UNIVERSITI PUTRA MALAYSIA

NUTRIENT REMOVAL USING COMMON REED (*PHRAGMITES KARKA*) AND TUBE SEDGE (*LEPIRONIA ARTICULATA*) IN A CONSTRUCTED SURFACE FLOW WETLAND SYSTEM IN PUTRAJAYA, MALAYSIA

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By

SIM CHENG HUA

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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DEDICATION

To my dearest husband, David Li Zuowei who has provided invaluable assistance in the field and support throughout this period. Also to all my family members and friends for their encouragement and support.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

NUTRIENT REMOVAL USING COMMON REED (*PHRAGMITES KARKA*) AND TUBE SEDGE (*LEPIRONIA ARTICULATA*) IN A CONSTRUCTED SURFACE FLOW WETLAND SYSTEM IN PUTRAJAYA, MALAYSIA

By

SIM CHENG HUA

March 2007

Chairman: Associate Professor Mohd Kamil Yusoff, PhD

Faculty: Environmental Studies

A pilot tank study was carried out to determine the nutrient removal efficiency of the common reed *Phragmites karka* and tube sedge *Lepironia articulata*. The replicate planted tanks were continuously fed with a nutrient solution at a rate of 50.0 mg l^{-1} N and 5.0 mg l^{-1} P and control planted tanks were set up without nutrient supplements. The plant growth rate, plant nutrient removal efficiency and nutrient content in the substrate were analysed. In addition, a field study at the 3 wetland cells Upper North 4-6 in Putrajaya Wetlands was carried out to assess the plant nutrient removal efficiency and the nutrient removal rates along the 3 wetland cells.

In the pilot study, the growth rate and total harvested biomass of treated wetland plants were significantly higher than of those in the control tanks. The treated samples of the common reed experienced a long growth period before they experienced senescence. However no flowering stage was observed throughout the 30-week experimental period.

The treated tube sedge stands collapsed after 8 weeks in the first experimental period, probably due to nutrient overload conditions. In the second experimental period, the plant collapsed after 16 weeks under half nutrient concentration.

Nutrient removal through nutrient accumulation by the common reed was higher than those in tube sedge at 42.12% N; 28.92% P and 17.43% N; 26.08% P respectively, and the differences were significant.

The field study in Putrajaya Wetlands showed that water quality normally improved with flow length along the wetland cells. However the improvement is reduced during periods of rainfall where levels of Total Suspended Solids, Nitrate and Phosphate were highly variable. Nutrient removal performance was 82.11% Total Nitrogen (70.74% Nitrate-Nitrogen); and 84.32% Phosphate from UN 6 to UN 1 (2025 m) from April to December 2004.

Both the pilot and field studies indicated that these two selected wetland plants grew well in the field and in the pilot tank study. Thus, both plant species are good examples of emergent plant species for constructed wetlands.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENYINGKIRAN NUTRIEN DENGAN RUMPUT GEDABONG (*PHRAGMITES KARKA*) AND RUMPUT KERCUT (*LEPIRONIA ARTICULATA*) DALAM SATU SISTEM WETLAND BUATAN JENIS ALIRAN PERMUKAAN DI PUTRAJAYA, MALAYSIA

Oleh

SIM CHENG HUA

Mac 2007

Pengerusi: Profesor Madya Mohd Kamil Yusoff, PhD

Fakulti: Pengajian Alam Sekitar

Satu kajian tangki perintis telah dijalankan bagi menentukan kecekapan rumput gedabong *Phragmites karka* dan rumput purun / kercut *Lepironia articulata* dalam penyingkiran nutrien. Tangki rawatan yang ditanam dengan tumbuhan disalurkan larutan nutrien secara berterusan pada kadar 50.0 mg l^{-1} N and 5.0 mg l^{-1} P manakala tangki kawalan yang juga ditanam dengan tumbuhan tidak dibekalkan nutrien. Kadar tumbesaran tumbuhan, kadar kecekapan penyingkiran nutrien tumbuhan dan kandungan nutrien dalam substrat dianalisa. Tambahan lagi, satu kajian lapangan telah dijalankan di 3 sel wetland Upper North 4-6 di Wetland Putrajaya untuk menentukan kadar penyingkiran nutrien oleh tumbuhan ini dan peningkatan kadar penyingkiran di sepanjang 3 sel wetland ini.

