

**BUKU  
ABSTRAK  
LANJUTAN**

# **KOLOKIUUM SISWAZAH LESTARI 2023**

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**PENYELIDIKAN  
CEMERLANG,  
ASPIRASI  
NEGARA.**



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**INSTITUT ALAM SEKITAR DAN  
PEMBANGUNAN (LESTARI)  
UNIVERSITI KEBANGSAAN MALAYSIA (UKM )**

**T : 03 8921 4149**  
E : [siswazah\\_lestari@ukm.edu.my](mailto:siswazah_lestari@ukm.edu.my)

**PENYUNTING: KU ADRIANI KU AYOB & MOHD FUAD TEPIT**

# KATA ALUAN PENGARAH

Salam sejahtera.

Institut Alam Sekitar dan Pembangunan (LESTARI), Universiti Kebangsaan Malaysia telah menganjurkan Kolokium Siswazah LESTARI (KSL) hampir dua dekad sejak penubuhan institut ini. Objektif utama penganjuran KSL adalah untuk memberi peluang kepada pelajar siswazah berkongsi hasil penyelidikan serta perkembangan penyelidikan mereka dengan semua warga LESTARI. KSL dilihat sebagai satu platform untuk membangun keupayaan serta melatih pelajar mengukuhkan kemahiran penyelidikan dan komunikasi.

Melalui platform ini, pelajar dapat menerima input dan komen daripada para akademik terhadap hasil penyelidikan yang diperolehi melalui kajian mereka. Input ini adalah penting untuk menambahbaik dan meningkatkan kefahaman mereka mengenai kaedah penyelidikan yang dijalankan di samping meningkatkan keyakinan mereka dalam usaha menyebarkan hasil dan maklumat penyelidikan. KSL ini juga dapat mengukuhkan lagi kapasiti dan keterampilan pelajar dalam membentang, menganalisis dan berhujah mengenai penyelidikan yang dilaksanakan.

Selaras dengan aspirasi dan falsafah pendidikan negara, KSL merupakan salah satu inisiatif penting dalam melahirkan siswazah yang berwibawa dalam menjalankan penyelidikan yang memberi impak khususnya kepada komuniti akademik serta masyarakat umum secara keseluruhannya.

Akhir kata, diharapkan para pelajar LESTARI menggunakan platform KSL dengan optimum dan menggunakan peluang yang ada untuk berkongsi dan menerima maklum balas daripada felo penyelidik di LESTARI dan rakan-rakan seperjuangan demi memastikan penyelidikan yang berkualiti.

Sekian, terima kasih.

**Professor Madya ChM. Dr. Goh Choo Ta**

Pengarah

Institut Alam Sekitar dan Pembangunan (LESTARI)

# PRAKATA

Kolokium Siswazah LESTARI (KSL) merupakan satu platform penting untuk pelajar siswazah berkongsi pengetahuan mengenai penyelidikan mereka di samping mendapat maklumbalas untuk tujuan penambahbaikan. Setelah hampir tiga tahun negara berhadapan dengan cabaran pandemik COVID-19, KSL 2023 kembali diadakan secara fizikal untuk memastikan penglibatan secara langsung semua warga LESTARI.

“Penyelidikan Cemerlang, Aspirasi Negara” merupakan tema untuk KSL 2023 yang menyoroti bagaimana penyelidikan berkualiti dan inovatif dapat memainkan peranan utama dalam menyelesaikan cabaran-cabaran semasa dan merangkul aspirasi untuk masa depan yang lebih baik.

KSL 2023 menyaksikan keterlibatan 18 orang pelajar siswazah merangkumi semua pusat penyelidikan di LESTARI. Buku Abstrak Lanjutan ini memaparkan koleksi abstrak peserta yang bakal membentangi dalam KSL 2023. Diharapkan melalui KSL 2023, para peserta dapat mencipta pengalaman dan persekitaran yang mempromosikan ilmu, pemahaman tentang kandungan penyelidikan dengan lebih baik dan perkembangan ilmu pengetahuan dan teknologi.

Akhir kata, terima kasih kepada semua felo akademik LESTARI, para pegawai dan kakitangan LESTARI yang sama-sama menjayakan KSL 2023.

Sekian, terima kasih.

**Gs. Dr. Nurfashareena Binti Muhamad**  
Pengerusi  
Kolokium Siswazah LESTARI 2023

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**KOLOKIUUM SISWAZAH LESTARI 2023**  
**11-12 OKTOBER 2023**  
**BILIK KULIAH UTAMA LESTARI**

**11 OKTOBER 2023 (RABU)**

WAKTU		PERKARA
8.30-9.00 pagi		Pendaftaran
9.00-9.10 pagi		Ucapan Aluan Pengarah LESTARI
9.10-9.20 pagi		Taklimat Pengerusi Kolokium Gs. Dr. Nurfashareena Muhamad
<b>SESI 1</b> <b>9.20-10.45 pagi</b>		<b>Moderator : Dr. Minhaz Farid Ahmed</b> <b>Penilai : 1. Prof. Ts. Dr. Lee Khai Ern</b> <b>2. Prof. Madya Dr. Tanot Unjah</b> <b>3. Dr. Ahmad Aldrie Amir</b>
P1	9.30-9.55 pagi	Nurul Ain Zulhaimi (P114966) Doktor Falsafah
P2	9.55-10.20 pagi	Siti Morni Umor (P103706) Doktor Falsafah
P3	10.20-10.45 pagi	Chong Hwei Teeng (P109634) Doktor Falsafah
<b>SESI 2</b> <b>10.45-12.10 t/hari</b>		<b>Moderator : Dr. Minhaz Farid Ahmed</b> <b>Penilai : 1. Prof. Dr. Muhammad Rizal Razman</b> <b>2. Prof. Madya ChM. Dr Goh Choo Ta</b> <b>3. Dr. Mir Sujaul Islam</b>
P4	10.55-11.20 t/hari	Wang Rui (P102374) Doktor Falsafah
P5	11.20-11.45 t/hari	Zhong Zhaodong (P118022) Doktor Falsafah
P6	11.45-12.10 t/hari	Dayang Nor Izan Abang Halil (P114227) Doktor Falsafah
12.10-12.40 t/hari		<b>Ucuptama</b> <b>Prof. Emeritus ChM. Dato' Dr. Mazlin bin Mokhtar</b>
12.40-2.00 petang		<b>Sambutan dan Jamuan Ulangtahun LESTARI ke 29 Tahun</b>
<b>SESI 3</b> <b>2.00-3.25 petang</b>		<b>Moderator : Dr. Aida Soraya Shamsuddin</b> <b>Penilai : 1. Prof. Dr. Joy Jacqueline Pereira</b> <b>2. Ts. Dr. Lim Chen Kim</b> <b>3. Gs. Dr. Nurfashareena Muhamad</b>
P7	2.10-2.35 petang	Asma' Jamal (P107390) Doktor Falsafah
P8	2.35-3.00 petang	Suhailah Shamsudin (P115954) Doktor Falsafah
P9	3.00-3.25 petang	Jeremy Jason Chin Chwan Chuong (P118359) Sarjana

<b>SESI 4</b> <b>3.25-4.50 petang</b>		<b>Moderator : Dr. Aida Soraya Shamsuddin</b> <b>Penilai : 1. Prof. Madya Dr. Saiful Arif Abdullah</b> <b>2. Prof. Madya ChM. Dr. Tan Ling Ling</b> <b>3. Dr. Aziemah Zulkifli</b>
P10	3.35-4.00 petang	Ainul Rasyidah Ab Rahim (P106520) Doktor Falsafah
P11	4.00-4.25 petang	Noor Zarina Mohd Nazir (P106519) Doktor Falsafah
P12	4.25-4.50 petang	Siti Khadijah Imam Supaat (P115825) Doktor Falsafah
4.50 petang		Bersurai

## 12 OKTOBER 2023 (KHAMIS)

MASA		PERKARA
8.30-9.00 pagi		Pendaftaran
<b>SESI 5</b> <b>9.00-10.25 pagi</b>		<b>Moderator : Prof. Madya Dr. Sharina Abdul Halim</b> <b>Penilai : 1. Prof. Dr. Ahmad Fariz Mohamed</b> <b>2. Ts. Dr. Murnira Othman</b> <b>3. Gs. Dr. Nuriah Abd Majid</b>
P13	9.10-9.35 pagi	Ellena A/P John (P116173) Sarjana
P14	9.35-10.00 pagi	Nik Azyati Abdul Kadir (P103373) Sarjana
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<b>SESI 6</b> <b>10.25-11.50 pagi</b>		<b>Moderator : Prof. Madya Dr. Sharina Abdul Halim</b> <b>Penilai : 1. Prof. Dr. Sharifah Zarina Syed Zakaria</b> <b>2. Dr. Rospidah Ghazali</b> <b>3. Dr. Nor Diana Mohd Idris</b>
P16	10.35-11.00 pagi	Nadiah Ibrahim (P110052) Doktor Falsafah
P17	11.00-11.25 pagi	Intan Nuramera Yusaini (P115841) Sarjana
P18	11.25-11.50 pagi	Asraf M.M. Zohud (P110470) Doktor Falsafah
<b>11.50-12.50 t/hari</b>		<b>Mesyuarat JK Pelajar</b>
12.50-2.00 petang		Rehat
2.30-2.45 petang		Rumusan - Wakil pelajar LESTARI
2.45-3.00 petang		Rumusan - Pengerusi Kolokium
3.00-3.30 petang		Penyampaian Hadiah/Sijil - peserta terbaik Abstrak Lanjutan Kategori Sarjana - peserta terbaik Abstrak Lanjutan Kategori Doktor Falsafah (PhD) - peserta terbaik Kategori Sarjana - peserta terbaik Kategori Doktor Falsafah (PhD)
3.30-4.00 petang		Ucapan penutup oleh Timbalan Pengarah LESTARI
4.00 petang		Bersurai



