UNIVERSITI PUTRA MALAYSIA

EFFECT OF URBANIZATION ON WATER QUALITY AND DISCHARGE IN TAMAN MAYANG, SELANGOR

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September 2000

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Faculty : Engineering

Urbanization in Malaysia has taken place very rapidly in the last ten years or more due to the economic boom in the country especially in the Klang Valley. One direct consequence of rapid urbanization is the rapid increase in impervious areas such as roads and highways, pavement and parking lots. Industrial, commercial and domestics activities resulting in severe pollution and flood problems in urban areas. The main objective of this study is to determine the effect of urbanization on water quality and discharge in urban area. The Taman Mayang catchment area was selected as a case study.

Water quality analysis was done on the water with in-situ measurements and laboratory analysis. The parameters are pH, Temperature (Temp), Turbidity, Electric Conductivity (EC), Dissolved `Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammoniacal Nitrogen (AN), Suspended Solid (SS), Sulphate (SO_4), Chromium (Cr), Boron (B), Sulphide (S_2), Copper (Cu), Iron (Fe), Chlorine (Cl), Cyanide (Cn), Nickel (Ni), Phosphate (PO_4), Mercury (Hg), Cadmium (Cd), Arsenic (As), Manganese (Mn), Zinc (Zn), Plumbum (Pb), Stanum

(Sn) and Phenol. Two methods were used to estimate Water Quality Index (WQI), which were Harkins' WQI and DOE-WQI.

Based on results for this study, the water quality of the river in Taman Mayang can be classified into Class III and IV by on overall river classification based on Harkins' WQI and DOE-WQI. The study showed that the Taman Mayang discharge was polluted and needs intensive treatment to clean the river. For an urban area, Taman Mayang has BOD value ranging between 3.5 - 7.0 mg/l and COD value which ranges from 20.0- 49.0 mg/l. The pollution sources were identified to originate from the industrial and residential areas. The other parameters did not have serious effect to the environment and human population. From the hydrologic study, rainfall intensity was found to be 86.36 mm/hr for 2 year return period, 134.62 mm/hr for 10 year return period and 187.96 mm/hr for 100 year return period. The total discharge from Taman Mayang were 20.51 m^3/s for 2 year return period, 31.87 m^3/s for 10 year return period and 44.64 m^3/s for 100 year return period. The results of this study can be used as a basis for future studies on water quality on the similar urbanized areas in Malaysia.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan ijazah Master Sains

KESAN PEMBANGUNAN KEPADA KUALITI DAN ALIRAN AIR DI TAMAN MAYANG, SELANGOR

By

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September 2000

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Pembangunan di Malaysia telah berlaku dengan pesatnya dalam sepuluh tahun kebelakangan ini rentetan dengan meningkatnya bidang ekonomi di negara ini terutamanya di Lembah Klang. Salah satu kesan daripada peningkatan pembangunan ialah meningkatnya pembinaan pada kawasan yang belum membangun untuk jalan raya, lebuh raya, tempat pejalan kaki dan tempat letak kereta. Aktiviti-aktiviti dari kawasan kilang, perdagangan dan perumahan telah menyumbang kepada pencemaran dan masalah banjir di beberapa kawasan membangun. Objektif utama kajian ini adalah untuk mengkaji kesan pembangunan terhadap kualiti air dan kadar alirannya di kawasan membangun. Kawasan bandar Taman Mayang telah dipilih sebagai kawasan untuk kajian ini.

Analisis terhadap air telah dilakukan secara ujian setempat (in-situ) dan juga analisis di makmal. Parameter – parameter yang dipilih adalah pH, Suhu (Temp), Kekeruhan, Pengkonduktoran Elektrik (EC), Oksigen Terlarut (DO), Permintaan Biokimia Oksigen (BOD), Permintaan Kimia Oksigen (COD), Ammonia Nitrogen (AN), Pepejal Terampai (SS), Sulfat (SO_4), Kromium (Cr), Boron (B), Sulfit (S_2), Kuprum (Cu), Besi (Fe), Klorin (Cl), Sianida (Cn), Nikel (Ni), Fosfat (PO_4), Raksa

(Hg), Kadmium (Cd), Arsenik (As), Mangan (Mn), Zink (Zn), Plumbum (Pb), Stanum (Sn) and Phenol. Dua kaedah telah digunakan untuk mengira Index Kualiti Air (WQI) iaitu Indek Kualiti Air Harkin (Harkins' WQI) dan Indek Kualiti Air DOE (DOE-WQI).

