



Assessment of Water Usage and Water Management in Mae Fah Luang University

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Abstract

A university may be compared by its size of population and activities to a small city, with high water consumption and in need of effective water conservation strategies. This study presents the results of a study of water consumption on the Mae Fah Luang University campus in Chiang Rai, Thailand. Consumption was classified by activity type, water usage and water saving behavior of students and staff. The results suggest strategies for water conservation on campus. With a water conservation plan focusing on residential areas (halls and homes), which accounted for the highest levels of consumption on the campus. The study also identified activities where water-use behavior was wasteful; hence, we propose practical strategies to reduce the university's water use by a) raising awareness of the costs of wasting water; b) education to improve knowledge, attitude, and behavior in regard to water conservation, with examples of good practice.

Keywords: Water consumption; Water conservation plan; Water-use behavior

Introduction

Water is the most precious and undervalued natural resources on the planet [1]. With the world population forecast to reach 9 billion by 2050 [2] per capita demand for water is projected to increase by 50 % over this period [3]. In addition, approximately one in six people

worldwide lack access to safe drinking water [4]. Like other countries, Thailand faces major challenges from climate change impacts and accessibility to clean water. Water demand in all key economic sectors including tourism, industry and agriculture continues to increase, causing a major impact on the country's fragile water

infrastructure and resources [5]. For Thailand, the worst drought in 50 years was forecast in 2016, with water levels in the country's main dams falling to their lowest levels since 1994 [6].

In terms of population, size and activities, a university may be defined as a small city which generates direct and indirect impacts on the environment [3], particular in regard to its high water consumption. Several universities have developed water conservation strategies as part of their environmental management system (EMS) of which ISO14001, an international standard with generic requirements for EMS [3, 7-8], is usually applied.

Mae Fah Luang University (MFU) is situated in Chiang Rai, the northernmost province of Thailand. It is a medium sized university currently accommodating 15,000 students and 1,300 staff. One of the university's four main mission statements is to conserve the environment [9]. The Universitas Indonesia (UI) Green Metric World University Ranking in 2014 ranked MFU 81 out of 360 universities worldwide. One important ranking criterion is water management, comprising factors such as decreased water usage, an expanding conservation program and habitat protection, for which MFU could improve its performance. In order to set policies and implement suitable water conservation programs, basic information about water usage and water use behavior in the university need to be available.

The objectives of this paper are to study water usage by various activities on campus, water use behavior of students and staff, and to propose water management strategies for MFU.

Methods

The study examined water consumption in MFU by its major activities such as teaching and learning, office, residential and other uses. Water consumption was assessed during the academic term of August-December 2015, while

water use behavior was identified by questionnaire during the academic term of November-December 2015.

Primary data were divided into 2 categories: (i) assessment of water consumption in buildings (selected by random sampling) in which there are activities related to teaching, office work, and other activities including hospital and watering green areas, as shown in Table 1; and (ii) water consumption by all residential buildings. The questionnaire on water use consisted of 2 sections: a) personal information and b) water-saving behavior. Respondents were selected by simple random sampling from students and staff members. The total number of questionnaires involved 394 respondents.

For the water-saving behavior questionnaire, responses were scored using a five-point Likert scale, with responses ranging from "1" (never) to "5" (always/very frequently). The interpretation of the score was demonstrated in Watson (2011) [10]. The mean score was calculated and interpreted as follows; 4.21-5.00 means very good, 3.41-4.20 means good, 2.61-3.40 means moderate, 1.81-2.60 means poor, 1.00-1.80 means very poor. The descriptive analysis was applied for data analysis using SPSS version 16.0.

Table 1 Buildings chosen randomly and classified by activity

Activities	Building names
Teaching and learning	C2,C3, S3 and S4
Office	E1, AD2 and E3
Others	MFU hospital and-green areas

Results and discussion

The study building in each activity and the focusing residential areas are shown in Figure 1. The study area (MFU) is located in Chiang Rai, Thailand's northernmost province. A water reservoir supplies raw water which is processed to supply the university (Figure 1). The amount of stored water in the reservoir varies from year

to year and within any given year, depending on precipitation. In 2015, the amount of water in reservoir decreased, in same-month water collection comparisons with 2013 to 2014, as shown in Figure 2. MFU's annual student intake continues to increase; however, water availability is limited, increasing the risk of shortages, especially during the academic term.