# **Abstrak Lanjutan Pembentang**



## PEMBENTUKAN KERANGKA DAYA TAHAN TERHADAP BAHAYA BERKAITAN IKLIM DI WILAYAH PERSEKUTUAN LABUAN

*Nurul Ain Zulhaimi | P114966 | Doktor Falsafah*

Penyelia:

*Prof. Dr. Joy Jacqueline Pereira  
Gs. Dr. Nurfashareena Muhamad*

### 1. PENGENALAN

Perubahan iklim merupakan cabaran global yang telah mencetuskan ketidaktentuan dan mengancam sistem semulajadi dan manusia. Antara cabaran tersebut adalah kekerapan dan intensiti kejadian bahaya berkaitan iklim yang berlaku. Salah satu kawasan yang mudah terancam kesan daripada bahaya berkaitan iklim ialah pulau kerana faktor geografi pulau, saiz, isolasi, dan kebergantungan kepada sumber semula jadi (Rovisham & Doorga 2022). Masyarakat di pulau menghadapi risiko bahaya iklim seperti kenaikan aras air laut, pusuan ribut, hakisan pantai, gelombang haba dan ribut taufan. Setiap kejadian bahaya ini memberi kesan terhadap ekosistem, ekonomi, kesihatan dan sosial. Sejalan dengan itu, sebuah kerangka daya tahan adalah amat diperlukan bagi memastikan kesejahteraan masyarakat dalam menangani kesan bahaya berkaitan iklim.

### 2. PERMASALAHAN KAJIAN DAN SOROTON KAJIAN

Wilayah Persekutuan Labuan (WP Labuan) menghadapi kesan perubahan iklim melalui ancaman kenaikan paras laut, banjir, ribut dan hakisan pantai. Rentetan kejadian bahaya berkaitan iklim ini boleh memberi ancaman kepada sistem sosial, ekonomi dan persekitaran (Currenti et al. 2019; Griggs & Reguero 2021). Kedudukan geografi WP Labuan yang terpencil, kelemahan dan kebergantungan kepada pengangkutan udara dan air merupakan antara cabaran WP Labuan dalam menghadapi bahaya berkaitan iklim. Terdapat inisiatif meningkatkan daya tahan yang dijalankan, namun keberkesanannya masih tidak jelas kerana ketiadaan rangka kerja daya tahan yang komprehensif yang memenuhi keperluan spesifik di pulau. Ini boleh menyumbang kepada kesan sosial dan ekonomi WP Labuan kerana kebergantungan ekonomi Labuan kepada perkhidmatan kewangan dan perbankan serta pelancongan. Justeru, kajian ini cuba membentuk sebuah kerangka daya tahan yang mengambil kira semua aspek penting dalam menghadapi bahaya berkaitan iklim. Dalam pembinaan kerangka daya tahan, penilaian kemudahterancaman perlu dilaksanakan bagi mengenalpasti komuniti dan kawasan yang terancam (Huynh & Stringer 2018) bagi memastikan kecekapan langkah penyelamatan, pencegahan dan perlindungan dapat difokuskan kepada kawasan yang sepatutnya. Proses penilaian kemudahterancaman ini dimulakan dengan mengenalpasti jenis – jenis bahaya berkaitan iklim yang berlaku di sesuatu kawasan. Penilaian kemudahterancaman juga perlu bersifat spesifik dalam konteks lokal kerana perbezaan sosio-ekonomi dan ciri-ciri kesan yang diterima daripada bahaya iklim (Umamaheswari et al. 2021).

Kajian lepas banyak menggambarkan kemudahterancaman pulau terhadap bahaya berkaitan iklim dan kepentingan mengenal pasti tahap kemudahterancaman serta membina daya tahan

yang bersesuaian (Almutairi et al. 2020; Hoque et al. 2019). Penilaian kemudahterancaman merangkumi pelbagai dimensi seperti sosial, ekonomi, persekitaran dan fizikal. Komponen yang terangkum dalam kemudahterancaman adalah keterdedahan, sensitiviti dan kapasiti beradaptasi (Alves et al. 2021; Nguyen et al. 2019). Kapasiti beradaptasi juga merupakan satu komponen di bawah daya tahan selain daripada impak dan bencana. Satu set kriteria – kriteria yang boleh mengukur kemudahterancaman dan daya tahan terhadap bahaya berkaitan iklim perlu dikenal pasti sebelum penilaian dapat dijalankan. Oleh yang demikian, sebuah kerangka daya tahan yang memenuhi semua kriteria dapat digunakan untuk pihak berkepentingan bagi mengesan langkah sewajarnya ke arah mencapai masyarakat yang berdaya tahan.

### **3. OBJEKTIF KAJIAN**

Kajian ini mempunyai tiga objektif yang memfokuskan pada pembentukan kerangka daya tahan bencana iklim. Namun yang demikian, bagi pembentangan kolokium, objektif yang dibentangkan adalah objektif pertama iaitu mengenal pasti kriteria bagi kemudahterancaman dan daya tahan terhadap bahaya berkaitan iklim.

### **4. KAEDAH KAJIAN**

Kaedah yang digunakan bagi memenuhi objektif ini adalah analisis kandungan. Dokumen-dokumen yang dipilih secara pensampelan bertujuan merangkumi dasar, polisi, garis panduan berkaitan pembangunan, pemajuan, alam sekitar dan perubahan iklim WP Labuan. Dengan menggunakan ATLAS.ti, analisis kandungan digunakan dimulakan dengan menetapkan objektif, mengumpulkan dokumen berkaitan, membentuk kod, memahami dokumen bagi mengekstrakkan kriteria, pengkodan data (Bengtsson 2016; Hsieh & Shannon 2005) serta mengkategorikan kod-kod yang mengandungi kriteria kemudahterancaman, daya tahan serta mengenalpasti jenis dan kejadian bahaya berkaitan iklim di WP Labuan.

### **5. KEPUTUSAN DAN PERBINCANGAN**

Bahaya berkaitan iklim yang dikenalpasti di WP Labuan melalui analisis kandungan, terdiri daripada banjir kilat, hakisan pantai, ribut petir dan kenaikan paras air laut. Untuk kemudahterancaman, tiga komponen yang utama adalah keterdedahan, sensitiviti dan kapasiti beradaptasi. Bagi komponen keterdedahan, kriteria yang dikenalpasti jenis bahaya, lokasi geografi dan topografi, frekuensi dan intensiti bahaya. Kriteria bagi komponen sensitiviti pula adalah demografi populasi dan kebergantungan ekonomi kepada sumber asli pulau. Seterusnya, kapasiti beradaptasi merangkumi kriteria akses kepada utiliti asas seperti air, tenaga, sisa kumbahan dan pengurusan sisa pepejal. Selain itu, kriteria lain adalah jaringan pengangkutan, perumahan dan jenis guna tanah, akses kepada maklumat bahaya, pendidikan dan kesedaran, status kesihatan, pemilikan kediaman, pemilikan aset fizikal dan kepelbagaian sumber pendapatan. Bagi aspek daya tahan, kriteria bagi komponen impak adalah jenis dan intensiti impak yang diambil kira selepas komponen bencana dikenalpasti. Seterusnya, kriteria bagi kapasiti beradaptasi ialah keperluan asas, perumahan dan jenis guna tanah, status kesihatan dan pendidikan, penyertaan dalam komuniti serta kepelbagaian sumber pendapatan. Kriteria-kriteria ini adalah sama dengan kriteria kapasiti beradaptasi bagi kemudahterancaman. Kriteria lain yang dikenalpasti adalah struktur populasi merangkumi kadar pertumbuhan, penduduk setinggan dan kepadatan. Manakala bagi kriteria tambahan bagi daya tahan adalah infrastruktur dan bangunan, kesedaran dan persediaan komuniti,

sistem amaran awal dan fleksibiliti ekonomi serta rangka kerja tadbir urus dan dasar daripada kerajaan pusat dan tempatan. Kriteria-kriteria bagi kedua-dua kemudahterancaman dan daya tahan ini dapat dikategorikan kepada sosial, fizikal, ekonomi, kesihatan, persekitaran dan urus tadbir.

## 6. KESIMPULAN

Pembentukan kerangka daya tahan yang komprehensif terhadap ancaman bahaya berkaitan iklim di WP Labuan adalah diperlukan bagi memastikan impak yang diterima boleh diminimumkan dan penduduk yang terlibat segera pulih serta mempunyai keupayaan untuk bangkit semula. Kriteria-kriteria kemudahterancaman dan daya tahan yang dikenalpasti dapat diaplikasikan dalam proses seterusnya iaitu menilai tahap kemudahterancaman dan pembentukan kerangka daya tahan terhadap bencana iklim.

