

UNIVERSITI MALAYSIA PAHANG

DECLARATION OF THESIS AND COPYRIGHT

Author's full name : NURUL ASYIKIN BINTI MOHD ROFI

Date of birth : 28TH NOVEMBER 1993

Title : WATER FOOTPRINT ASSESSMENT OF WATER SUPPLY
TREATMENT PROCESS: A CASE STUDY OF SEMAMBU
WATER TREATMENT PLANT

Academic Session :2015/2016

I declare that this thesis is classified as:

CONFIDENTIAL (Contains confidential information under the Official Secret Act 1972)*

RESTRICTED (Contains restricted information as specified by the organization where research was done)*

OPEN ACCESS I agree that my thesis to be published as online open access (Full text)

I acknowledge that Universiti Malaysia Pahang reserve the right as follows:

1. The Thesis is the Property of University Malaysia Pahang
2. The Library of University Malaysia Pahang has the right to make copies for the purpose of research only.
3. The Library has the right to make copies of the thesis for academic exchange.

Certified By:

(Student's Signature)

931128-03-5006

New IC / Passport Number

Date:

(Signature of Supervisor)

Dr. Edriyana A. Aziz

Name of Supervisor

Date:

**WATER FOOTPRINT ASSESSMENT OF WATER SUPPLY TREATMENT
PROCESS: A CASE STUDY OF SEMAMBU WATER TREATMENT PLANT**

NURUL ASYIKIN BINTI MOHD ROFI

**Thesis submitted in fulfilment of the requirements for the award of the
Bachelor of Engineering (Hons.) in Civil Engineering**

**Faculty of Civil Engineering and Earth Resources
UNIVERSITY MALAYSIA PAHANG**

JUNE 2016

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion, this thesis is adequate in term of scope and quality for the award of the degree of Bachelor (Hons.) of Civil Engineering.

Signature :

Name of Supervisor : DR. EDRIYANA BT A.AZIZ

Position : LECTURER

Date :

STUDENT'S DECLARATION

I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. This project has not been accepted for any degree and is not concurrently submitted for award of other degree

Signature :

Name : NURUL ASYIKIN BINTI MOHD ROFI

ID Number : AA12177

Date :

TABLE OF CONTENTS

		Page
SUPERVISOR’S DECLARATION		ii
STUDENT’S DECLARATION		iii
ACKNOMLEDGEMENTS		v
ABSTRACT		vi
ABSTRAK		vii
TABLE OF CONTENTS		viii
LIST OF TABLES		xi
LIST OF FIGURES		xiii
LIST OF ABBREVIATION		xiv
CHAPTER 1	INTRODUCTION	
1.1	Background of Study	1
1.2	Problem Statement	3
1.3	Objectives of Study	3
1.4	Scope of Study	4
1.5	Significant of Study	4
CHAPTER 2	LITERATURE REVIEW	
2.1	Water Resources	5
	2.1.1 The Sustainability Water Use	7
2.2	Water Crisis	7
	2.2.1 Water Scarcity	8
2.3	Efforts to Better Management of Water	8
2.4	Convention Water Supply Treatment Process	9
	2.4.1 Water Intake	10
	2.4.2 Aeration Process	11

	2.4.3	Coagulation and Flocculation Process	13
	2.4.4	Sedimentation Process	13
	2.4.5	Filtration Process	13
	2.4.6	Disinfection Process	14
2.5		Water Footprint	14
	2.5.1	Types of Water Footprint	15
	2.5.2	Water Footprint Assessment	16
		2.5.2.1 Setting Goals and Scope	17
		2.5.2.2 Water Footprint Accounting	17
		2.5.2.3 Water Footprint Sustainability Assessment	17
		2.5.2.4 Water Footprint Response Formulation	18
	2.5.3	Water Footprint Calculation	18
2.6		Land Use Development in Malaysia	19
2.7		Weather Condition in Malaysia	20
	2.7.1	Types of Monsoon in Malaysia	20
	2.7.2	Precipitation in Malaysia	21
	2.7.3	Evaporation in Malaysia	21
		2.7.3.1 Penman Method	21
		2.7.3.2 Blaney and Criddle Method	22
CHAPTER 3		METHODOLOGY	
3.1		Introduction	24
3.2		Data Analysis	25
	3.2.1	Data Collection	25
	3.2.2	Schematic Diagram of Semambu WSTP	26
	3.2.3	Water Footprint Accounting	28
3.4		Flow Chart	31
CHAPTER 4		RESULT AND DISCUSSION	
4.1		Introduction	32
4.2		Types of Water Footprint for Each Stage	35
4.3		Water Footprint Accounting	36

4.4	Water Footprint Affected by Population, Water Demand by Land Use and Monsoonal Changes	43
4.4.1	Water Footprint Affected by Population	44
4.4.2	Water Footprint Affected by Water Demand in term of Land Use	46
4.4.3	Relationship of Water Footprint per Population with Global Water Footprint	48
4.4.4	Water Footprint Affected by Monsoonal Changes	50
CHAPTER 5	CONCLUSION AND RECOMMENDATION	
5.1	Conclusion	53
5.2	Recommendation for the Future Research	54
	REFERENCES	55
	APPENDICES	58
A	Water Footprint Analysis 2010	58
B	Water Footprint Analysis 2011	59
C	Water Footprint Analysis 2012	60
D	Water Footprint Analysis 2013	61
E	Water Footprint Analysis 2014	62
F	Water Footprint Analysis 2015	63