Table 2 shows water consumption for teaching and learning, office and other activities. All buildings have restrooms with flushing toilets, hand wash basins, taps for floor cleaning, drinking water from dispenser machines. E1, E3, and the hospital have canteens run by several independent restaurants and drink shops using water for cooking and washing up.

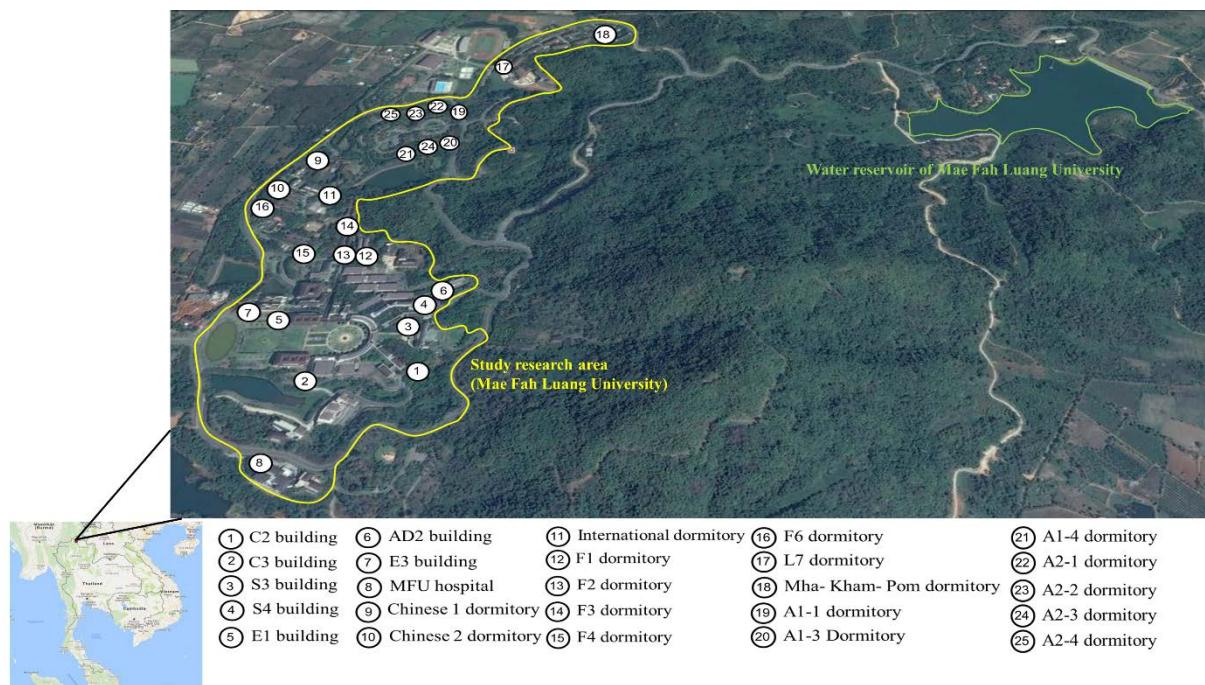


Figure 1 Study buildings in each activity, Mae Fah Luang University, Thailand (Google Earth).

