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Water usage in Australian indigenous communities

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WATER SUPPLY MANAGEMENT options for communities with naturally occurring levels of uranium above the Australian Drinking Water Guidelines were being investigated. Three remote Indigenous communities in the Central Deserts region of the Northern Territory were assessed for non-potable water usage patterns and drinking water intake during the winter of 2003. The guidelines for most chemical parameters with chronic effects assume a daily water intake of 2 litres per person. The estimated 95 percentile tap water intake was found to be approximately 2 litres. However, interpersonal variations, seasonal intake requirements and problems with measurement could result in the acceptable average daily intake being exceeded.

Drinking water has been observed to be obtained from the most convenient source irrespective of water quality or palatability. This creates a problem in the design of dual supply systems, where users are required to obtain drinking water from a designated potable supply water point, usually the kitchen sink. In the communities visited, the outdoor tap is commonly used for cooking and drinking, but is also used for yard watering and body temperature control. Yard watering and cooling both use substantial amounts of water leaving the problem of where to provide the potable supply water points most efficiently. Water intake, and potable supply requirements are quantified in this paper while water usage patterns are briefly discussed.

KEYWORDS: Demand, Water quality, Water sources, Water supply, Health aspects, Drinking water intake

Introduction

Many remote Indigenous communities in Australia are located in arid regions and are associated with limited or marginal water supplies. Without water in these communities, inhabitants may be forced to move to the larger towns where traditional foods are unavailable, alcohol is readily obtainable and traditionally segregated groups are mixed leading to higher social unrest. This study was conducted during the winter of 2003 in three communities in the Central Desert region of the Northern Territory, Australia. All communities had reticulated water supplied to all permanent dwellings. Communities 1 and 3 spoke Anmatyerre and the population was between 150-300. Community 2 was primarily composed of Kaytej speakers and had a population of between 10-60. Due to the highly mobile nature of the Kaytej and Anmatyerre, large increases or decreases in population can occur overnight due to ceremonies, sporting events or during periods of mourning. All communities had levels of naturally occurring uranium in their water supplies above the Australian Drinking Water Quality Guidelines (NHMRC and ARMCANZ, 1996). These guidelines list the value for uranium at 0.02 mg/l based on average daily direct and indirect water intake of 2 litres person per day (L/p/d) for a body mass of 70 kg. This guideline value is also based on a lifetime exposure to uranium, rather than a short-term, acute dose. The high temperatures (up to 45 degrees Celsius) and low humidity (mean 3 pm relative humidity around 25%) could result in higher hydration requirements in the central deserts region and hence necessitate more conservative guidelines to be adopted. This research addresses two main issues. Firstly, whether the current water intake poses a potential risk to public health given the daily consumption of uranium in drinking water. Secondly, how water supplies can be managed to alleviate this problem in a manner best suited to the needs of the community.

Methodology

A study was conducted during the winter months of May and June to investigate drinking water intake. This involved the use of language interpreter assisted surveys of community residents, observation and measurement of intake on hunting trips, physical measurement of volume prior to and after consumption and collection of store records to estimate direct water intake. Surveys addressed sources of water used, preferences, factors affecting intake and quantified intake of water on the previous day through recall of beverages and food consumed. Physical measurement involved the provision of 11 litres of water to all households in the community with daily measurements taken of the amount remaining. Store records were collected for average summer and average winter purchases and provided a comparison of survey results for purchased beverages with actual winter intake measured by store turnover.

Water consumption patterns were determined by individual or focus group discussions, observation around the community and quantified by water meters. Logged water meters were installed at the main household connection and mechanical meters were installed on various water fixtures in two houses (houses A and J) located in Community 3.

Results

Water Intake

The results are tabulated in table 1 for the surveys, observation, measurement and flow meters. With the exception of the flow meters, the results are comparable indicating that all methods contribute to knowledge on water intake, despite measuring slightly different types of water intake. Only direct intake through beverage consumption was measured because indirect intake was too difficult to measure as part of this study. The 95 percentile reported by survey respondents was 2.775 L/p/d for both water and purchased drinks as direct intake. However, the 95 percentile for direct tap water intake only was 2.075 L/p/d and only just exceeds 2 l/p/d. These survey results were compared to the researcher's observations during hunting trips lasting between 2 and 7 hours. A comparison of the two methods indicated that observation provided a higher estimate for four individuals compared to a survey the following day. The observation method also indicated that fluid intake was actually higher during periods of physical activity as expected.

Another method employed was to supply 11 litre bottles to houses and monitor the amount used daily. This method provides not dissimilar values to the reported direct tap water in the surveys although the average and 95 percentile was slightly higher possibly due to the inclusion of cooking water with drinking water by this method.