Dalam kajian perintis, kadar pertumbuhan dan jumlah biomasa tumbuhan yang dirawat adalah lebih tinggi daripada sampel kawalan. Sampel rumput gedabong yang dirawat mengalami tempoh tumbesaran yang panjang sebelum mengalami kelayuan (senesense), tetapi, ia tidak berbunga di sepanjang tempoh eksperimen 30 minggu. Sampel rumput kercut dalam tangki rawatan tumbang selepas 8 minggu dalam tempoh eksperimen yang pertama, mungkin disebabkan oleh kandungan nutrien yang terlampau tinggi. Dalam eksperimen yang kedua, tumbuhan tumbang selepas 16 minggu dalam kepekatan nutrien separuh.

Kadar penyingkiran nutrien melalui pengambilan tumbuhan oleh rumput gedabong adalah lebih tinggi daripada yang dicapai oleh rumput kercut pada 42.12% N; 28.92% P dan 17.43% N; 26.08% P masing-masing, dan perbezaan adalah bererti.

Keputusan kajian lapangan di Wetland Putrajaya menunjukkan kualiti air bertambah baik apabila mengalir melalui satu jarak sepanjang sel-sel wetland. Walaubagaimanapun, kualiti air merosot semasa tempoh hujan dimana paras-paras Partikel Terapung, Nitrat dan Fosforus banyak berubah. Kadar penyingkiran nutrien adalah dalam 82.11% Jumlah Nitrogen (70.74% Nitrat-Nitrogen); dan 84.32% Fosforus dari sel-sel wetland UN 6 hingga UN 1 (2025 m) dari April hingga Disember 2004.

Kedua-dua kajian perintis dan lapangan membuktikan bahawa kedua-dua jenis tumbuhan yang terpilih dapat tumbuh dengan baik di lapangan dan tangki rawatan.

Maka, kedua-dua spesies adalah contoh tumbuhan emergen yang sesuai untuk wetland buatan.

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I certify that an Examination Committee has met on 23 March 2007 to conduct the final examination of Sim Cheng Hua on her Doctor of Philosophy thesis entitled "Nutrient Removal Using Common Reed (*Phragmites karka*) and Tube Sedge (*Lepironia articulata*) in a Constructed Surface Flow Wetland System in Putrajaya, Malaysia" in accordance with Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

Ahmad Makmom Hj. Abdullah, PhD
Associate Professor
Faculty of Environmental Studies
Universiti Putra Malaysia
(Chairman)

Fatimah Md Yusoff, PhD
Professor
Faculty of Science
Universiti Putra Malaysia
(Internal Examiner)

Mohamad Ismail Yaziz, PhD
Associate Professor
Faculty of Environmental Studies
Universiti Putra Malaysia
(Internal Examiner)

Datin Hj. Ann Anton, PhD
Professor
School of Science and Technology
Universiti Malaysia Sabah
(External Examiner)

HASANAH MOHD. GHAZALI, PhD
Professor/Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 21 JUNE 2007

This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee are as follows:

Mohd Kamil Yusoff, PhD
Associate Professor
Faculty of Environmental Studies
Universiti Putra Malaysia
(Chairman)

Ho Sinn Chye, PhD
Professor
School of Biological Sciences
Universiti Sains Malaysia
(Member)

Mashhor Mansor, PhD
Professor
School of Biological Sciences
Universiti Sains Malaysia
(Member)

Brian Shutes, PhD
Professor
Biomedical and Environmental Sciences
Middlesex University, United Kingdom
(Member)

AINI IDERIS, PhD
Professor/ Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 17 JULY 2007

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

SIM CHENG HUA

Date: 17 MAY 2007

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