Berdasarkan kepada keputusan kajian ini, kualiti air di sungai Taman Mayang boleh diklasifikasikan didalam kelas III dan IV oleh pengkelasan keseluruhan berdasarkan kepada Harkins' WQI dan DOE-WQI. Kajian ini telah menunjukkan bahawa aliran air di Taman Mayang telah tercemar dan memerlukan rawatan intensif untuk tujuan pembersihan. Bagi kawasan bandar, didapati Taman Mayang mempunyai nilai BOD yang didalam julat 3.5-7.0 mg/l dan nilai COD diantara 20-49.0 mg/l. Sumber pencemaran telah dikenalpasti dari kawasan perumahan dan perindustrian. Parameter-parameter lain tidak begitu merbahayakan kelompok manusia dan alam sekitar. Daripada kajian hidrologi, kekerapan hujan bagi 2 tahun masa kembali ialah 86.36 mm/hr, 10 tahun masa kembali ialah 134.62 mm/hr dan 100 tahun masa kembali ialah 187.96 mm/hr. Jumlah aliran air yang mengalir keluar dari kawasan Taman Mayang ialah 20.51 m^3/s untuk kala kembali 2 tahun, 31.87 m^3/s untuk kala kembali 10 tahun dan 44.64 m^3/s untuk kala kembali 100 tahun. Hasil keputusan daripada kajian ini boleh dijadikan maklumat permulaan bagi kajian kualiti air bagi kawasan membangun di Malaysia untuk masa hadapan.

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LIST OF ABBREVIATIONS

AN	Ammoniacal Nitrogen
As	Arsenic
AWWA	American Water Works' Association
B	Boron
BOD	Biochemical Oxygen Demand
Cd	Cadmium
Cl	Chlorine
Cn	Cyanide
Cr^{+6}	Chromium Hexavalent
Cr^{+3}	Chromium Trivalent
Cu	Copper
d	day
DID	Drainage and Irrigation Department, JPT
DO	Dissolved Oxygen
DOE	Department of Environment
d/s	downstream
Fe	Iron
ha	hectares
Hg	Mercury
HP	Hydrological Procedure
km^2	square kilometer
Mn	Manganese
m^3/s	cubic meter per second

Ni	Nickel
Pb	Plumbum
PO_4	Phosphate
S_2	Sulphide
Sn	Stanum
Sg.	Sungai
SIAN	Subindex for Ammoniacal Nitrogen
SIBOD	Subindex for Biochemical Oxygen Demand
SIDO	Subindex for Dissolved Oxygen
SIPH	Subindex for pH
SISS	Subindex for Suspended Solid
SO_4	Sulphate
TSS	Total suspended Solid
u/s	upstream
WHO	World Health Organization
WQ	Water Quality
WQI	Water Quality Index
Zn	Zinc

CHAPTER I

INTRODUCTION

Surface water originates from surface runoff, underground springs, ground water depletion, lakes or other water bodies. Because the point of origin influences the composition of surface water, test results for the overall quality of the water often reveal its sources. Surface water reflects the environment and recent weather conditions more than the geology of the catchment area. Surface waters are also characteristized by their contents of suspended matter, both organic and inorganic. Surface water received nutrients from the growth of aquatic plants, fish and other water fauna and flora. Surface water is also used for other purposes such as industrial water supply, irrigation, propagation of fish and other aquatic life, navigation, power generation and recreation (WHO, 1978).

The availability of water supply in terms of both quantity and quality is essential to human existence. Earlier people recognized the importance of water from a quantitative viewpoint. Civilization developed around water bodies that could support agriculture and transportation as well as providing drinking water. Recognition of the importance of water quality developed more slowly. Earlier people could judge water quality only through the physical senses of sight, taste and smell. Not until the biological, chemical and medical sciences developed were methods available to measure water quality and to determine its effects on human health and well being (Peavy, *et al.*, 1985).

