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

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

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SUPERVISOR'S DECLARATION

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

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STUDENT'S DECLARATION

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

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LIST OF SYMBOLS

a	Leaching-run-off fraction
$Abstr$	Volume of water abstraction
$Appl$	Application of a chemical
C	Per capita consumption
c_{max}	Maximum acceptable concentration of a chemical
c_{nat}	Natural concentration of a chemical in the receiving water body
c_{effl}	Concentration of a chemical in an effluent
c_{act}	Actual concentration of a chemical in a water body
D_n	Additional demand
ea	Actual vapor pressure
$Effl$	Volume of effluent (wastewater flow)
es	Saturation vapor
ET_0	Reference evaporation
F	Service factor
G	Soil heat flux density
L	Pollutant load
p	Mean daily percentage of annual daytime hours
P_n	Projection population
Rn	Net radiation of the crop surface
T	Air temperature
T_{effl}	Temperature of an effluent
T_{act}	Actual temperature
T_{max}	Maximum temperature

T_{nat}	Natural temperature
$u2$	Wind speed
WF_{blue}	Blue water footprint
WD_n	Water demand
WF_{green}	Green water footprint
WF_{grey}	Grey water footprint
$WF_{greytreated}$	Grey treated water footprint
$WF_{proc,grey}$	Green water footprint of a process
WF_{total}	Total water footprint
γ	Psychrometric constant
^{o}C	Degree Celsius
Δ	Slope vapor curve

LIST OF ABBREVIATIONS

CAWST	Centre for Affordable Water and Sanitation Technology
DNA	Deoxyribonucleic acid
HOCl	Hypochlorous acid
JPS	Jabatan Pengairan dan Saliran
LCA	Life cycle assessment
MMD	Malaysia Meteorological Department
MLD	Million liters per day
NWRS	National Water Resource Strategy.
OCl-	Hypochlorite ions
PAIP	Pengurusan Air Pahang
SDWF	Safe Drinking Water Foundation
WF	Water footprint
WSTP	Water supply treatment process
WTP	Water treatment plant
WFA	Water footprint assessment
WHO	World Health Organization

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ABSTRACT

The instability changes of socio economic as well as monsoonal changes have long been tortured the water resource management system. Until to this date, water scarcity still being as the main issues globally. In Malaysia, several water shortages problems might be created from several factors. In this regard, the efficiency of our water supply system has raised the concern. Some studies have been made to assess the sustainability of our water supply such as by using Life Cycle Assessment (LCA). In this study, an attempt to use Water Footprint Assessment is carried out. This approach covers water utilization accounting during the treatment process. Therefore, the objectives of this study are to determine the water footprint for the in-line process of water supply treatment process and also how it is affected by the population, land use and monsoonal changes. The study area is at conventional water supply treatment process (WSTP) at Peramu, Pekan Pahang. The value of water footprint in each process of water supply treatment process is divide into WF_{blue}, WF_{green} and WF_{grey}. In addition to that, the effect of socio economic and monsoonal changes were also calculated and analyzed. From the results obtained, the monsoonal changes has affected the water footprint accounting. However, population and land use activities has the huge impact on water footprint accounting. So, the unregulated development whereby the water supply is from similar water intake would create water shortage.

ABSTRAK

Ketidakstabilan perubahan ekonomi serta perubahan monsoon memberi tekanan kepada sistem pengurusan sumber air.Sehingga ke hari ini,kekurangan air masih menjadi isu utama di peringkat global.Di Malaysia umumnya, isu kekurangan air mungkin disebabkan daripada beberapa factor dan punca.Dalam hal ini, kecekapan system pengurusan bekalan air telah menimbulkan kebimbangan.Beberapa kajian telah dibuat untuk menilai kemampanan bekalan air kita seperti menggunakan Penilai Kitar Hayat (LCA).Dalam kajian ini, kaedah Penilaian Jejak Air (WFA) dijalankan.Pendekatan ini meliputi pengiraan penggunaan air semasa process rawatan.Oleh itu, objektif kajian ini adalah untuk mengenalpasti jejak air dalam talian proses rawatan bekalan air (WSTP) dan juag bagaimana ia dipengaruhi oleh taburan penduduk, aktiviti guna tanah dan perubahan monsoon.Kajian dijalanka di Loji rawatan air Peramu (Peramu WTP), Pekan ,Pahang.Jejak air (WF) di setiap process rawatan bekalan terbahagi kepada WF_{blue},WF_{green} dan WF_{grey}.Disamping itu,kesan perubahan ekonomi dan perubahan monsoon kepada nilai jejak air (WF) juga diambil kira dan dianalisis.Daripada analysis yang diperolehi,perubahan monsun dan taburan penduduk memberi kesan kepada nilai jejak air (WF).Walau bagaimanapun,perubahan monsun tidak sepenuhnya mempengaruhi nilai jejak air (WF) kerana perubahan penduduk dan pembangunan memberi kesan besar kepada nilai jejak air (WF).Oleh itu, pembangunan yang tidak terkawal di mana pengambilan air adalah daripada sumber yang sama boleh membawa kepada isu kekurangan air yang kritikal.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Water is one of the most precious resources in earth as it act as foundation of life. Water is the humanities basic needs as it is essential to life. Water affect everything such as education, health, poverty, women and children. People need water to survive and improve their live. The survival of life is impossible in the absences of water.

