vast majority of respondents felt that tap water in the UAE is not good enough for humans to drink, only 40.8% indicated that they utilize an in-home purification system (carbon filter 21.4%; boiling 10.6%; other 3.9%; reverse osmosis 3.6%; and UV 1.4%). Rather than being taken as a contradiction between people's self-reported opinion (i.e., having a low opinion of tap water) and their behavior (i.e., drinking tap water), the relatively low rate of in-home purification system use should be understood as a reflection of the preference for drinking bottled water, and the prevalence of home and office delivery of bottled water. Throughout the UAE, a number of private (e.g., Oasis, Masafi, and Nestle brands) and semi-governmental (e.g., "Al Zula" brand) companies deliver 15 and 20 liter bottles of water directly to people's home, at a typical price of AED 5-12 (USD 1.26 – 3.26) per bottle. This bottled water includes both desalinated water treated to a higher level of purity and taste than normal tap water (e.g., Al Zula – AED 5 / 20 liter refillable bottle), and groundwater (e.g., Masafi – AED 12 / 15 liter disposable bottle).

### Water Pricing

Survey respondents characterized the amount of money they spend each month on tap water and on bottled water. For those who pay for water, the mean monthly spending on tap water was reported as AED 232 (USD 63). Under the present pricing structure in Dubai of AED 0.03 per imperial gallon, this average of the self-reported monthly tap water spending would correspond to a monthly average volume of 7733 imperial gallons (35.2 m<sup>3</sup>).

In Dubai, DEWA (2007) has estimated the average monthly residential water demand to be 16.4 million m<sup>3</sup> for their 267,492 residential connections, or approximately 61.3 m<sup>3</sup> per connection per month. Two primary factors may account for the difference between DEWA-reported actual demand and the back-calculated demands based on survey respondents' reports of monthly tap water spending: (1) the fact that some people are not required to pay for the water that they use, and (2) the practice of residents sharing accommodations (and thus splitting water bills). Most UAE nationals receive free or heavily-subsidized water from the electricity and water authority in the emirate where they live. Additionally, residents of governmentally-owned facilities (e.g., universities, military / police barracks, etc.) typically do not pay for tap water. Tap water price increases are planned or have been announced in the UAE; for example, in 2008 DEWA will raise tap water rates to AED 0.03 for the first 6000 imperial gallons per month consumed, AED 0.035 for the next 6000 imperial gallons per month consumed, and AED 0.04 for each gallon beyond 12,000 imperial gallons per month consumed (Landais, 2008). However, price subsidies for UAE nationals are set to continue (Salama, 2008), meaning that up to 20% of the UAE population will continue to receive free or reduced-price tap water.

Survey respondents reported spending, on average, AED 69 (USD 19) per month on bottled water. Although there is some variation in the price of bottle water sold in restaurants, at most other retail outlets and vending machines in the UAE, bottled water sells for AED 1 (USD 0.27) per 500 mL bottle, or AED 1.5 (USD 0.41) per 1.5 L bottle. When asked to characterize the price of bottled water where they live, 68.5% indicated that the price is "just right", 29.6% answered "too expensive", and 1.9% replied "too cheap".

When asked whether a doubling of the price of tap water would decrease the amount they used, 43.2% answered yes, and 56.8% answered no. Among UAE nationals, 53.1% of respondents indicated that a doubling of water rates would decrease consumption. Thus, inasmuch as many UAE nationals who presently receive free or heavily-subsidized water indicate that pricing adjustments would influence their demand, it is reasonable to conclude that expanding the proposed slab pricing



structures to all water customers could have a significant impact on reducing water demand, particularly on those consumers who presently have no economic incentive to conserve.

### Bottled Water versus Tap Water

Asked “when you have a choice, which do you prefer to drink”, 87.2% of survey respondents selected bottled water and 12.8% selected tap water. Those preferring bottled water were asked to indicate all of the reasons why it was their preferred choice, and “bottled water is more healthy” was cited by 76.4%, followed by “bottled water tastes better” (58.0%), “bottled water is more portable and convenient than tap water” (25.5%), other (23.2%), “I prefer the temperature of bottled water more than tap water” (15.0%), “tap water is not available when I want to drink” (11.5%), and “I prefer bottled water because of social pressure” (6.1%).