LIST OF TABLES

Table No.	Title	Page
3.1	List of Departments as well as the data involved	26
4.1	Type of water footprint at each stage	36
4.2	Latitude for intake and plant station	36
4.3	Data for 4 th December 2010	37
4.4	p value for intake and plant station	37
4.5	Water footprint accounting for each process	38
4.6	Example table of water footprint analysis	41
4.7	Total water footprint per year	42
4.8	Total water footprint against total water intake per year	43
4.9	Changes in population in Beserah and Sungai Karang	44
4.10	Water footprint per population per year	45
4.11	The land use data of Beserah and Sungai Karang	46
4.12	Total water demands per year	47
4.13	Percentage of water demand on water footprint	47
4.14	Global water footprint per person against water footprint per population	49
4.15	Relationship between rainfall intensity and water intake and its its water footprint	52
6.1	Water footprint analysis 2010	58
6.2	Water footprint analysis 2011	59
6.3	Water footprint analysis 2012	60
6.4	Water footprint analysis 2013	61

6.5	Water footprint analysis 2014	62
6.6	Water footprint analysis 2015	63

LIST OF FIGURES

Figure No.	Title	Page
2.1	Hydrological concepts to water resources concepts	6
2.2	Illustration of standard water supply treatment process	10
2.3	Cascade aerators type	12
2.4	Multiple tray aerators type	12
2.5	Four district phases in water footprint assessment	17
2.6	Physical map indicating the thirty selected rainfall station in Peninsular Malaysia	20
2.7	Mean daily percentage of annual daytime hours, p, by month for different northern and southern latitude	23
3.1	The schematic diagram of Semambu water supply treatment process	27
4.1	Semambu water treatment plant distribution system phase I	33
4.2	Semambu water treatment plant distribution system phase II	34
4.3	Total water footprint against water intake per year	43
4.4	Water footprints per population per year	45
4.5	Effect of water demand by land use on water footprint	48
4.6	Global water footprint per person against water footprint per population	49
4.7	Rainfall intensity during southwest and northeast monsoon	51

LIST OF ABBREVIATIONS

CO ₂	Carbon dioxide
FOA	Food and Agriculture Organization
H ₂ S	Hydrogen sulfide
NEM	Northeast monsoon
NH ₃	Ammonia
NWRC	National Water Resources Council
PAIP	Pengurusan Air Pahang Berhad
SWM	Southwest monsoon
WF	Water footprint
WFA	Water footprint assessment
WFN	Water Footprint Network
WHO	World Health Organization
WSTP	Water supply treatment process
WWF	World Wide Fund

**WATER FOOTPRINT ASSESSMENT OF WATER SUPPLY TREATMENT
PROCESS: A CASE STUDY OF SEMAMBU WATER TREATMENT PLANT**

NURUL ASYIKIN BINTI MOHD ROFI

**Thesis submitted in fulfilment of the requirements for the award of the
Bachelor of Engineering (Hons.) in Civil Engineering**

**Faculty of Civil Engineering and Earth Resources
UNIVERSITY MALAYSIA PAHANG**

JUNE 2016

ABSTRACT

In many parts of the world, freshwater is already a scarce and overexploited, raising the concern about global water scarcity. Previously, the Life Cycle Assessment (LCA) has been used to assess the impact of pollution to the environment. In 2002, Water Footprint Assessment (WFA) has been introduced. However, WFA has been only conducted to assess the product. In this study, the sustainability assessment by using WFA approach was conducted to assess the water supply treatment process (WSTP) of Semambu Water Treatment Plant. The study identified the type of water footprint (WF) at each stage of WSTP and calculated its water footprint for the period 2010 to 2015. Two factors that influenced the accounting of WF such as population and monsoonal changes were also evaluated. From the results obtained, the increasing water due to the increases population and land use factors affected the total water footprint per year; however the pattern of rainfall intensity due to monsoonal changes did not directly influenced the total amount of water footprint however it has slightly affected the total water intake. Thus, if the pattern keeps increasing due to the unregulated development and occurrences of climate changing, the water intake river is afraid to be insufficient and this may lead to water scarcity. The findings suggest interventions to reduce the water footprint will likely have as great impact on freshwater resources availability by regulating the placement area of development.