Statement of Problems

Urbanization in Malaysia has taken place very rapidly in the last ten years or more due to the economic boom in the country especially in the Klang Valley. One direct consequence of rapid urbanization is the rapid increase in impervious areas such as roads and highways, pavement, parking lots, housing and industries. Those activities resulting a huge amount of pollution and flood problems in the drainage system

Taman Mayang catchment area has been chosen as a study area to determine the effects of urbanization to the river system. The study area is located in Petaling Jaya, Selangor. Taman Mayang study area is a fully developed urban area with a mixed development setup primarily of housing and some commercial activities and also has some open space. Taman Mayang catchment area is also one of the government projects to clean the pollution from the river. Further information of study area is explained in Chapter III.

Objectives and Scope of Works

The main objective of this study was to determine the effects of urbanization to the water quality and river discharge in the study area. The specific objectives were:

1. Analyze the water quality of Taman Mayang urban area. The water quality data were determined from in-situ measurement and laboratory analysis. The water sample was taken from eleven selected stations in the Taman Mayang drainage system.
2. Classify the river in Taman Mayang using water quality index based on Harkins'-WQI and DOE-WQI.
3. Study the hydrological data to estimate the discharge and relate the hydrological data (land-use pattern) to the water quality of Taman Mayang urban area. Hydrological data was predicted from DID Hydrological Procedure NO.1 and some measured data from the Hydrology Division of DID, Ampang.

CHAPTER II

LITERATURE REVIEW

Hydrology Study

Introduction

Hydrology treats for the occurrence, circulation and distribution, chemical and physical properties and the reaction with the environment including their relationship to living things. The domain of hydrology embraces the full life history of water on earth. Engineering hydrology includes those segments of the field pertinent to planning, design and operation of engineering projects for the control and use of water (Linsley, *et al*., 1988).

Hydrologic Cycle and Water Quality

The study of the hydrological cycle is very important as it relates to global water resources. Currently, the issue of looking after the environment is the global issue and it represents a problem that must be given serious consideration by everyone as indirectly it relates to the source and quality of water that is being produced.

Hence, the importance of maintaining the hydrologic cycle and ensuring that it is continues to be in balances is vital. As such, knowledge regarding the hydrologic cycle is prerequisite to addressing and solving the problem.

Peavy, *et al.* (1985) expressed that water is one of the most abundant compounds found in nature, covering approximately three-fourths of the surface of the earth. In spite of this apparent abundance, several factors serve to limit the amount of water available for human use. As shown in Table 2.1, over 97 percent of the total water supply is contained in the oceans and other saline bodies of water and is not readily usable for most purposes. Of the remaining 3 percent, a little over 2 percent is tied up in ice caps and glaciers and along with atmospheric and soil moisture that is inaccessible. Thus, for their general livelihood and the support of their varied technical and agricultural activities, humans must depend upon the remaining 0.62 percent found in freshwater lakes, rivers and groundwater supplies.

Water is in a constant state of motion as depicted in the hydrologic cycle shown in Figure 2.1. Atmospheric water condenses and falls to the earth as rain, snow or some other form of precipitation. Once on the earth's surface, water flows into streams, lakes and eventually the oceans or percolates through evaporation from surface waters or by evapotranspiration from plants, water molecules return to the atmosphere to repeat the cycle. Although the movement through some parts of the cycle may be relatively rapid, complete recycling of groundwater must often be measured in geologic time.

