UNIVERSITI PUTRA MALAYSIA

CORRELATION BETWEEN RIPARIAN VEGETATION CHARACTERISTICS AND WATER QUALITY IN SELECTED FOREST STANDS, MALAYSIA

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By

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Faculty: Forestry

Riparian zones have been accounted as the most productive ecosystems and also one of the most sensitive to human influences and potentially most threatened ecosystems. Within production forest of Permanent Forest Reserve in Peninsular Malaysia buffer zone is usually demarcated in the regulation, but the size of the buffer zones varies depending on the state's law and also the steepness and width of the stream. Despite that, logging activities still contributed significantly to the degradation of riparian zones due to the poor planning of logging roads and skidder trails.

The study was conducted in Pasoh Forest Reserve (PFR) and Ayer Hitam Forest Reserve (AHFR). The main objectives of this study are to; 1) characterize the riparian plant communities in lowland forest based on species composition, structure and diversity; 2) assess the effect of logging activities and other disturbance on water quality and riparian plant communities in lowland forest; and 3) correlate the composition, structure and diversity of riparian vegetation with the water quality parameters.

Three different types of forest were chosen for each site. For PFR; Compt. 47 has been logged on October 2009; Compartment 55 was logged on 2005 and finally, undisturbed forest of Compartment 51. While in AHFR, Compartment 15 and Compartment 13 were logged over forest since 1950's and Compartment 14 was a logged over forest since 1960's. Water quality parameters were measured in each station by *In-situ* for Dissolved Oxygen (DO) and pH and *Ex-situ* for Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonia Nitrogen (NH_3N) and Total Suspended Solids (TSS) to establish the current water quality status in particular river at both study sites.

Canonical Correspondence Analysis (CCA) method was used to elucidate the relationship between riparian plant communities with their adaptation to the stream water quality and summarize the variation in the relative frequencies of the response variables (species) (Leps and Smilauer, 2003). Additionally, Cluster Analysis by using Bray-Curtis Similarity Coefficient was performed to establish a dendrogram inferring similarity of species composition between those compartments. For water quality analysis, One Way of Variance (ANOVA) and t-test were used to compare water quality status among stations within study areas.

Results showed that a total of 1362 individual tree enumerated belonging to 308 species, 188 genera and 75 families were recorded in PFR. In AHFR however, the numbers were lesser than PFR with 1217 individuals from 108 species, 89 genera and 51 families. Composition of species showed that *Pometia pinnata* (Kasai) is the most abundant species for trees while shrubs of *Clidemia hirta* (Senduduk bulu) is the most abundant

shrubs in PFR. In AHFR, *Saraca declinata* (Gapis) is the most abundant tree while *Donax grandis* (Bemban) is the most abundant for non tree species. For Importance Value Index (IVI), the IVI based on family in PFR is contributed largely from Sapindaceae with the value of 1.025 followed by Annonaceae (0.9682), Dipterocarpaceae (0.7217), Leguminosae (0.5945) and Euphorbiaceae (0.5681). In AHFR, the highest IVI based on family is recorded mostly by family Dipterocarpaceae with the value of 0.8179 followed by Leguminosae (0.4570), Moraceae (0.4220), Myristicaceae (0.3202) and Rubiaceae (0.2760). Similarly at species level, dipterocarp tree play significant role in forming riparian plant communities.

The water quality status of Sebaling River, Marong Kiri River and Rasau River are classified as class II which is suitable for recreational but need to be treated for supply of domesticated water. Canonical Correspondence Analysis (CCA) indicated that the composition of riparian plant species is closely related to these environmental variables.

Based on this study, riparian plant communities have strong correlation with water quality parameters depending on the forest types with major or minor disturbances like logging history and anthropogenic disturbances. However, a better understanding can be produce if the study can be extended for a longer period and the plot size should be expanded for a bigger size which can be covered all types of riparian plants communities along the streams including mosses.

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

KORELASI ANTARA CIRI-CIRI VEGETASI RIPARIAN DAN KUALITI AIR DI DIRIAN HUTAN TERPILIH DI MALAYSIA

By

AZLIZA BINTI MURAD

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Zon riparian adalah sebuah ekosistem yang produktif dan juga zon yang paling sensitif dengan gangguan manusia dan berpotensi untuk menjadi ekosistem yang terancam. Di dalam hutan pengeluaran di Hutan Simpan Kekal di Semenanjung Malaysia biasanya ada dibataskan dalam undang-undang tetapi saiz zon penampan berbeza-beza bergantung pada undang-undang negeri dan juga kecuraman dan kelebaran sungai. Walaubagaimanapun, aktiviti pembalakan masih menyumbang kepada degradasi zon riparian disebabkan perancangan yang kurang baik dan kesan dari jalan pembalakan dan laluan jentolak.

Kajian telah dijalankan di Hutan Simpan Pasoh (HSP) dan Hutan Simpan Ayer Hitam (HSAH). Objektif utama kajian ini ialah untuk; 1) mengenali ciri-ciri komuniti tumbuhan riparian dalam hutan tanah pamah daripada data komposisi spesis, struktur dan kepelbagaian spesis; 2) menilai kesan aktiviti pembalakan ke atas komuniti tumbuhan riparian dan kualiti air sungai dalam hutan tanah pamah; 3) mengaitkan

komposisi, struktur dan kepelbagaian tumbuhan riparian dengan parameter kualiti air dalam hutan tanah pamah.