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# KEPENTINGAN PENILAIAN IMPAK PENGOPERASIAN STESEN PEMANTAUAN KUALITI AIR DALAM USAHA MENANGANI MASALAH GANGGUAN BEKALAN AIR YANG DISEBABKAN OLEH INSIDEN PENCEMARAN AIR SUNGAI DI LEMBANGAN SUNGAI LANGAT, SELANGOR

*Siti Morni Umor | P103706 | Doktor Falsafah*

Penyelia

*Prof. Madya ChM. Dr. Goh Choo Ta*

*Prof. Emeritus Dato' ChM. Dr. Mazlin bin Mokhtar*

## 1. PENGENALAN

Penilaian impak merupakan suatu proses untuk menilai kesan dan akibat sesuatu aktiviti dan program bagi memastikan sumber air yang bersih dan selamat mencukupi. Rangkaian stesen pemantauan kualiti air yang telah beroperasi harus disemak dan dikaji semula secara berkala selepas jangka masa tertentu untuk menilai pencapaian objektif (Lee et al. 2013; Ouyang 2005; YILMAZ & Özçelik 2018). Hasil penilaian akan membantu penambahbaikan pengoperasian, atau membangun semula reka bentuk rangkaian stesen pemantauan yang lebih baik (Mavukkandy et al. 2014) yang merupakan salah satu strategik bagi mendiagnosis kelemahan dan kelebihan untuk perancangan intervensi yang bertepatan untuk memulih sungai tercemar (Bastidas et al. 2017). Kajian ini akan melibatkan penilaian semula ketepatan lokasi stesen persampelan, kesesuaian pemilihan parameter dan kekerapan persampelan (Lee et al. 2013; Ouyang 2005; Yenilmez et al. 2015; YILMAZ & Özçelik 2018).

Peruntukan kos pengurusan air yang terhad merupakan cabaran dalam melaksanakan program pemantauan kualiti air yang berkesan terutama di kawasan lembangan sungai yang luas, oleh itu kajian penilaian impak diperlukan untuk memastikan objektif program yang optimum (Fang et al. 2019; Sabzipour et al. 2019a, 2019b; Yenilmez et al. 2015; YILMAZ & Özçelik 2018). Kekangan sumber kewangan di negara membangun seperti Malaysia menjadi salah satu punca rangkaian stesen pemantauan tidak mencukupi di kawasan tadahan (Camara et al. 2020). Melalui kajian ini dapat memahami dan menentukan prestasi keseluruhan rangkaian stesen pemantauan sedia ada, dan maklumat tersebut boleh digunakan dalam menentukan hala tuju dan perancangan pengurusan sumber air dan insiden pencemaran air sungai di masa depan dengan lebih berkesan (Fang et al. 2019; Sabzipour et al. 2019a; Yenilmez et al. 2015).

## 2. PERMASALAHAN KAJIAN DAN SOROTAN KAJIAN

Isu pencemaran air sungai sehingga mengakibatkan gangguan bekalan air di Malaysia telah berlaku berulang kali dan semakin kerap sejak beberapa tahun kebelakangan terutama di negeri Selangor walaupun terdapat program pemantauan kualiti air sungai yang komprehensif dan menyeluruh (Ahmed et al. 2022). Ini mungkin disebabkan proses pemantauan kualiti air yang kompleks dan terlalu banyak aspek perlu diambil kira untuk pengurusan yang tepat dan berkesan (Moriken & Camara n.d.; Villas-Boas et al. 2017). Oleh itu terdapat keperluan untuk kajian penilaian impak keberkesanan pengoperasian rangkaian

stesen pemantauan kualiti air sedia ada bagi menilai pencapaian objektif dan mengukur fungsi stesen pemantauan sebagai alat pemberi amaran awal sekiranya berlaku sebarang insiden pencemaran air sungai.

### 3. OBJEKTIF KAJIAN

Kajian asal penyelidikan ini mempunyai empat objektif utama yang ditentukan bagi menyediakan salah satu solusi bagi menangani isu gangguan bekalan air akibat pencemaran air sungai. Namun begitu, untuk tujuan pembentangan kolokium kali ini hanya fokus kepada objektif kedua iaitu menilai impak dan keberkesanan pengoperasian rangkaian stesen pemantauan kualiti air sedia ada (manual dan automatik) dari aspek kesesuaian pemilihan lokasi stesen, parameter pengukuran dan kekerapan persampelan.

### 4. KAEDAH KAJIAN

Kajian ini menggunakan data stesen pemantauan kualiti air manual (36 stesen) dan automatik (5 stesen) daripada Jabatan Alam Sekitar (JAS) dan Lembaga Urus Air Selangor (LUAS). Analisis ini turut menggunakan data 12 lokasi Loji Rawatan Air (LRA) dan 47 data kes insiden pencemaran air sungai di Lembangan Sungai Langat yang telah mengakibatkan gangguan bekalan air atau berisiko tinggi mencemar LRA bagi tahun 2016 sehingga 2022. Data kes mahkamah yang telah selesai bicara berkaitan kes pencemaran air sungai juga digunakan sebagai data sokongan untuk menyokong dapatan dan analisis yang dijalankan. Analisis spatial jarak antara stesen-stesen menggunakan *proximity "near" tools* dilakukan untuk mengenal pasti stesen-stesen pemantauan yang mempunyai pertindihan kawasan pemantauan berdasarkan jarak terdekat antara stesen. Analisis *Kernel Density* dilakukan bagi pemetaan kawasan *hotspot* insiden pencemaran, dan kawasan risiko tinggi mencemar berdasarkan aktiviti guna tanah. Analisis *overlay* antara stesen pemantauan manual, peta *hotspot* dan risiko mencemar digunakan untuk kenal pasti stesen yang berada di kawasan kurang kritikal pemantauan. Analisis statistik data kualiti air stesen pemantauan dilakukan untuk melihat perubahan corak data dan kesamaan hasil cerapan. Analisis jarak antara stesen pemantauan automatik dengan LRA juga dilakukan untuk menentukan jarak paling sesuai dan pratikal bagi pemilihan lokasi stesen pemantauan automatik pertama di hulu LRA sebagai perisai terakhir untuk mencegah sebarang pencemaran sampai di LRA, dan selain itu menentukan jarak yang strategik untuk penempatan stesen-stesen automatik sebagai alat untuk memberi amaran awal pengesanan pencemaran air sungai di lapangan agar stesen dapat berfungsi dengan tepat dan berkesan.

### 5. KEPUTUSAN DAN PERBINCANGAN

Hasil analisis spatial jarak antara stesen-stesen pemantauan manual mendapati terdapat 26 stesen mempunyai jarak kurang daripada 3km, dan 9 stesen mempunyai jarak antara stesen dalam lingkungan 3km hingga 10km. Kajian ini mengklasifikasikan stesen yang mempunyai jarak antara stesen kurang daripada 3km sebagai stesen yang mempunyai pertindihan kawasan pemantauan kerana pada jarak berkenaan menghasilkan pengumpulan data yang serupa dan tidak memberi informasi tambahan yang signifikan. Ini bermakna terdapat 12 stesen yang diklasifikasikan berada di kawasan bertindih pemantauan dan perlu semakan semula ketepatan pemilihan lokasi untuk penggunaan sumber yang optimum. Analisis stesen diluar kawasan *hotspot* mendapati terdapat 13 stesen (36.11%) berada di luar kawasan *hotspot* insiden pencemaran. Manakala 17 (47.22%) daripada 36 stesen pemantauan berada



di luar kawasan mencemar berdasarkan aktiviti guna tanah. Daripada analisis ini juga didapati terdapat sebanyak 7 stesen yang dikenalpasti berada di luar kawasan kritikal pemantauan dan perlu semakan semula ketepatan lokasi persampelan. Stesen tersebut adalah 2BCHU001, 2BGLT006, 2BGLT015, 2BGLT026, 2BGLT027, 2BGLT028, dan 2BGLT030.

Analisis spatial jarak antara stesen-stesen pemantauan automatik dengan lokasi LRA juga dilakukan untuk menentukan jarak sesuai penempatan stesen pemantauan automatik pertama di hulu LRA supaya dapat mengesan pencemaran diperingkat awal dan tindakan kawalan dan rawatan pencemaran dapat dilakukan segera sebelum sampai di LRA. Hasil kajian mendapati jarak yang paling ideal antara 10km hingga 11km. Ia berdasarkan pada analisis kajian kes insiden pencemaran air sungai sebenar yang telah dapat dikesan oleh stesen pemantauan automatik, namun masih berlaku gangguan bekalan air pada masa tersebut.

## 6. KESIMPULAN

Hasil kajian membuktikan analisis impak penting dan telah berjaya mengesan beberapa stesen yang perlu dikaji semula ketepatan lokasi penempatan stesen untuk pengurusan kualiti air yang lebih berkesan. Penilaian impak wajar dilakukan secara berkala untuk tempoh tertentu bagi memastikan kebolehpercayaan data cerapan sentiasa terjamin dan relevan. Berdasarkan hasil analisis, kajian ini mencadangkan untuk pembangunan satu rangka kerja dan panduan kaedah penilaian impak dan keberkesanan stesen pemantauan dalam skop penentuan lokasi, kekerapan masa cerapan, dan parameter pengukuran kualiti air. Ini penting untuk meningkatkan keberkesanan fungsi rangkaian stesen pemantauan.

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## MOBILE VIRTUAL REALITY USABILITY MODEL FOR CULTURE HERITAGE SUSTANABILITY DEVELOPMENT

*Chong Hwei Teeng | P109634 | Doctor of Philosophy*

Supervisors:

*Ts. Dr. Lim Chen Kim*

*Prof. Emeritus Dato' ChM. Dr. Mazlin Mokhtar*

*Dr. Lam Meng Chun*

### 1. INTRODUCTION

Culture Heritage (CH) sites plays a crucial role to act as a reference towards culture identity of the communities. It is important to pay attention and protect CH as it holds societies values that sustain the humanity (Suaib et al., 2020). This research focused to preserve the Malaysia United Nations Educational, Scientific and Cultural Organization (UNESCO) based at Langkawi in the state of Kedah, namely the Kubang Badak biogeotrail, charcoal kilns that located at Siam Village Remnant. There are studies that highlights the local efforts towards sustainable activities, however due to the ecological factors, the context of physical charcoal kilns will remain transforming (Lim et al., 2023). Therefore, this research study focuses to analyze the context of CH sites and develop a mobile Virtual Reality (VR) application to preserve the CH site for the community's accessibility towards sustainable development practice.