Meters installed on two houses enabled the monitoring of total flow through kitchen and laundry taps, which is commonly used for drinking, cooking and washing dishes. This was between 30 to 66 L per person per day. Although, it is not clear what quantity is actually intake, it will be discussed later with reference to design potable supply volumes.

Water usage patterns and preferences

Meter readings for the period February to June 2003 showed the daily per capita household consumption to vary between 170 to 1,600 L/p/d, with the average being 230 L/p/d and 610 L/p/d for houses A and J respectively. Meters installed on various water fixtures in the home enabled the type of water use to be determined. The high average usage at one house during the summer months of February to June can be attributed to watering the lawn and the need for temperature control. This can be estimated at 370 L/p/d for a household size around 6 persons in the period February 27 to June 4. Temperature control was reported to be achieved through filling up small 1.5 m x 25cm deep children's pools, often continuously, for up to 8 hours every day during the summer. Water was also used by children playing in the yard with water, adults pouring water over themselves or having a shower. The range of values for outdoor and other water uses measured are shown in figure 1. The meters also indicated that potable demand at the kitchen and laundry taps during winter was between 30-66 L/p/d as shown in Table 1.

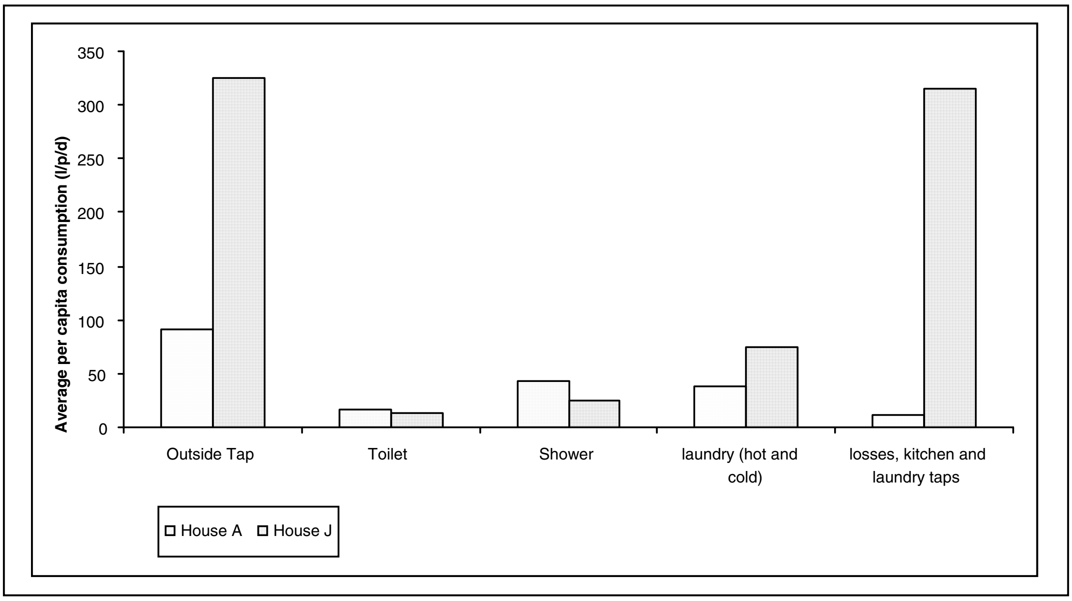
Discussions with community residents and observation revealed that selection of a drinking water source by community residents appeared to be opportunistic with the closest, culturally appropriate source, being used, irrespective of palatability. Water quality preferences (with the exception of bottled water in summer) play little part in the source of drinking water chosen.

Discussion

Using the winter tap water direct intake, 95% of people would not exceed 2 L/p/d and the current guideline value of 0.02 mg/L for Uranium would be acceptable provided indirect intake through food was negligible. However, if all bottled water was substituted by tap water, 25% of people would have a total direct fluid intake exceeding 2 L/p/d. Indirect fluid intake through cooked foods, and summer-

Table 1. Comparison of different measurement methods for estimation of total fluid and water intake during winter in litres

What was measured →	Total drinking fluid intake (L)	Total drinking fluid intake during activity (L)	Tap water drinking intake (L)	Bottled water drinking and cooking intake (L)	Total potable supply (L)
Methodology used → ↓	Survey	Hunting trip observations	Survey	11 litre consumption measurement	Kitchen & laundry flow meters
Minimum	0.500	0	0	0.275	30
Maximum	3.250	5.250	2.750	3.097	66
Average	1.442	3.138	0.903	1.182	-
75 percentile	2.010	-	1.125	1.753	-
95 percentile	2.775	-	2.075	3.097	-



note: Losses for house J includes outdoor tap usage at the second tap due to a faulty meter

Figure 1. Average per capita water consumption for individual fixtures in houses A and J over entire monitoring period

time temperatures would further increase the intake of uranium through water. In addition, the observation method showed some individuals during physical activity in winter to have an estimated direct fluid intake as high as 5.25 L/p/d.