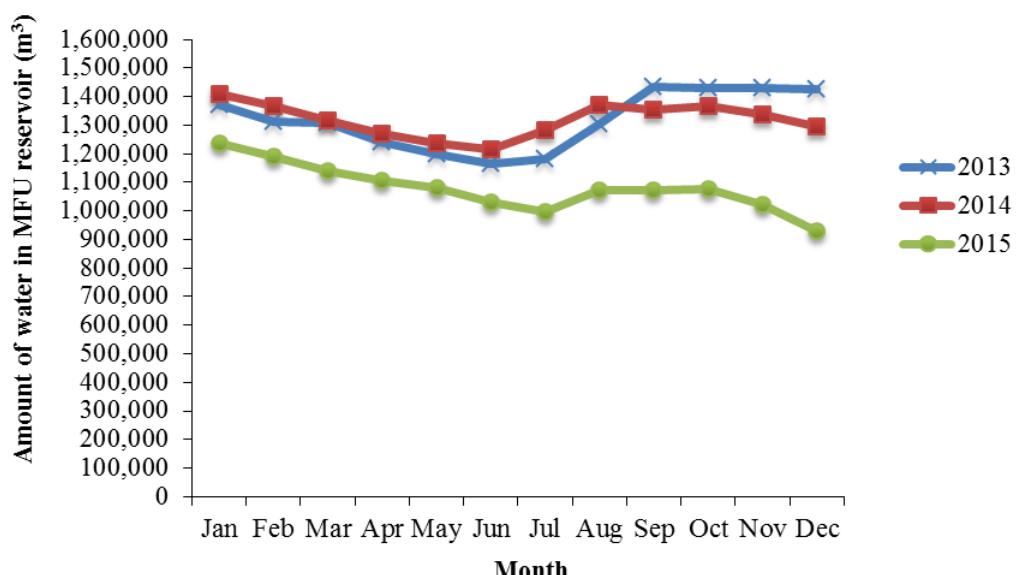


Figure 2 Water in MFU reservoir.

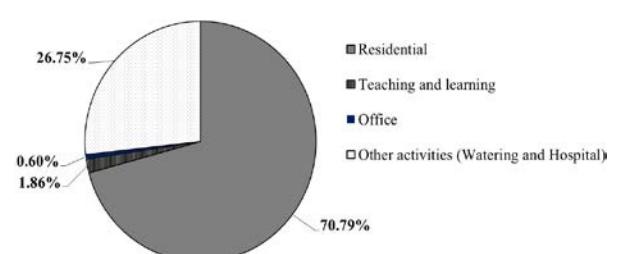
Table 2 Estimated water consumption for sub-activities

Activities	Average water usage in sub-activities ($\text{m}^3 \text{d}^{-1}$)								Total ($\text{m}^3 \text{d}^{-1}$)	
	Restroom	Cleaning	Drinking	Laboratory	Commercial	Canteen	Kitchen	Emergency room		
					drinking water production					
Teaching and learning										
C2	19.60	1.30	5.10	-	-	-	-	-	26.00	
C3	13.39	0.61	-	-	-	-	-	-	14.00	
S3	8.90	0.10	-	11.00	-	-	-	-	20.00	
S4	17.70	-	-	2.85	0.44	-	-	-	20.99	
Office										
E1	1.59	0.41	0.01	-	-	10	-	-	12.00	
AD2	5.98	0.02	-	-	-	-	-	-	6.00	
E3	7.59	0.004	-	-	-	-	0.40	-	7.99	
Other activities										
Hospital	438.40	0.067	-	-	-	-	-	18.92	6.60	464.00
Watering	-	-	-	-	-	-	-	-	-	698.65

Table 3 shows water consumption in residential halls and homes on campus. The survey included 17 buildings occupied by 2,466 people. The estimated amount of water consumption for each activity in the table was based on figures from a previous study [11]. Water consumption patterns are classified into indoor use (drinking, personal hygiene and kitchen) and outdoor use (vegetable garden, house and yard cleaning) [12]. The majority of water is used in the residential activities in MFU. Usually, residents notice that their indoor water-saving activities use more water than their actual consumption [13]. The amount of water use was directly proportional to the population. Average water consumption was approximately $170 \text{ L capita}^{-1} \text{ d}^{-1}$ (lpcd) based on the 10,001 to 20,000 range of population [14]. The total number of students and staff on campus is about 13,000. The amount of water needed is roughly $2,210 \text{ m}^3 \text{ d}^{-1}$. Figure 3 exhibits the percentage of water use for each activity, it was found that the residential account for 70.79 % of all water consumption, compared to 26.75 % for other activities (watering and MFU hospital), 1.86 % for teaching and learning activity and 0.60 % for office activity use. This finding indicated that the priority water conservation plan should focus on residential activities in MFU.

Table 3 Water consumption for residential activities in MFU

Building	Population (persons)	Amount of water used ($\text{m}^3 \text{d}^{-1}$)
Chinese 1 Dormitory	156	518
Chinese 2 Dormitory	151	317
International Dormitory	208	484
F1 Dormitory	318	555
F2 Dormitory	317	753
F3 Dormitory	312	67
F4 Dormitory	215	127
F6 Dormitory	301	66
L7 Dormitory	320	70
Mha -Kham -Pom Dormitory	80	51
A1-1 Dormitory	13	2
A1-3 Dormitory	18	5
A1-4 Dormitory	25	3
A2-1 Dormitory	8	24
A2-2 Dormitory	9	2
A2-3 Dormitory	8	30
A2-4 Dormitory	7	2
Total	2,466	3,076

**Figure 3** The percentage of water use for each activity.

In personal information, over 20 % were male (n = 84) with 80 % female (n = 310). Respondent age ranged from 18-22 (n = 347), the majority of whom lived in the MFU dormitory (n = 268). Most respondents were students (n= 378), of whom a majority were in their first year (n = 230).