### 2. PROBLEM STATEMENT

Since Langkawi was recognized as the UNESCO, there have been many efforts towards sustainable development. However, deterioration or destruction of CH sites overtime and restriction within the area of visit among visitors results lower accessibility and public awareness (Bec et al., 2021). In addition, public awareness towards CH values learning declines among the local communities (Azman et al., 2011; Ibrahim et al., 2021). Besides that, with rapid technology internet advancement, getting information through digital devices is the new trend (Ebert & Duarte, 2018). Technology application in CH context can impact users' perception and attitude towards sustainability activities. Focusing on reality technology system, lack of mobile VR system is implemented in the context of CH due to the variety types of technology that causes unfamiliarity, complexity and high resources needed (Carter et al., 2018; Checa et al., 2017; Gek Siang et al., 2020). The issues are explained in the scope of application system design and development output that may affect the level of positivity in user experience (UX) towards conservation development of the CH sites.

### 3. OBJECTIVES

This study has two main objectives that aimed to deploy a mobile VR application which delivers high positive UX and ability to widen the accessibility opportunity among the communities and societies which contributes towards sustainable development. The objectives are:

Objective 1: To investigate the existing research and developments in the area of mobile VR for CH in practice to identify the concepts for development output.

Objective 2: To design and develop a high UX mobile VR application for CH sustainable development practice.

### 4. METHOD



4.1 The investigation phase involved a systematic review based of (Kitchenham, 2004) procedure in reviewing journal articles to identify the challenges and gaps. Then, reviewing and testing the creation of VR CH application from reviewed development articles. Spontaneous search through the internet with the keyword “Virtual Reality Culture Heritage Application” to check other applications that are not listed in the articles to further identify and propose a framework. Framework is then drawn into a wireframe for development phase.

4.2 In design and development phase, the historical context in the application is drawn from written reference (Komoo et al., 2019; Lim et al., 2023) and visiting the charcoal kiln site to capture the existing environment. The design phase in will also draw out the hardware and software application together with the illustration of application flow before the development on site and postproduction takes place.

#### 4.2.1 Hardware List

Visuals are captured with Insta360 Pro 2 camera setup with tripod stand and ambient audio is recorded with Zoom H5 audio recorder. In addition to drone shot is captured with DJI (Mavic Air 2).

#### 4.2.2 Software List

Before the editing phase, Insta360 stitcher is required to stich the recorded footage. Then, Adobe Premier Pro and Photoshop is utilized to clean up the video and photo images before compiling for interaction output using 3DVista Virtual Tour Pro software.

The development output should meet the usability requirements for users to access and experience. Good user experience can impact the level of awareness and knowledge learning towards CH context which contributes towards sustainability development activities.

## 5. RESULTS

Throughout the investigation, latest findings from Lim et. al. (2023) highlighted the lack of knowledge and awareness on the CH site among the local communities and the younger generations. Besides that, on the technology aspect, most of the challenges and gaps mainly highlighted usability issues that causes bad user experience. Usability issues such as unfamiliarity and complexity usage of technology application which led to learning diversion that focused on technology rather than the CH context. This can lead to lower accessibility that can impact the level of awareness and sustainability development influences towards users' CH site.

Based on all the finding, mobile VR application is concepted, designed and developed into an online web-based application that can be viewed through any digital devices connected to internet. With the development of mobile VR application in 4.2, users can easily access to the CH site with their own smartphone, tablet or computer with internet connection. A guide through interface is designed to teach and ease users' navigation and information on the CH site is presented. This is to solve the complexity of usage, comforness and affordance. Users can now experience a 360-degree walkthrough of the CH charcoal kiln site in this website (<http://wowystudio.com/360-ck/index.html>). In addition, the focus of this application is to widen the accessibility and to extend public awareness to learn about the CH context that can contribute towards sustainable development goal 11.4 "strengthen efforts to protect and safeguard the world's cultural and natural heritage'.

## 6. DISCUSSION

The local communities and societies can now interactively access the CH charcoal kiln site virtually anytime and anywhere to learn and appreciate on the CH values of the site. The development of 360-degree walkthrough of CH charcoal kiln site contributed towards digital preservation to overcome deterioration of physical structure and remote learning to empower local communities culture values for culture exchange. The use of this technology also plays a role to further engage and motivate users to participate in the learnings. Current limitation would be limited internet access in the rural areas for users and possibly users' gadgets are outdated that does not allow them to view or open the application. Future work will involve testing and data collection from users. This is to study on the perspective of using mobile VR CH application towards CH learning and how would it impact the CH values towards sustainable development goal of 11.4.

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## SUSTAINABILITY GOVERNANCE FRAMEWORK FOR MALAYSIA-CHINA PALM OIL SUPPLY CHAIN UNDER THE GREEN BELT AND ROAD INITIATIVE

*Wang Rui | P102374 | Doctor of Philosophy*

Supervisors:

*Prof. Ts. Dr. Lee Khai Ern*

*Prof. Emeritus Dato' ChM. Dr. Mazlin Bin Mokhtar*

*Ts. Ir. Dr. Goh Thian Lai*

### 1. INTRODUCTION

Malaysia is the second-largest producer and exporter of palm oil in the global market (MPOC, 2020), while China is the second-largest importer of palm oil globally (Segi Enam, 2020). The role or significance of both countries in the context of sustainability governance for palm oil supply chain is unquestionable (World Wildlife Fund, 2022). Relative to Malaysia's active role in sustainable palm oil, the players and other stakeholders on the China's side are of low-key, not for the prominent performance but for the opposite side (Schleifer & Sun, 2018). This situation could be mitigated in the context of the Green Belt and Road Initiative (BRI). BRI which is an essential diplomatic strategy of China (Szcudlik-Tatar, 2015; Aoyama, 2016), from 2017 onwards, has imparted green development as one of the main themes of its activities (Enfors et al., 2008; Plieninger et al., 2013; Oteros-Rozas et al., 2015). Hence, the main focus on this research is to discuss the framework for sustainability governance of palm oil activities between Malaysia and China by placing them in the context of BRI.

### 2. PROBLEM STATEMENT

Palm oil presents an ongoing series of social and environmental disputes, such as deforestation, biodiversity destruction and human rights issues, which have contributed to the plight of the palm oil industry (Ivancic & Koh, 2016; Putri et al., 2022). With increasing global demand driven by prominent consumer goods manufacturers, palm oil has become a targeted commodity for consumers and civil society (Tan et al., 2009). The environmental sustainability of the Malaysian palm oil industry has been the subject of intense debate (Islam et al., 2009).

Barthel et al. (2018) listed a range of challenges to palm oil sustainability, which include the inadequate participation of major consuming countries (e.g. India and China). Kadarusman & Pramudya (2019) argued that stakeholders in China are less interested in environmental sustainability issues, especially when it comes to purchasing palm oil. Apart from the consumption habits of consumers here (who are more concerned about quality and price), palm oil is also related to food security and numerous industrial products, which makes the footprint of the institution or policy prudent. The absence of both external pressure and internal motivation, the desire of Chinese companies to buy sustainable palm oil fail to be aroused. Given that the invisible hand (the market) and the visible hand (the government) work together in China, the role of the government needs to be brought in when the role of the market is not significant. The exploratory objective of this article is to determine how the



power of institutions can be used to achieve the sustainability governance framework for Malaysia-China palm oil supply chain.

### **3. OBJECTIVE**

Based on the research questions, three research objectives are identified:

- i. To identify the issues and challenges in implementing sustainable palm oil within the Malaysia-China supply chain.
- ii. To analyse rules, roles and organisations taking place for palm oil sustainability governance within the Malaysia-China supply chain.
- iii. To formulate a sustainability governance framework for the Malaysia-China palm oil supply chain under the Green BRI.

### **4. METHOD**

For the purpose of this colloquium, this paper presents the method adopted in addressing Objective 1 which is to collate literature in the public domain and related research literature since 2000. The sources of data include official announcements, NGOs, corporate annual /sustainability reports, mainstream media, etc. Document content analysis was conducted to identify the issues and challenges in implementing sustainable palm oil within the Malaysia-China supply chain by looking into relevant keywords.

### **5. RESULTS AND DISCUSSION**

This paper focuses the discussion on the Chinese end of the palm oil supply chain. The methods described earlier was used in this paper in identifying the issues and challenges to sustainability governance in the Malaysia-China palm oil supply chain. The issues and challenges are manifested in three areas: (i) institutional hollowing; (ii) low level of interdependence between stakeholders and (iii) high path dependency of organisations. The rule, role and organisation in the Malaysia-China palm oil sector were also correlated was the three barriers. The veins of the Chinese palm oil sector are cleared to pave the way for a sustainability governance framework, which is still anchored on trust (in the context of BRI).

### **6. CONCLUSION**

Palm oil has an aura of diversity in Malaysia, with its economic nature is seen as contributing to zero hunger (SDG 2), freedom from undignified work and driving economic growth (SDG 8). In the context of sustainable palm oil development, actions affecting climate at production (SDG 13), negative impacts on life on the land (SDG 15) are predictably mitigated by commitments to responsible production (SDG 12) and NGO campaigns. An interaction between palm oil producing and consuming countries is entailed by the SDGs to promote the sustainability of palm oil. By embedding palm oil in the Green BRI, it will also continue to extend to industry, innovation and infrastructure (SDG 9) and to achieving partnerships (SDG 17). This confirms the view of this paper that placing palm oil in a BRI context is more conducive to its sustainability implementation in China.