Conventionally, management of water supplies of poor quality was through treatment of the entire water supply to meet drinking water quality guidelines. Reverse osmosis has proved problematic in communities because of maintenance problems, high energy requirements and the generation of wastewater which is difficult to dispose of. Considering the high level of water consumption for non potable uses, treatment for peak demands of up to 1,600 L/p/d would needlessly treat large amounts of water where households would require at most 30-66 L/p/d for potable uses including drinking cooking and cleaning dishes in winter months. One response to addressing this problem is to investigate the use of culturally appropriate sustainable management options, for instance dual supply systems. Other potentially acceptable management options include blending of high quality water with poor quality water, community acceptance of risk and maintaining the status quo or the provision of bottled drinking water. However, this paper will focus on dual reticulation systems by either treatment of a proportion of the water supply or use of supplementary sources such as rainwater tanks for potable uses only. In order to design dual supply systems, the total volume of potable water to be supplied and where it should be provided needs to be first considered.

The meters installed on the houses in Community 3 indicated that between 30-66 L/p/d are used at the kitchen and laundry taps during winter. The upper value, or around 70 L/p/d could be used as a potable supply guideline although this does not take into account water required at communal taps around the community or in the yard for potable supply. A comparison with another community (Division of State Aboriginal Affairs, 2000), monitored as part of a separate study, where only kitchen taps are monitored, found the consumption to be substantially lower, at around 3-6 L/p/d. This discrepancy can partly be explained by the fact the laundry taps in the other study were not included, however Community 3 may simply still use more water from these taps. Supply guidelines for cooking and drinking are 20-30 L/p/d (Australian Water Resources Council, 1989), which is lower than the metered estimates in Community 3. This high degree of variability in both intra and inter-community potable demand would necessitate a conservative approach to be taken in determining the design potable supply.

Dual supply systems such as treatment by reverse osmosis or use of rainwater tanks to provide a potable supply would need to supply water at multiple taps within the home and throughout the community. This is because it is not possible to supply one tap (eg kitchen) with potable water and ensure non potable water is not consumed. Those camping outside (the elderly, or those with low incomes), who incidentally are also less likely to purchase bottled drinks from the shop, would potentially consume a higher dose. Areas of high potable use are outdoor taps, those at communal areas and the laundry tap. The problem with supply of potable water at the yard tap is that it has a particularly high demand as it is used for garden watering and temperature control. Alternative ways of keeping cool could decrease consumption from the yard tap. However, the problem remains in whether to supply potable water at this tap and have a large amount wasted, or provide non potable water and risk increased ingestion of water of marginal quality. As such participatory planning process should be engaged to determine location of potable water points and investigate what is an acceptable level of risk for the community.

Conclusions

The 95 percentile winter direct tap water intake does not necessitate a more conservative uranium guideline to be applied in communities with marginal supplies. However, high intake through cooked foods, high temperatures, physical exertion and reduced access to bottled beverages would result in a higher than desired dose and necessitate some intervention. Difficulties in water treatment and the low proportion of potable consumption naturally lead to the potential for dual supply systems to minimise these problems, although other alternatives such as blending should also be investigated. The design of dual supply systems needs appropriate water points to be located and a design potable supply to be quantified. The provision of potable supply at only the kitchen tap is inappropriate due to the opportunistic nature of water use with the preferred source being the most convenient, irrespective of palatability. As such, dual supply systems would need to supply water at multiple taps within the home and throughout the community particularly in communal areas. The monitored households indicated a high garden usage for yard watering and body temperature control, which would lead to high wastage of potable water if provided at the outdoor tap. As a result participatory planning process should be engaged to determine the location of potable water points, volume of potable supply and the communities desires for their water supply system. Further research is required on both water intake and potable supply volumes for the summer months to determine the impact of seasonal variability.

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References

Australian Water Resources Council (1989) *Guidelines for low cost water supplies for small communities,* Australian Government Publishing Service, Canberra.

Division of State Aboriginal Affairs (2000) *Water Meter Readings for Indulkana*, excel spreadsheet, Division of State Aboriginal Affairs, Adelaide

NHMRC and ARMCANZ (1996) *Australian Drinking Water Guidelines*, National Health and Medical Research Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

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