Table 2.1: World water distribution

Location	Volume, $10^{12}m^3$	% of total
Land areas:		
Freshwater lakes	125	0.009
Saline lakes and inland seas	104	0.008
Rivers	1.25	0.0001
Soil moisture	67	0.005
Groundwater	8,350	0.61
Ice caps and glaciers	29,200	2.14
Total land are (rounded)	37,800	2.8
Atmosphere (water vapor)	13	0.001
Oceans	1,320,000	97.3
Total all locations (rounded)	1,360,000	100

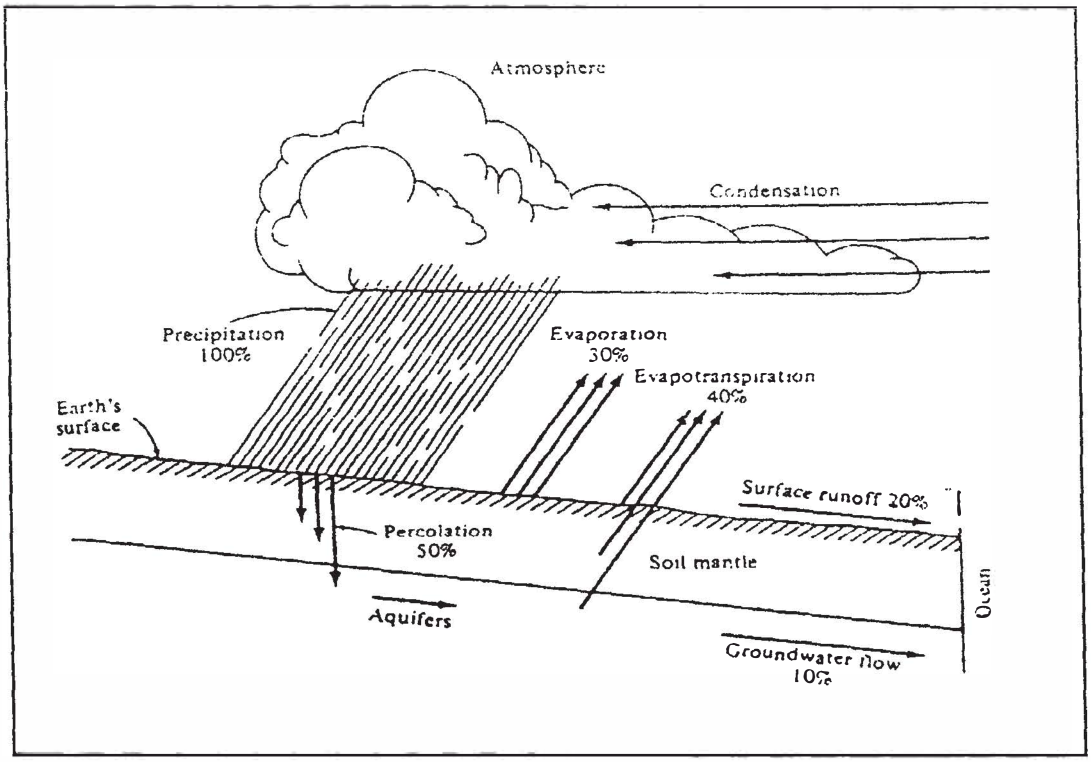

Figure 2.1: Hydrologic cycle

Source: Peavy, *et al.* (1985)

Peavy, *et al.* (1985) also said that human activities contribute addressing further impurities in the form of industrial and domestic wastes, agricultural chemicals and other less obvious contaminants. Ultimately, these impure waters will complete the hydrologic cycle and return to atmosphere as relatively pure water molecules. However, it is water quality in the intermediate stage, which is of greatest concern because it is the quality at this stage that will affect human use of the water.

Surface water exists in natural basins and stream channels. Where minimum flows in streams or rivers are large in relation to water demands of adjacent lands, towns and cities, development of surface waters is accomplished by direct withdrawal from the flow. In many streams and rivers, flow fluctuates widely from season to season and from year to year. Further, peak demands from many major rivers occur at seasons in minimum flow and require that much of the annual flow as possible be conserved and diverted for beneficial use.

Runoff Coefficient

The runoff coefficient remains a practical tool in engineering hydrology. In classical 'rational formula' (Dooge, 1957), it is considered to be a constant, differing in value between types of surface cover of a catchment (Gottschalk, *et al.*, 1998).

The Department of Drainage Irrigation (1991) Malaysia also said that the runoff coefficient (C) is the variable of the Rational Method least susceptible to precise determination and understanding on the part of engineering. The values adopted in design are to be based on the ultimate expected development of the land.