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## IDENTIFY URBAN SUSTAINABILITY INDICATORS OF URBAN ROAD TRAFFIC NETWORK AND URBAN LAND USE

Zhong Zhaodong | P118022 | Doctor of Philosophy

Supervisors:

Gs. Dr. Nurfashareena Muhamad

Prof. Ts. Dr. Lee Khai Ern

Assoc. Prof. Wang Lei

### 1. INTRODUCTION

Urban sustainability indicators has become an important means and tool to implement the concept of urban sustainability and it has been widely concerned (Ruan & Yan, 2022, Merino-Saum et al., 2020). Many indicators are used to evaluate the sustainability of cities, so as to provide decision-making basis for the sustainable development of cities (Pedro et al., 2019, Pedro et al., 2018). Sustainability indicators are organized in the form of Dimension-Indicator categories-Indicators, and finally the sustainability of cities is evaluated by aggregating these indicators (*BREEAM, 2012., CASBEE-UD, 2014., LEED ND, 2021*). But these results would ignore the links between the indicators, and whether they are coordinated with each other has a great impact on the urban sustainability. Some papers have studied the relationship between the indicators. (Alalouch et al., 2019, Zhang, L et al., 2022). However, these indicators cannot cover three pillars of sustainable development. This paper attempts to identify the indicators of urban road traffic network and land use that cover the three pillars of the urban sustainability, so as to prepare for the next step to study the relationship between them.

### 2. PROBLEM STATEMENT

Improving the long-term well-being of humanity by balancing the three pillars of sustainable development deriving from the definition of sustainability has become a general consensus (UN-Habitat,1996, Habitat,1997, Cmagi, 2017). They are supposed to measure all the three pillars of urban sustainability. Huang et al. (2015) show that there are mainly two urban sustainability indicator systems, indicator set and single composite indices. They all consist of a lot of indicators, but not all of them can cover the three pillars of urban sustainable development. Some of them cover two or one of the pillars. According to the criteria or thresholds, each indicator will receive a score, and their weights are assigned, finally they are aggregated. Then, the urban sustainability can be evaluated (*BREEAM, 2012., LEED ND, 2021*). Such aggregated evaluation results ignore the relationship between indicators(Ali-Toudert et al., 2020). And They cannot evaluate the necessary detail in practice and cannot linked to the causes of unsustainability (Pissourios, 2013). Moreover, Lack of scientifically determined thresholds has been pointed out by many authors(Shen & Zhou, 2014., Shen & Zhou, 2014).So far, it has been difficult to develop an indicators system that can be applied to all cities worldwide (Shen & Guo, 2014).

Urban road traffic and land use are important components of any city. It is of great significance to identify the indicators of them that can cover the three pillars of sustainable development and analyze the relationship between them.

### **3. OBJECTIVE**

To identify indicators of urban road traffic networks and land use which can cover the three pillars of the urban sustainability

### **4. METHOD**

47 papers are retrieved from the WOS database from 1 January 2018 to 31 December 2022. The search term is "Sustainable urban development" OR "Urban sustainability") AND (indicator\* OR indicator set OR index\* OR indices)". The search scope is limited to the title, abstract, and keywords of the paper. Then, 17 papers with clear results on urban sustainability indicators were identified. The references of these papers were downloaded. Title and the authors of these references, the journals in which the references were located, and as well as the top 25 publications, the top 10 authors, and the top 25 journals listed by Sharifi, A. (2020) were entered into a Microsoft Excel file and compared using the "conditional formatting" - "duplicate values" function so that the number of influential authors, publications, and journals included in these references could be obtained.

For the results of the urban sustainability indicator in the 17 papers, a "text search" was conducted in NVIVO Software using the search term "transport or traffic or road or street" and "Land ". Then, Indicators related to urban traffic and urban land use will be got. These indicators are placed in environmental, social, and economic codes according to the dimension of sustainability they belong to. In the same way, "per or ratio or density" and "network or mileage or length or time or density Kilometres or Accessibility" was conducted. Indicators related to urban transport networks and land use intensity can be obtained, as well as the number of sustainability pillars to which these indicators belong.

### **5. RESULTS AND DISCUSSION**

The data sources used in this analysis are highly representative. The references of 17 papers with explicit findings of urban sustainability indicators were downloaded. The journals in which these references are located cover 20 of the top 25 for impact. The authors of the references covered 14 of the top 25 influential authors. The references cover three of the top 10 influential papers.

Urban traffic and land use cover the three pillars of sustainability. The number of papers vesting urban traffic-related indicators in environmental, social and economic pillars was 10, 9 and 4, respectively. the number of papers vesting urban land use related indicators in environmental, social and economic pillars were 7, 4 and 1 respectively. Urban road traffic network and land use intensity cover the three pillars of sustainability. As Table 1 shows, the number of papers vesting indicators related to urban road traffic network in the environmental, social, and economic pillars was 4, 5 and 1. The number of papers vesting indicators related to urban land-use intensity in the environmental, social, and economic pillars was 4, 3 and 1.

Urban traffic and land use are related, as some indicators are related to both of them. For example, Land area consumed by transit facilities, Per capital area of paved roads and so on. The urban transportation network indicator Closeness and the land use intensity indicator Building density covering the three pillars of sustainable development and are rarely used in existing urban sustainability indicators.

Table 1: Number of papers in which indicators related to urban traffic, land use, urban road traffic network, urban land-use intensity are vested in the environmental, social and economic pillars

Urban sustainability pillars	Indicators related to urban traffic	Indicators related to urban land use	Indicators related to urban traffic network	Indicators to urban land use intensity
Environment	10	7	4	4
Society	9	4	3	5
Economy	3(4)	1	1	1

## 6. CONCLUSION

According to the result of analysis, the indicators of Closeness and building density which cover the three pillars of the urban sustainability were identified to evaluate the urban sustainability by studying the relationship between them.

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## CLIMATE HAZARD-HUMAN MOBILITY NEXUS

*Dayang Nor Izan Abang Halil | P114227 | Doctor of Philosophy*

Supervisors:

*Prof. Dr. Joy Jacqueline Pereira  
Prof. Madya Dr. Sharina Abdul Halim  
Dr. Lisa Schipper*

### 1. INTRODUCTION

Climate change and its associated incremental levels of extreme climate hazards, such as heatwaves, floods, cyclones, and sea-level rise, threaten humankind and ecosystems (Intergovernmental Panel on Climate Change (IPCC) 2021). This contributes to humanitarian crises, including large-scale human mobility (Spilker et al. 2020). In the context of climate change, human mobility encompasses displacement, migration, and planned relocation (Barnett & McMichael 2018). In 2021, the International Organization for Migration (IOM) (2022) recorded 23.7 million internal displacements triggered by disasters. Meanwhile, about 216 million people from vulnerable regions are expected to be at risk of forced migration by 2050 (Viviane et al. 2021). Although displacement is often forced, people also relocate or migrate voluntarily to avoid future risks (Black et al. 2011; Zander & Garnett 2020). Little is known concerning the fate of the people who have moved to a new destination (Helbling 2020; Henning et al. 2022; Zander et al. 2022). Therefore, this research intent to investigate the acceptance of communities in developing country towards human mobility as a response to climate hazards. For this purpose, a case study will be conducted in Selangor, Malaysia.

### 2. PROBLEM STATEMENT AND LITERATURE REVIEW

Asia is experiencing and projected to face incremental temperature rise that will escalate the scale of extreme weather events (IPCC 2022). This will contribute to the increase of future climate-induced human mobility, subsequently altering migration patterns and intensifying migration flows (Hauer et al. 2020). Malaysia is identified as one of the main destinations for migrants from Southeast Asia and South Asia, as well as from the Middle East and African countries due to its strategic location, developed economy, and workforce needs (IOM 2023). Although Malaysia is not a signatory to the United Nations Convention Relating to the Status of Refugees, it continues to provide humanitarian assistance to asylum seekers and refugees that resides in the country (ibid.). A large influx of migrants into destination cities or countries may lead to significant economic, social, political, and environmental challenges, among others (Spilker et al. 2020). Hence, receiving communities may have differing perceptions and acceptance towards migrants (Bye et al. 2023; Helbling 2020; Henning et al. 2022). However, there are limited research pertaining to the fate of migrants in their new destination and the acceptance of receiving communities, especially in developing countries (ibid.). Therefore, it is relevant to investigate the acceptance of urban and rural communities in Malaysia towards internal and international climate-induced human mobility as a response to climate hazards.

### **3. OBJECTIVE**

This research comprises three objectives, that is to identify the effects of climate hazards and influence on human mobility; investigate the acceptance of communities on internal and international human mobility as a response to climate hazards; and recommend approaches to address internal and international climate-induced human mobility. However, this paper will be focusing on the first objective.

### **4. METHOD**

Document analysis method was applied to identify the effects of climate hazards and influence on human mobility (Bowen 2009; Morgan 2022). Data was collected from documents published by international and regional organisations as well as national government agencies, such as the IPCC, IOM, World Bank, Asian Development Bank, Association of Southeast Asian Nations, Department of Statistics Malaysia, and National Disaster Management Agency (NADMA). 25 sets of documents were analysed and chosen through purposive sampling technique based on the specific nature of the objective of the study (Polkinghorne 2005).

