INFLUENCE OF ENHANCED BIORETENTION MEDIA AND TROPICAL SHRUB ON NUTRIENT REMOVAL FOR URBAN RUNOFF IN MIXED DEVELOPMENT AREA

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LIST OF ABBREVIATION

Al	aluminium
ANOVA	analysis of variance
ASTM	American Society for Testing and Materials
Aus.	Australia
BAM	bio-sorption activated media
BMPs	Best Management Practices
BOD	biochemical oxygen demand
BOD_5	five-day biochemical oxygen demand
C	carbon
Ca	calcium
Ca^{2+}	calcium ion
$CaCO_3$	calcium carbonate
$Ca_5(PO_4)_3(OH)$	calcium hydroxyapatite
CEC	cation exchange capacity
CH	coconut husk mesocosm
C:N	carbon: nitrogen
COD	chemical oxygen demand
CS	crushed cockle shell mesocosm
Cu	Copper
DEP	Department of Environmental Protection Pennsylvania
DID	Department of Irrigation and Drainage Malaysia
DIN	dissolved inorganic nitrogen
DO	dissolved oxygen

DOC	dissolved organic carbon
DOE	Department of Environment Malaysia
DON	dissolved organic nitrogen
EMCs	event mean concentrations
EQR	Environment Quality Report Malaysia
Fe	iron
H_3PO_4	Orthophosphate
HRT	hydraulic retention time
LMW	low molecular weight
MLR	multilinear regression analysis
MSMA	Manual Saliran Mesra Alam
N	nitrogen
N_2O	nitrous oxide
NH_3-N	ammonical nitrogen
NJDEP	New Jersey Department of Environmental Protection
NO_2-N	nitrite-nitrogen
NO_3-N	nitrate-nitrogen
NO_x-N	oxidized nitrogen
NP	shredded newspaper mesocosm
NPDES	National Pollutant Discharge Elimination Systems
NV	non-vegetated mesocosm
NWQS	national water quality standard
O_2	oxygen gas
P	phosphorus
Pb	lead

PCA	principle component analysis
PGC	Prince George's County Maryland
PO_4^{3-}	phosphate
PON	particulate organic nitrogen
PP	shredded printed paper mesocosm
PSD	particle size distribution
PUB	Singapore Public Utility Board
PVC	polyvinyl chloride
REDAC	River Engineering and Urban Drainage Research Centre
SD	standard deviation
SEM	scanning electron microscope
SS	suspended solids
STD	standard mesocosm
TC	tyre crumb mesocosm
TDN	total dissolved nitrogen
TDP	total dissolved phosphorus
TDS	total dissolved solids
TKN	Total Kjeldahl Nitrogen
TN	total nitrogen
TOC	total organic carbon
TP	total phosphorus
TSS	total suspended solids
UK	United Kingdom
US	United States
USDA	United States Department of Agriculture

USEPA	United States Environmental Protection Agency
V	vegetated mesocosm
VSSF	vertical subsurface flow constructed wetlands
WQI	water quality index
WSUD	Water Sensitive Urban Design Australia
WTR	water treatment residue
Zn	zink

LIST OF SYMBOLS

$\mathcal{E}$	Error
β	Relevant parameters
$\Delta Canopy$	Canopy growth rate
$\Delta Canopy_{media}$	Average canopy growth rate for each media type
ΔH	Height growth rate
ΔH_{media}	Average height growth rate for each media type
$\Sigma\Delta Canopy_{media}$	Total average canopy growth rate
$\Sigma\Delta H_{media}$	Total average height growth rate
ΣF_{media}	Total number of flower
ΣM_{media}	Total plant achieved maturity
C_{eff}	Effluent concentration
$\overline{C_{eff}}$	Mean effluent concentration
C_{inf}	Influent concentration
$\overline{C_{inf}}$	Mean influent concentration
C_R	% concentration reduction
C_S	Saturated DO concentration
$Canopy_f$	Final canopy width
$Canopy_i$	Initial canopy width
d_{50}	Diameter of particle size that intercept at 50% of the cumulative mass
df	Degree of freedom
DO_x	Measured DO
DO_{sat}	Dissolved oxygen saturation percentage

e	Residuals
F	Factor
F_{media}	Number of flower for each media type
H_0	Null hypothesis
H_f	Final height
H_i	Initial height
k	Hydraulic conductivity
k_s	Saturated hydraulic conductivity
L	Depth of bioretention media
M_f	Final sample mass
M_i	Initial sample mass
M_{media}	Number of plant achieved maturity for each media type
MS	Mean square
M_{total}	Cumulative mass removal
p	Ponding depth
Q	Infiltration flow rate
r	Pearson's correlation coefficient
R^2	Coefficient of determination
R_{Canopy}	Canopy growth ratio
R_F	Flower ratio
R_H	Height growth ratio
R_M	Maturity ratio
S	Cross section of the column
Sig.	Significance
SS	Sum of square

SS_{res}	Sum of squares of residuals
$SStot$	Total sum of squares of the deviations
$Vol.$	Volume
$Vol._{eff}$	Effluent volume
$Vol._{inf}$	Influent volume
X	Independent variables
Y	Dependent variables

PENGARUH MEDIA *BIORETENTION* YANG DITAMBAH BAIK DAN POKOK RENEK TROPIKA TERHADAP PENGURANGAN NUTRIEN DALAM AIR LARIAN BANDAR DI KAWASAN PEMBANGUNAN BERCAMPUR

ABSTRAK

Input nutrien daripada aliran air bandar terutamanya nitrogen (N) dan fosforus (P), merupakan masalah utama dalam perlindungan ekosistem akuatik. Kajian makmal ini bertujuan menyiasat penambahbaikan sistem *bioretention* untuk mengetahui prestasi dan mengoptimumkan komposisi bahan tambahan dalam media *bioretention* bagi menyingkirkan nutrien, dan menyiasat potensi fitopemulihan *Hibiscus rosa-sinensis* (bunga raya) dalam sistem *bioretention* melalui kajian tanah dan tumbuhan. Kajian ini dijalankan dalam dua peringkat. Pada Peringkat 1, kajian dilakukan dengan mengubahsuai media *bioretention* dengan 10% (mengikut isi padu) bahan tambahan dari pelbagai bahan-bahan buangan (kulit kerang, akhbar, kertas bercetak, sabut kelapa, dan remah tayar) dan ditanam dengan *Hibiscus rosa-sinensis*. Hasilnya, media yang diubahsuai dengan hirisan akhbar (NP) menunjukkan jumlah penyingkiran pepejal terampai (TSS) tertinggi (98.4%), berbanding dengan media *bioretention* standard (STD, 85.4%), dan menunjukkan peningkatan yang ketara dalam penyingkiran jumlah nitrogen (TN, 80.4%), berbanding dengan STD (57.5%) apabila disiram dengan air larian sebenar. Medium yang diubahsuai dengan hancuran kulit kerang (CS) menunjukkan jumlah penyingkiran fosforus (TP) yang paling tinggi (93.3%), berbanding dengan STD (84.8%), dan media ini juga menunjukkan pertumbuhan pokok yang lebih baik, berbanding dengan media lain. Oleh itu, NP dan CS telah dipilih untuk kajian di Peringkat 2, dan tiga jenis komposisi media (komposit