In 2002, the concept of 'water footprint' is being introduced by Hoekstra (Hoekstra, 2003). Water footprint concept is to analyses how the human consumption and the appropriation of freshwater resources is related for the key of environmental indicator (AY Hoekstra, 2011). The water footprint is an indicator of water use that looks at both direct and indirect water use. It is measures the amount of water used to produce each of the goods and services we use. This is to see the clear amount of water that being for such usage and demand (AY Hoekstra, 2011).

Water footprint assessment act as an approaches to assess potential impacts of products and services on water consumption. For instance, the water footprint shown 2700 liters of water was consumed to make one t-shirt (UN Water, 2007). In accounting water footprint for t-shirt, we have to consider the amount of water used in each of material and the amount of water used for the process. For example, the amount of water used in the dyeing process is the water footprint of the t-shirt.

In this study, an attempt to use Water Footprint Assessment is carried out. This approach covers water consumption accounting during the treatment process. In addition to that, factors such as population, land use and monsoonal changes that may affecting the WF accounting as well as its pattern for the duration of five years was also been carried out. From this accounting, the water footprint trend will be able to visualize current sustainability of nation water supply treatment process of Water Treatment Plant (WTP) and also predicted the future.

1.2 PROBLEM STATEMENT

Water scarcity is the main issues in the world nowadays (UN Water, 2007). Actually there is enough freshwater on the planet for almost seven billion people but it is distributed unevenly and too much of it is wasted and polluted (UN Water, 2007). In general, there are some factors that affect the water consumption pattern such as rapid population growth, rapid urbanization and industrialization tourism and climatic changes.

Due to modern technology as well as modern life style, the demand of clean water keeps increasing. Based on this trend it is expected that our water resources will be under stress and cause high probability to scarce. Although Malaysia has abundance of water, with the current climate changing phenomenon in addition to inefficient water management, the potential to be at risk is high. Our water resources have to be ensured its sustainability. Therefore, a better management for the recent water resources is crucial. Recently, several water shortage occurrences have raised concern to the efficiency of our national water supply system. The sustainability of the water supply treatment process is thus an important aspects to be assessed.

1.3 OBJECTIVES

The objectives of this study are:-

1) To identify types of water footprint (WF) involve at each stages of water supply treatment process of Peramu Water Treatment Plant (WTP)

2) To calculate water footprint (WF) at each stages of water supply treatment process of Peramu water treatment plant (WTP) for 5 years duration.

3) To study the effect of population and monsoonal changes to the water footprint (WF) at each stages of water supply treatment process of Peramu WTP for 5 years duration.

1.4 SCOPE OF STUDY

The study conducted was a water footprint (WF) assessment of water supply treatment process (WSTP) at Peramu water treatment plant (WTP). The coverage area of Peramu Water treatment plant (WTP) is Mukim Kuala Pahang where University Malaysia Pahang is located, Taman Mawar, Tanjung Selangor and Kuala Pahang. This study focused on the water footprint accounting for duration five years since 2010 to 2015. Population and monsoonal changes were the only factors assessed to study their effect to the WF accounting. All the data involved in this study were obtained from Jabatan Pengairan dan Saliran (JPS) Pahang, Pengurusan Air Pahang (PAIP), Malaysia Statistical Department, Malaysian Meteorological Department (MMD) and Pejabat Tanah & Galian Kuantan.

1.5 SIGNIFICANT OF STUDY

The significance of the study is to assess the sustainability of water supply treatment process. This study is essential especially during this day as recently some parts of Malaysia were facing water shortages. Furthermore, at the same time, Malaysia was hit by El Nino. From the water footprint assessment, the water consumption in producing domestic water supply will be able to attain and evaluate for further action to be taken. As an unregulated development such as the placement of residential areas and industrial activities are rapidly constructed at one particular area in addition to climatic changes thus this study is pertinent to assess the sustainability of water supply treatment process at Peramu Water Treatment Plant (WTP) to distribute adequate and safe treated water to the consumers