ABSTRAK

Di dalam banyak bahagian dunia, air tawar mulai sukar didapati dan pengestrakan berlebihan, telah meningkatkan kebimbangan mengenai kekurangan air global. Sebelum ini, Penilaian Kitar Hayat (LCA) telah digunakan untuk menilai kesan pencemaran kepada alam sekitar. Pada tahun 2002, Penilaian Jejak Air (WFA) telah diperkenalkan. Walaubagaimanapun, WFA hanya dijalankan untuk menilai produk. Dalam kajian ini, penilaian dengan menggunakan pendekatan WFA telah dijalankan untuk menilai proses di Proses Rawatan Bekalan Air (WSTP) di Loji Rawatan Air Semambu. Kajian ini mengenalpasti jenis jejak air (WF) di setiap peringkat di WSTP dan mengira jumlah jejak air bagi tempoh 2010 hingga 2015. Dua faktor yang mempengaruhi pengiraan WF seperti penduduk dan perubahan monsun juga dinilai. Dari keputusan yang diperoleh, peningkatan air disebabkan oleh faktor peningkatan populasi dan guna tanah memberi kesan jumlah jejak air setahun, bagaimanapun corak kehadiran hujan yang disebabkan oleh perubahan monsun langsung tidak mempengaruhi jumlah jejak air sepenuhnya, tetapi sedikit menjejaskan jumlah pengambil air keseluruhannya. Oleh sebab itu, jika corak ini semakin bertambah disebabkan pembangunan yang tidak terkawal dan fenomena perubahan iklim, tidak mustahil air sungai menjadi tidak mencukupi dan menyumbang kepada masalah kekurangan air. Hasil kajian menunjukkan campur tangan untuk mengurangkan kesan jejak air akan memberikan kesan kepada ketersediaan sumber air tawar.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Water is one of the most important mechanics to health and essential day life. Two parts of hydrogen and one parts of oxygen is combined to form H₂O elements. The body either humans, animals and plants cannot work without water, just similar to the analogy of the vehicle cannot run without oil and gas. In fact, all the organs and cells functions that makes up the whole anatomy and physiology rest on water for their functioning. The water can be gained from different sources such surface water, rivers or lakes, rock catchment areas and rock holes, excavated dams, rainwater tanks, bores and well and groundwater (Natural Resources Management and Environment Department).

Nowadays, the main problem faced by many societies is water scarcity. Water scarcity is a relative notion and can be come about at any level of demand or supply. Water scarcity can be defined as the lack of adequate water supplies and resources to fulfill the demands of water usage within a region. Water use has been increasing at more than twice the rate of population growing whereby, people put ever increasing demands on limited supplies of water. The monsoonal changes also one of the factors that lead to the water

scarcity, since the amount of uses water during wet and dry season is differenced (eSchoolToday, 2010).

For Kuantan city, the main sources of clean water are Kuantan River and groundwater. Unfortunately, the domestic water is usually discharged directly into the drains and rivers, which contribute to increasing risk of river pollution and a threat to marine life. Basically, Kuantan was supplied by 11 different water treatment plants placed at Bukit Ubi, Pasir Kemudi, Bukit Goh, Kampung Pandan, Paya Bungor, Kuala Kenau, Kampung Kolek, Bukit Kunin, Kampung Penor, Alur Batu and Semambu.

Before clean water arriving at home tap, water is treated at the water treatment plant in order to remove sediment, bacteria and other impurities. The water treatment process may slightly different depends on the locations, technology of the plant and uses of water, but the principles to produce clean and safe water still the same (Abdollah, 1985). Water treatment is a method of making water suitable for its application or returning its natural state. It is needed to eliminate the impurities that are contained in water as found in nature. Water treatment is functioned to produce clean and safe water for public demand. There are several stages that involved in water treatment process; aeration, coagulation and flocculation, sedimentation, filtration, and disinfection.

Man usually use a lots of water for daily activities such drinking, cooking and washing, but more uses of growing food, producing of clothing, and electronic products. Water footprint can be defined as the amount of water that use in or around home, office and school throughout the day. It also includes the measurement of water took to produce the products, goods and service. The Water Footprint (WF) consists of three elements which are green, blue and grey water footprint. These three elements serve a comprehensive image about uses of water by showing the source of water consumed, either rainfall or groundwater, and the amount of fresh water needed for consumption of pollutants (Network, 2013)

1.2 PROBLEM STATEMENT

The main function of water treatment process (WTP) is to produce clean and safe water to be used. However, the demand for clean water is increased from year to year due to the increase in the population of users, whether human, animal and plant life, other than a request from the industry for the production of products that require water supply besides the demand during the wet and dry season. Therefore, the water treatment process management needs to provide sufficient water supply in order to fulfill the requirements of it. Sufficiently of water supply is dependent to the river water availability. The El Nino phenomenal has put Malaysia at the risk of water scarcity. Due to unregulated placement of population, agriculture and industrial area, more and more development will be placed at one area where the water intake will be at similar point. At the same time, the sustainability of national water treatment methods has also raised a great concern.

The study was conducted to calculate the amount of water consumption at each stage of water treatment process. The water footprint was further assessed by taken into consideration water demand which was based on population and land use factor and also monsoonal changes for the period of five years from the year 2010 to 2015.

1.3 OBJECTIVES OF STUDY

The objectives of the study are:

- i. To identify types of water footprint (WF) for each stage of Semambu Water Treatment Plant (WTP).
- ii. To calculate the water footprint (WF) for each stage of Semambu Water Treatment Process for 5 years duration (2010-2015).
- iii. To study the effect of population, land use and monsoonal changes to water footprint (WF) account at Semambu WTP.