### **5. RESULT AND DISCUSSION**

The findings show that East, South and Southeast Asia are experiencing similar types of climate hazards but varies in terms of intensity and frequency. Likewise, the impacts of climate hazards on the countries in the regions differs regarding severity, influenced by several factors, including magnitude and complexity of hazards, level of socioeconomic development, population distribution, poverty, and governance (Wouter Botzen et al. 2019). The findings also show that climate change, through extreme climate hazards induces human mobility, which is expected to last and grow over time, leading to increased displacement and migration (IPCC 2022; Viviane et al. 2021). In 2019, cyclones, floods and typhoons caused internal displacement of 9.6 million people in East and Southeast Asia, which is about 30% of global displacements (IPCC 2022). Meanwhile, Malaysia recorded 208,643 displacements in 2021, and 199,244 displacements in 2022, due to floodings (NADMA 2022). Displacement risk is projected to increase in South Asia by 3.7 % and South-East Asia by 2.4 % (IOM 2022). Displacement is mostly due to impacts of sudden-onset hazards and is generally temporary. Extreme impacts of sudden-onset hazards or slow-onset hazards may induce migration that can be temporary, seasonal, or permanent. Meanwhile, slow-onset hazards, such as sea-level rise that causes permanent losses of land area and coastal settlements, will trigger permanent migration or planned relocation, either within country or to another country (Koubi et al. 2022; Zander & Garnett 2020). Oftentimes, human mobility is not the outcome of a single factor, but of complex interactions of multiple, interdependent, and interacting factors that facilitate, enable, constrain, or trigger migration processes in complex ways (Black et al 2011; IOM 2023; UNHCR 2014). These factors include economic, security, climate change, political, demographic, sociocultural and individual, which is grouped into three categories namely, macro-, meso- and micro-level factors (ibid.).

## 6. CONCLUSION

In conclusion, East, South and Southeast Asia are adversely impacted by climatic changes and extreme climate hazards. The severe impacts of climate hazards are inducing human mobility and are expected to alter migration patterns and flows. As Malaysia is one of the main destinations in Southeast Asia for migrants and refugees, the country may be affected by this future scenario whereby an influx of migrants come into the country and may bring about implications to the nation and its people. Thus, it is critical to know the acceptance of receiving communities towards human mobility as a response to climate hazards.

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## ECOSYSTEM SERVICES AND DISSERVICES OF MANGROVE FORESTS IN KUALA SELANGOR: EXPLORATION TOWARDS ACHIEVING UNITED NATION AGENDA 2030 FOR SUSTAINABLE DEVELOPMENT

*Asma' Jamal | P107390 | Doctor of Philosophy*

Supervisors:

*Assoc. Prof. Dr. Sharina Abdul Halim*

*Prof. Daniel A. Friess*

### 1. INTRODUCTION

Research on Ecosystem Services (ES) – the goods and benefits that nature provide to people- has proliferated since the Millennium Assessment (MEA) in 2005 and become a strong tool in conservation efforts. On the other hand, ecosystem disservice (EDS) is a fairly new academic concept that reflects potential negative social ecological interactions that can strongly shape people's perception of nature, hence influencing the conservation agenda. Mangrove forests is a social ecological-system widely attested for its ecological, economic and cultural importance by many stakeholders (Broszeit et al. 2022; Dahdouh-Guebas et al. 2021). Nevertheless, perceived and actual ecosystem disservices have historically been common for mangroves (Friess 2016; Friess et al. 2020), which may have contributed to them being threatened by various anthropogenic threats and fall under short term profit decision makings (Aldrie 2021). Despite the established mangrove ecosystem services (MES), mangrove ecosystem disservices (MEDS) at the community level is not yet well understood compared to other disservices of other ecosystems such as the urban, forestry and agriculture (Agbenyega et al. 2009; Guo et al. 2022; Lyytimäki & Sipila 2009; Zhang et al. 2007). Identifying and addressing MEDS potentially enhance community's well-being by improving the understanding and mitigating the ecological functions and social ecological interactions at the local level (Guo et al. 2022). Mitigating aspects of MEDS may indirectly improve the aspects of MES (Knight et al. 2017) as well as promote cost-effective management (Shackleton et al. 2016). Understanding both paradigms from the perspective of the mangrove community may create a new worldview of mangrove to the stakeholders, particularly the managements, decision makers, and investors, hence boosting conservation agenda. Current knowledge gap between the two dimensions impedes effective management and full understanding of the mangrove social ecological system dynamics. A full assessment of mangrove ecosystem services (MES) and disservices under a common assessment framework will allow a better understanding of the balance and synergies between services and disservices, providing more balanced information for management.

### 2. PROBLEM STATEMENT AND LITERATURE REVIEW

Kuala Selangor is a coastal district in one of the fast developing states in Selangor, Malaysia, that presently facing enormous threats especially from urban development (Aldrie 2022; Chan & Aida 2022). Study by Zainora Asmawi et al., (2021) indicated Kuala Selangor is rich with historic and cultural heritage, as well as visually captivating. Approximately 226 762 hectare of environmentally sensitive area in Kuala Selangor was identified in year 2021 and is depleting by



the year (Zainora Asmawi et al. 2021). Mangroves in Kuala Selangor is one of the sensitive areas that meets the criteria listed under the Ramsar Convention for wetland of significant importance (Haliza 2005) which imply the significance of its conservation. Degradation of mangrove forests in Kuala Selangor may not only be ecologically detrimental to the adjacent ecosystems, but also risk the sustainability of mangrove goods and services for coastal community's livelihood and general people (Aldrie 2022). The attraction of Kuala Selangor mangroves as a tourist site and source of livelihood demonstrated the interaction and interdependence between community and mangroves as a social ecological system. Unfortunately, mangroves are closely associated with perceived and actual threats to the well-being of the public and its surrounding community - known as ecosystem disservice. Such historical notion may jeopardize conservation efforts through induced misconceptions and misperceptions (Campagne et al. 2018; Friess 2016; Friess et al. 2020) created from third parties' perspectives unless it is addressed and fully understood from the perspective of the locals as mangrove dependent communities. Empirical study on MEDS is lacking in Malaysia and not well understood compared to the well-established MES to environment and mankind. The push to recognize the benefits of ecosystem in mangrove management has not seen a concomitant focus on EDS, despite their support in public support and ecosystem use. There is a need to recognize MEDS, which are strongly perceived by many, yet understudied, and integrate it with MES under one common framework of comprehensive trade-off and synergy assessment. Identifying both MES and MEDS allows identifying trade-offs and help decision makers make sound judgements for mangrove management.

### **3. OBJECTIVE**

The study has four objectives which are, (i) to identify the MES and MEDS in different settings of mangrove forest in Kuala Selangor; (ii) to validate and understand the societal perception on mangrove and its services and disservices in Kuala Selangor; (iii) to assess drivers influencing mangrove services and disservices in connection with social well-being; and (iv) to investigate the connectivity and interrelation of MES with Sustainable Development Goals (SDG). Only objectives (i) and (ii) of the study will be presented and discussed in the upcoming colloquium.

### **4. METHOD**

A Rapid Rural Appraisal consisting of a mixed methodological framework (Nyangoko et al. 2022) was conducted at six villages in the district of Kuala Selangor, Selangor. The method encompasses a structured, but flexible approach to communicate and interact with the rural community with the aid of a questionnaire as a tool (Philip 1996). To meet the first objective, a data triangulation approach (Guion 2002) encompassing direct observations, key informant interviews (n=19), focus group discussions (n=12), and household surveys (n=62) was performed with mangrove communities who interact with mangrove on a daily basis. For the second objective, a public survey (n=156) was conducted by means of random sampling at the Firefly Sanctuary, Kampung Kuantan, Kuala Selangor Nature Park (KSNP) and the vicinity of the Melawati Town of Kuala Selangor to obtain a wider scope of society sample (local, visitor, and public). The questionnaire was designed and modified from published surveys (Azharizan et al. 2017; Mazni Adibah & M. Zainora 2016; Nyangoko et al. 2021). They were verified by social experts in the field, tested among targeted group of study, and underwent improvements thrice before final administration. The questionnaire comprises of five sections which entail (a) socio-



demography; (b) societal perception towards mangrove; (c) societal knowledge on mangrove; (d) societal attitude towards mangrove; and (e) societal perception on how mangrove can contribute to human lives and well-being. Qualitative data were analysed using content analysis while quantitative data were analysed descriptively using the Statistical Package for Social Science (SPSS) version 27.

## 5. RESULTS AND DISCUSSION

Seventeen MES and their importance were recognized in Kuala Selangor. Provisioning services (fish and seafood catchments) were perceived to dominate the mangrove fringe area as MES domination converts to cultural services (recreation and tourism) at the riverine environment. Different provisioning services also become apparent with different species found in different environmental settings (function of mangrove trees as fishing poles as oppose to nipah for nipah roof and *otak-otak* wraps). Ecological settings and distance from the coast determines socio-economic and cultural activities and how MES are manifested, in alignment with the study by Nyangoko et al. (2021). Mangrove forests are prominent to support coastal protection since the catastrophic tsunami in 2004 (Dahdouh-Guebas et al. 2005), which suggests why supporting services showed to be the most perceived important service for all local (n=62), visitor (n=36), and public (n=21) respondents. As for MEDS, eight form of EDS were identified based on literatures and validated by the respondents. In general, locals have lower perceived disservices of mangrove compared to visitors and the public. However, they unanimously agree on perceived disservices of safety and health. While the general respondents may be influenced by perceived fear of the unknown, the locals experience mental distress from monkey disturbance and actual illness due to snake bite. On the contrary, monkeys were considered as an attraction to the visitors in Kuala Selangor. This come to show that MEDS affect oneself at different magnitude and may be a disservice to one, but a service to another. These findings imply that one same instance can be perceived as two distinct ecosystem paradigms by differing group of stakeholders which may be influenced by various determinants, supporting the extensive discussion by Shackleton et al. (2016).

## 6. CONCLUSION

Discovering MES and MEDS empirically improves and strengthens understanding of the dynamics, functional and processes of the interaction between the mangrove ecosystem paradigms and the social system in a social ecological system. By recognizing MEDS, we realize that MEDS may be distinct from, but complement to MES. In terms of implication, MEDS and MES impact differently across group of stakeholders and may differ spatial-temporally. Such phenomenon shows the more important it is to include both dimension in an integrated framework that can enhance management plans through scientific and empirical evidence and provide comprehensive understandings of synergies and trade-offs. A full assessment of both paradigms is expected to offer a trade-off analysis of balance and synergies for management enhancement, social well-being and ecosystem sustainability.