Table 4 presents the water-use behavior of students and staff in MFU (n = 394). As assessed by the rating scale. A previous study [15] found that students at the Rajamangala University of Technology Phra Nakhon had a moderate level of water-use behavior, in line with our own findings, if we set up the interpretation of the score at the three levels (3.68-5.00 means good, 2.34-3.67 means moderate, 1.00-2.33 means poor). However, in this study inferred the score in the 5 levels as described in above. Hence, the most respondents had good level of water-use behavior (overall average score of 3.63). The top three rates were "Check taps and pipes for leakage regularly", "Turn off the tap after every use" and "Turn off the tap completely" (average score of 4.61, 4.47 and 4.40, respectively) implying that respondents followed these top three water-use behaviors. The water-use behaviors of respondents had been in the moderate to poor level such as "Use

water left over from vegetables, dish, or car washing to water plants", "Clean the house or wash the car using a cloth dampened with water instead of using a hose", "Use water from a bucket to wash instead of running a hose", "Use glass or bowl for collecting water while brushing teeth and clean toothbrush", "Store water enough for at least one day use in case of water flow crisis" and "Use left over water to clean toilet". This finding is helpful as a guide to defining priorities for a water conservation plan to reduce overall water consumption at MFU. The data indicate that residential activity accounts for the highest level of water consumption. Hence, water saving education and campaigns should target students and staff in residential areas of MFU. Water awareness campaigns have been shown to achieve their potential for longer in water users' behavior [16]. The second ranked water-consuming activities was 'other activities', especially watering gardens. This study makes several recommendations to improve water consumption in watering, as follows: use treated wastewater to water trees, fit hoses with nozzles or sprinklers, and limit watering time to mornings and evenings to minimize evaporation losses.

Table 4 Frequency of water-use behavior

Water-use behavior	Frequency of water-use behavior (in %)					Average
	Always	Frequently	Sometimes	Rarely	Never	
1. Turn off the tap while brushing teeth or soaping	28.9	28.7	28.7	8.4	5.1	3.67
2. Take shower instead of bath	49.0	30.5	14.0	3.3	3.0	4.18
3. Turn off the tap after every use	60.2	29.4	8.9	1.0	0.0	4.47
4. Turn off the tap completely	64.2	21.1	9.1	1.8	3.3	4.40
5. Wash dishes when there is a full load.	22.6	26.4	32.7	12.4	5.6	3.47
6. Wash vegetables and fruits in a large bowl	23.4	32.2	28.2	12.4	3.6	3.59
7. Use water left over from vegetables, dish, or car washing to water plants	16.2	18.0	32.0	19.5	14.0	3.02
8. Wash clothes when there is a full load.	42.4	36.3	17.0	3.6	0.3	4.15

Table 4 Frequency of water-use behavior (*continued*)

Water-use behavior	Frequency of water-use behavior (in %)					Average
	Always	Frequently	Sometimes	Rarely	Never	
9. Clean the house or wash the car using a cloth dampened with water instead of using a hose	16.8	25.1	39.1	13.5	5.1	3.34
10. Use water from a bucket to wash instead of running a hose	15.2	23.9	34.3	18.0	7.9	3.18
11. Use glass or bowl for collecting water while brushing teeth and clean toothbrush	18.3	18.8	23.9	23.1	15.7	3.00
12. Clean the floor by using a bucket of water and wet cloth.	23.4	35.8	31.0	5.8	3.8	3.68
13. Soak cloth with detergent before cloth-washing	26.6	36.0	23.6	10.2	3.3	3.72
14. Store water enough for at least one day use in case of water flow crisis.	14.7	24.1	25.6	22.6	12.4	3.05
15. Use left over water to clean toilet	8.9	15.5	26.1	23.6	25.6	2.58
16. Check taps and pipes for leakage regularly.	72.1	18.8	7.9	1.0	0.0	4.61

Conclusion

Complex and multifaceted water utilization existed in most buildings on MFU campus, making water use reduction in each activity far from straightforward. Greater awareness of water consumption and usage are key to changing behavior and reducing the water footprint of MFU. Providing more knowledge about the water saving will help to raise water consumption awareness.

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