Tiga jenis hutan berbeza telah dipilih untuk setiap tapak kajian. Untuk HSP; Komparmen 47 telah dibalak pada Oktober 2009; Komparmen 55 pula telah dibalak pada 2005 manakala, Komparmen 51 adalah hutan yang tak diganggu. Manakala di HSAH, Komparmen 15 dan Komparmen 13 adalah hutan yang telah dibalak sejak 1950-an manakala Komparmen 14 pula adalah hutan yang telah dibalak sejak 1960-an. Parameter kualiti air diukur di setiap stesen dengan dua keadeh iaitu; kaedah *In Situ* untuk Dissolved Oxygen (DO) dan pH dan kaedah *Ex- situ* pula untuk Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonia Nitrogen (NH_3N) dan Total Suspended Solids (TSS) untuk menentukan status kualiti air semasa khususnya sungai di kedua-dua tapak kajian.

Analisis Koresponden Kanonik (CCA) adalah analisis yang menunjukkan hubungan antara komuniti tumbuhan riparian dan penyesuaiannya dalam kualiti air sungai tertentu dan membuat ringkasan ke atas variasi dalam frekuensi relatif oleh pembolehubah-pembolehubah sambutan (spesies) (Leps and Smilauer, 2003). Selain itu, Analisis Kelompok juga digunakan dengan menggunakan Pekali Kesetaraan Bray Curtis dan gambarajah dendrogram yang merujuk kepada persamaan komposisi spesies antara hutan tanah. Untuk analisis kualiti air, Analisis Varians Satu Hala (ANOVA) dan Ujian T digunakan untuk menghasilkan satu perbandingan antara status kualiti air antara hutan-hutan yang berbeza berdasarkan sejarah pembalakan dalam kawasan tertentu.

Keputusan menunjukkan sejumlah 1362 individu daripada 308 spesies, 188 genus dan 75 keluarga telah direkodkan di HSP. Manakala di HSAH, bilangannya adalah kurang daripada HSP dengan hanya 1217 individu daripada 108 spesies, 89 genus dan 51 keluarga. Komposisi spesies menunjukkan *Pometia pinnata* (Kasai) ialah spesies yang paling banyak bagi tumbuhan berkayu manakala *Clidemia hirta* (Senduduk bulu) ialah spesies tidak berkayu yang paling banyak didapati di HSP. Di HSAH pula, *Saraca declinata* (Gapis) ialah spesis berkayu yang paling banyak dicatatkan manakala *Donax grandis* (Bemban) ialah spesis tidak berkayu yang paling banyak dicatatkan.

Untuk Indeks Nilai Kepentingan (IVI), IVI berdasarkan keluarga di HSP disumbangkan sebahagian besarnya dari keluarga Sapindaceae dengan nilai 1.025 diikuti oleh Annonaceae (0.9682), Dipterocarpaceae (0.7217), Leguminosae (0.5945) dan Euphorbiaceae (0.5681). Compt. 47 di HSP, spesies Dipterocarp (*Dipterocarpus baudii*) dengan IVI 0.2573 disenaraikan sebagai IVI yang tertinggi berdasarkan spesies. Walaubagaimanapun, Compt. 55 di HSP, spesies dipterokap adalah kurang penting. Tetapi, spesies tumbuhan riparian sebenar iaitu *Saraca cauliflora* menunjukkan IVI tertinggi dengan satu nilai 0.3390. Sebagaimana Compt. 55, Compt. 51 menunjukkan bahawa satu lagi spesies tumbuhan riparian sebenar, iaitu *Pometia pinnata* mempunyai IVI tertinggi dengan 0.3647. Di HSAH, IVI tertinggi berdasarkan keluarga direkodkan kebanyakannya oleh keluarga Dipterocarpaceae dengan nilai 0.8179 diikuti oleh Leguminosae (0.4570), Moraceae (0.4220), Myristicaceae (0.3202) dan Rubiaceae (0.2760). Begitu juga di tahap spesies, pokok dipterokap memainkan peranan penting dalam membentuk komuniti-komuniti tumbuhan riparian.

Indeks kualiti air (WQI) untuk setiap stesen di Sungai Sebaling, Sungai Marong Kiri dan Sungai Rasau tergolong dalam kelas II dimana ianya sesuai untuk rekreasi tetapi perlu dirawat untuk bekalan air. Analisis Koresponden Kanonik (CCA) menunjukkan bahawa komposisi spesies tumbuhan riparian adalah sangat berhubungkait dengan pembolehubah persekitaran.

Berdasarkan kajian ini, komuniti tumbuhan riparian mempunyai hubungkait yang erat dengan parameter kualiti air bergantung kepada jenis hutan dengan gangguan kecil atau besar seperti sejarah pembalakan dan gangguan dan pencerobohan oleh aktiviti manusia. Bagaimanapun, pemahaman yang lebih baik boleh dihasilkan jika kajian dapat dipanjangkan untuk satu tempoh lebih lama dan saiz plot harus diperbesarkan untuk satu saiz yang lebih besar yang mana boleh meliputi semua jenis komuniti tumbuhan riparian sepanjang sungai-sungai termasuk lumut.

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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Date:

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