It is notable that the top two reasons respondents cite for preferring bottled water both relate to water quality issues: the perception of superior water quality of bottled water compared to tap water, and the preferred taste of bottled water (typically groundwater, or desalinated water purified and remineralized beyond that which ordinary tap water generally is). While previously-described concerns about external water storage tanks are part of the reason why consumers seem to have concerns about tap water quality, other concerns cited include worries over leeching of materials from the distribution network, biological impurities in the source of tap water (i.e., the sea), and concerns that are tied to using seawater as a source and perception of seawater as inherently and unavoidably inadequate.

Perception about the original source being important to the final quality of tap water was also reflected in a question that asked “In your opinion, what kind of bottled water is best.” 56.9% answered “bottled water that comes from underground (i.e., wells, springs, etc.)”, 20.8% said that it doesn’t matter, 19.7% selected “bottled water that comes from a freshwater surface source, such as a lake, river, or stream”, and only 2.5% said “bottled water that comes from desalination of sea water”.

While respondents overwhelmingly preferred bottled water (87.2%) to tap water (12.8%), 57.3% reported having no preferred brand of bottled water. 44.1% indicated preferring domestic bottled water, 40.8% indicated having no preference when choosing between domestic and imported bottled water, and 15.1% indicated a preference for imported bottled water.

The same concerns and trends that underlie the generally unfavorable view of tap water in the UAE also appear to drive the significant preference among survey respondents for bottled water. The unfavorable view of tap water is troubling because it undercuts efforts to raise awareness of the importance of water conservation and the value of the water resources that are currently squandered. Were UAE residents to recognize tap water as being high quality enough to drink, it is reasonable to expect that there would be a reduced inclination to use this water for activities such as daily vehicle washing, watering plants and food crops that are unsuitable for an arid climate, and spraying exterior areas for dust removal. The significant consumer preference in favor of bottled water, and previously-cited statistics placing the UAE first in the world in terms of bottled water consumption, are troubling due to the substantial environmental impacts associated with bottled water (e.g., landfilling of plastic containers, and pollution associated with transporting the water via truck rather than pipe).

## CONCLUSIONS

A survey of UAE residents conducted to assess public attitudes towards tap water, perception of freshwater resource availability, and preferences concerning bottled water versus tap water found that, in general, residents of the UAE do not believe that tap water is suitable for drinking and believe that freshwater resources in the country are abundant. This widespread misperception about the availability of freshwater resources may help to explain why the UAE has one of the top per-capita water consumption rates in the world (Elewa, 2007). Analysis of results by national background found significant variations in people's level of concern about the potential for water shortages depending on whether they are originally from a western country or are indigenous to the Middle East region.

Additional research in this area is ongoing to assess related issues, such as (1) attitudes towards water in the UAE relative to attitudes of people in other countries, (2) the impact of the water price increases that have been proposed in the UAE, (3) and the degree of willingness among residents of the UAE to consider various water reclamation strategies. While study is ongoing, there are some recommendations that can already be made:

- Public awareness campaigns in the UAE should focus on correcting misconceptions about both the quantity of water resources available, and the quality of tap water generated by utilities in the UAE, including the potability of tap water. By increasing awareness that tap water is not inherently unsuitable for drinking, it is thought that awareness of the preciousness of water as a resource will increase and consumption of bottled water can be reduced.
- UAE utilities should undertake a program of ensuring sanitary conditions within the potable water distribution network, including inspections of water storage tanks.
- UAE utilities should discourage the practice of individually owned and serviced water storage tanks. In order to eliminate the perception that such tanks are necessary, utilities should improve water system reliability (i.e., eliminate water outages) and should add pressure booster pumps in areas where water pressure is low.
- Consumers of all nationalities should pay the actual cost of the water they consume, without governmental subsidies of initial infrastructure costs or the fuel consumed during desalination processes. Besides providing a disincentive to conservation, water subsidies promote economic and agricultural activities that are not sustainable in the long term.
- UAE municipalities should engage in appropriate and prudent use of water resources in order to demonstrate these habits to the general public. Specific water-reducing steps could include a review of developments with excessive green-space distributions, selection of drought-resistant grasses and plants for parks and other public places, moderation in the amount of vegetation planted near highway road areas, implementation of conservation techniques such as avoiding watering during midday hours, and quick repair of faulty irrigation equipment.

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