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## PERILAKU ALAM SEKITAR PERAMAL KEPADA KEINGINAN UNTUK MENYERTAI INISIATIF PEMBERSIHAN SUNGAI

*Suhailah Shamsudin | P115954 | Doktor Falsafah*

Penyelia:

*Dr. Ahmad Aldrie Amir*

*Dr. Norshamshida Razak*

*Prof. Madya Dr. Noorasiah Sulaiman*

### 1. PENGENALAN

Sungai Klang yang dikenali sebagai salah satu sungai paling tercemar di dunia dan menjadi penyumbang sampah plastik yang tidak terurus ke laut berpunca antara lainnya daripada kelakuan manusia yang tidak bertanggungjawab serta kesedaran awam yang masih di tahap minima. Namun begitu, peranan manusia merupakan tunjang dalam inisiatif pembersihan sungai sama ada melalui pendekatan kaedah berstruktur mahupun bukan berstruktur.

### 2. PERMASALAHAN KAJIAN DAN SOROTON KAJIAN

Pembuangan sisa plastik yang tidak terurus telah menjadi isu yang sangat membimbangkan kerana ianya menyumbang kepada pencemaran sungai dan laut (Arcadis Nederland B.V. 2021; Azizah et al. 2020). Data menunjukkan bahawa Malaysia kini menduduki tempat ketiga di antara 10 negara paling tercemar dengan pelepasan plastik sebanyak 0.073 juta tan metrik setahun ke dalam sungai dan lautan (Meijer et al. 2021). Pencemaran sisa plastik tidak terurus menjadi masalah serius di Malaysia terutamanya di bandar-bandar utama seperti Kuala Lumpur, Selangor dan Johor Bahru kerana bandar-bandar ini mempunyai kepadatan penduduk yang terletak berhampiran dengan sungai-sungai utama di Malaysia.

Landasan Lumayan Sdn Bhd (LLSB) sebuah anak syarikat milik kerajaan Negeri Selangor telah dimandatkan untuk menjalankan inisiatif pembersihan, pemulihan, pembangunan dan jaringan kesalinghubungan di sepanjang jajaran 56km Sungai Klang di bawah Projek Selangor Maritime Gateway (SMG). Usaha-usaha LLSB merangkumi pelbagai kaedah pembersihan termasuklah pendekatan berstruktur mahupun bukan berstruktur yang melibatkan masyarakat. Walaupun begitu, masalah pencemaran masih berterusan, terutamanya di bahagian hilir Sungai Klang kerana peningkatan populasi, corak penggunaan dan kurangnya kesedaran alam sekitar telah memberi kesan yang negatif (Malaysian Plastics Manufacturers Association & Malaysian Plastics Recyclers Association 2019; Noor 2019; Muhammad Saufi et al. 2021; Nunis 2020; Pfordten 2021).

Data daripada GEC (2022) menunjukkan usaha-usaha pembersihan sungai bukan berstruktur masih memerlukan peningkatan dan penglibatan yang lebih meluas. Justeru, usaha pemulihan Sungai Klang ini memerlukan sinergi dan kerjasama yang melibatkan penyelidikan ilmiah, inisiatif masyarakat, dan penglibatan pelbagai agensi serta pertubuhan agar langkah-langkah konkrit dan terkoordinasi dapat diambil untuk mengurangkan pencemaran dan memulihkan kualiti air Sungai Klang. Dengan kesedaran dan tindakan bersama, harapan akan terserlah untuk

menjadikan Sungai Klang kembali sebagai aset yang bersih dan berdaya tahan untuk generasi akan datang.

Menurut sumber-sumber seperti Ghani (2021); Malaysian Plastics Manufacturers Association & Malaysian Plastics Recyclers Association (2019) dan Nunis (2020), kurangnya pemahaman tentang signifikansi penjagaan sungai masih merupakan permasalahan yang memerlukan perhatian. Berdasarkan pandangan Datuk Seri Tuan Ibrahim Tuan Man (2021); Husin et al. (2021) dan Noor (2019), pendekatan pembersihan sungai berstruktur mahupun bukan berstruktur seharusnya diaplikasikan secara bersama untuk menampakkan hasil dan keberkesannya.

Dapatan kajian yang diperoleh dari Husin, Mariyanti, et al. (2021); Husin, Noor, et al. (2021); Noor (2019) menyatakan program perhubungan awam dibawah inisiatif bukan berstruktur mampu meningkatkan keberkesanan pembersihan Sungai Klang. Definisi program perhubungan awam adalah program yang dilaksanakan bagi menarik penglibatan komuniti secara sukarela dalam aktiviti-aktiviti pembersihan sungai.

Dalam konteks kajian ini, keinginan seseorang individu dalam menyertai inisiatif pembersihan sungai adalah dorongan yang terbit dari lahiriah seseorang individu tersebut. Penglibatan manusia di dalam aktiviti permbersihan sungai ini adalah terjadi apabila kegiatan yang dilakukan itu lahir dari perlakuannya yang ingin melihat perubahan positif terhadap alam sekitar. Manusia yang mempunyai tingkah laku pro-alam sekitar lebih cenderung melakukan aktiviti-aktiviti yang boleh memberi perubahan yang lebih baik dan akan melakukan sesuatu perkara yang kurang memberi impak terhadap alam sekitar (Alzaidi & Iyanna 2021; Amoah & Addoah 2021). Kajian mengenai keinginan individu untuk melibatkan diri dalam insiatif pembersihan sungai ini dipilih menjadi pembolehubah bersandar kerana penglibatan manusia memainkan peranan yang paling penting bagi melaksanakan sesuatu inisiatif dan akan memberi impak yang sangat besar dalam menjayakannya (Ahmed et al. 2020; Huber & Arnberger 2021; Kroneman et al. 2018).

Tingkah laku pro-alam sekitar ini giat digunakan di dalam kajian-kajian yang lepas, namun bagi kajian ini ianya telah digunakan dalam konteks berbeza iaitu tingkah laku manusia dalam menyertai inisiatif pembersihan sungai yang mana ianya masih lagi kurang digunapakai. Tingkah laku pro-alam sekitar memainkan peranan dalam menerbitkan keinginan untuk menyertai inisiatif pembersihan sungai kerana seseorang individu yang mempunyai tingkah laku pro-alam sekitar, individu ini lebih cenderung melakukan aktiviti-aktiviti yang boleh memberi perubahan yang lebih baik kepada keadaan sungai sedia ada melalui penglibatan mereka.

Yusliza et al. (2021) mentakrifkan *Green Self-efficacy* sebagai individu yang berupaya serta mempunyai keazaman dalam mengatur dan melaksanakan tindakan yang diperlukan bagi mencapai matlamat alam sekitar. Dalam konteks kajian ini, *Green Self-efficacy* ditakrifkan sebagai individu yang percaya di atas kemampuan dirinya untuk melakukan aktiviti pembersihan sungai secara berkesan. Bagi kajian ini, *Green Self-efficacy* akan digunakan sebagai pembolehubah bebas untuk melihat bagaimana ianya boleh mendorong seseorang individu itu untuk menyertai inisiatif pembersihan sungai. Menurut Yusliza et al. (2021), individu yang mempunyai *Green Self-efficacy* mencerminkan keyakinan terhadap keupayaannya dalam mengawal motivasi, tingkah laku dan persekitaran sosial mereka. Oleh itu, individu ini



mempunyai keberangkalian yang lebih tinggi untuk menjadikan sungai kelihatan lebih bersih dari sebelumnya dengan adanya penglibatan mereka dalam inisiatif pembersihan sungai.

Selain itu, teori yang akan digunakan bagi menjelaskan hubungan tingkah laku pro-alam sekitar dan *Green Self-efficacy* terhadap keinginan untuk menyertai inisiatif pembersihan sungai ialah *Self-Determination Theory* (SDT). Hal ini kerana penggunaan SDT masih lagi kurang digunapakai oleh para penyelidik yang terdahulu bagi menjelaskan pembolehubah tingkah laku pro-alam sekitar dan *Green Self-efficacy* (Yusliza et al. 2020).

### 3. OBJEKTIF KAJIAN

Objektif kajian adalah seperti berikut:

1. Untuk meramal hubungan positif di antara Tingkah Laku Pro-Alam Sekitar dan keinginan untuk menyertai inisiatif pembersihan sungai.
2. Untuk meramal hubungan positif di antara *Green Self-efficacy* dengan keinginan untuk menyertai inisiatif pembersihan sungai.

### 4. KAEDAH KAJIAN

Kajian ini akan menyelidik hubungan di antara peramal-peramal iaitu Tingkah laku Pro-alam Sekitar dan *Green Self-efficacy* terhadap keinginan untuk menyertai inisiatif pembersihan sungai melalui pengujian hipotesis berdasarkan kepada data kuantitatif. Saiz sampel ditentukan berdasarkan formula yang dibangunkan Krejcie dan Morgan (1970) seperti berikut:

$$n = \frac{x^2 NP(1 - P)}{d^2(N - 1) + x^2 P(1 - P)}$$

Nota:  $n$  = saiz sampel yang diperlukan;  $x$  = nilai Z (1.96 untuk 95% tahap keyakinan);  $N$  = saiz populasi;  $P$  = bahagian populasi diandaikan sebanyak 0.5);  $d$  = darjah ketepatan (0.05)

Berdasarkan formula di atas, saiz sampel yang diperlukan untuk kajian ini ialah sebanyak 293 sampel kerana populasi kajian berjumlah 1,220 ahli pengusaha-pengusaha bot kecil di kawasan Klang dan Pelabuhan Klang. Kaedah pengumpulan data adalah melalui soal selidik tadbir sendiri terhadap 350 orang responden yang diambil sebagai sampel daripada golongan pengusaha-pengusaha bot kecil di kalangan ahli Persatuan Bot Rekreasi Selangor (PBRs) dan Persatuan Nelayan Kawasan Pelabuhan Klang (PNKPK) yang menggunakan Sungai Klang sebagai laluan utama mereka untuk ke laut. Prosedur pensampelan yang akan digunakan adalah pensampelan rawak mudah daripada ahli PBRs dan PNKPK. Namun, terdapat pecahan mengikut kawasan tempat tinggal ahli-ahli nelayan ini dibawah tadbir urus PNKPK iaitu antaranya Persatuan Nelayan Kpg. Sg. Delek (PNKSD) dan Persatuan Nelayan Kpg. Sg. Sireh Tambahan 2 (PNKSST2). Penyelidik juga menjalankan kajian rintis untuk menguji strategi pensampelan yang ingin dikaji dengan mengambil 20 orang responden daripada PNKSST2.

Data yang diperoleh daripada dapatan kajian penuh disaring menggunakan SPSS. Seterusnya, data bersih dianalisis dengan menggunakan PLS-SEM untuk meramal sejauh mana Tingkah Laku Pro-alam Sekitar dan *Green Self-efficacy* dapat mempengaruhi keinginan untuk menyertai inisiatif pembersihan sungai. PLS-SEM digunakan kerana penyelidik menggunakan teori asas



yang telah wujud, menggunakan skala-skala yang telahpun diuji kebolehpercayaan dan kesahannya serta objektif kajian yang lebih kepada ramalan (*prediction*). Dalam ujian model struktur, ianya dinilai dengan menganalisis koefisien alur dan nilai-t untuk menentukan signifikan hubungan antara pembolehubah bebas dengan pembolehubah bersandar.

## 5. KEPUTUSAN DAN PERBINCANGAN

Hasil kajian mendapati, Hipotesis 1 adalah diterima. Dengan penggunaan Teori Penentuan Diri (SDT); individu yang mempunyai Tingkah Laku Pro-Alam Sekitar akan bersikap Pro-Alam Sekitar dengan seikhlas hatinya tanpa perlu dipantau oleh sesiapa dan individu ini mampu melakukan tindakan itu dengan sebaiknya kerana individu ini lebih cenderung melakukan aktiviti-aktiviti yang boleh memberi perubahan yang lebih baik kepada keadaan sungai sedia ada melalui penglibatan mereka. Hal ini kerana, golongan pengusaha-pengusaha bot kecil ini mempunyai disiplin diri dan kesedaran yang tinggi dalam diri untuk memelihara kebersihan Sungai Klang kerana ianya merupakan laluan utama mereka untuk ke laut. Sekiranya mereka tidak prihatin akan menyebabkan penambahan kos penyelenggaraan bot yang perlu dipikul dan menjadi bebanan kepada mereka kelak.

Hipotesis 2 juga diterima dengan menggunakan SDT, andaian mengenai individu yang mempunyai *Green Self-efficacy* adalah benar dan jelas menunjukkan individu ini mampu memacu kesedaran dalaman mereka untuk menyempurnakan sesuatu tugas berkaitan dengan alam sekitar dengan kebolehan dirinya sendiri ketika melibatkan diri dalam inisiatif pembersihan sungai.

Hal ini dijelaskan melalui situasi sebenar apabila golongan pengusaha-pengusaha bot kecil ini mampu mewujudkan keinginan untuk menyertai inisiatif pembersihan sungai disebabkan mereka merupakan pengguna utama laluan air (merangkumi sungai dan lautan) yang mana mereka adalah individu yang sangat cekap, berpengalaman dan berpengetahuan luas mengenai profil sungai tersebut. Oleh sebab itulah, mereka lebih bermotivasi untuk mengekalkan keadaan sungai yang bersih bagi kesejahteraan penggunaan bersama.

## 6. KESIMPULAN

Secara keseluruhannya, hasil kajian ini telah menerima hipotesis yang menunjukkan Tingkah Laku Pro-Alam Sekitar dan *Green Trust* mempunyai hubungan yang positif dengan keinginan untuk menyertai inisiatif pembersihan sungai. Justeru, ianya juga telah memberi implikasi baru kepada Teori Penentuan Diri (*Self Determination Theory - SDT*). Selain itu, turut menambahkan lagi bukti empirik kepada bidang pengetahuan (*body of knowledge*) sebagai panduan dan bahan rujukan dalam pengurusan sungai yang lestari amnya dan pembersihan sungai khususnya. Kajian ini juga dapat membantu pengamal yang terlibat di dalam sektor yang berkenaan dengan pengurusan sampah terapung di sungai supaya dapat melakukan penambahbaikan kepada keadaan sungai sedia ada.

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## DEVELOPMENT OF DNA BIOSENSOR AS EARLY WARNING SYSTEM FOR HARMFUL ALGAL BLOOM (HAB) DETECTION: A CASE STUDY IN TUMPAT, KELANTAN

*Jeremy Jason Chin Chwan Chuong | P118359 | Master*

Supervisors:

*Assoc. Prof. ChM. Dr. Tan Ling Ling*

*Dr. Andrew Pike*

*Dr. Yuziana Mohd Yusof*

*Assoc. Prof. ChM. Dr. Goh Choo Ta*

### 1. INTRODUCTION

Harmful Algal Bloom (HAB) constitutes a phenomenon arising from elevated phytoplankton abundances in both freshwater and marine environments, often resulting in water discoloration. Such blooming events can have dual outcomes: (I) the production of toxins that accumulate in shellfish, posing risks to consumers, and (II) the potential to obstruct fish gills and deplete dissolved oxygen content in water, consequently leading to fish mortality (Jipanin et al., 2019). The existing management approaches for HAB exhibit certain limitations, notably the absence of a dependable early warning monitoring system (Liu et al., 2022) and the ineffective implementation of mitigation strategies (Gallardo-Rodríguez et al., 2019). To enhance the early warning monitoring system for HAB, this study proposes a novel solution: the development of a generic DNA biosensor tool. While the choice of the research site, Tumpat, was selected due to the regular occurrence of blooming events (Lau et al., 2017).

### 2. PROBLEM STATEMENT

The current monitoring methods for Harmful Algal Bloom (HAB) events lack efficient and rapid detection approaches, resulting in delays (Chin et al., 2022). Those conventional techniques including ELISA, microarray, bioassay, and microscopic method are mainly tailored to specific HAB species and confined to laboratory settings (Liu et al., 2022), impeding timely preventive measures. Furthermore, there is still an underexplored aspect in revolutionizing HAB detection using nanomaterial-incorporated biosensors (Kulkarni et al., 2022). The utilization of nanomaterials with attributes including large specific surface area, high conductivity, and good stability through formation of composite could improve sensitivity and durability of designed biosensor (Gong et al., 2019; Ruecha et al., 2015).

### 3. OBJECTIVE

This research will involve 4 main objectives in regard to developing a potential generic and reliable single tool for HAB early warning monitoring system. These include (I) to analyze the occurrence and management of HAB in Malaysia for the past two decades; (II) to select a conserved DNA sequence among related HAB species and favorable nanomaterial for the enhancement of generic biosensing usage; (III) to develop and optimize the nanomaterial-based generic DNA electrode via differential pulse voltammetry (DPV) for biorecognition of HAB algae species; and (IV) to validate the developed electrochemical DNA biosensor response with cell

counting microscopy method for the analysis of HAB species in seawater samples. The colloquium presentation will focus on the third objective of developing and optimizing the DNA biosensor.

#### 4. METHOD

The polyaniline/graphene (PGN) was formed through reverse-phase polymerization. Aniline monomers were initially introduced to graphene, followed by the addition of ammonium persulfate to trigger aniline polymerization, resulting in nanocomposite structure formation on graphene. Polyvinylpyrrolidone (PVP) was added in the previous stage to prevent nanoparticle aggregation. The resulting PGN was combined with dimethylformamide (DMF) to form a well-dispersed nanocomposite suitable for application on working electrodes (WE). Subsequently, the selected DNA probe derived from the sxtA4 gene sequence of a major saxitoxin-producing HAB species was attached to the nanomaterial using a carbodiimide crosslinking reagent, facilitating attachment. This developed DNA biosensor was tested to detect complementary DNA targets related to Harmful Algal Bloom (HAB) species through differential pulse voltammetry (DPV). Finally, optimization strategies were employed to refine the performance of the DNA biosensor, involving factors such as (I) PGN concentration, (II) probe immobilization duration, and (III) hybridization duration.

#### 5. RESULTS AND DISCUSSION

The graphene's large surface area (Xie et al., 2017) and polyaniline's high conductivity (Du et al., 2012) combined as a PGN nanocomposite, synergize to enhance electron transfer on the electrode useful for electrochemical transductions. The synthesized PGN will require the aid of PVP to prevent nanoparticles aggregation via hydrophobic repulsive forces (Zein et al., 2022) in the DMF solvent, an organic solvent that is effective in dispersing graphene (Wei et al., 2015). Based on the mentioned synergistic effect, drop-casting well-synthesized PGN onto the WE active surface area yielded a high redox current. This was observed via cyclic voltammetry at a scan rate of  $100 \text{ mVs}^{-1}$  versus Ag/AgCl reference electrode within the potential window of  $-0.8 \text{ V}$  to  $1.3 \text{ V}$  in  $3 \text{ mM}$  ferri/ferrocyanide and  $0.1 \text{ M}$  KCl electrolyte solution. Next, the ideal PGN concentration for WE was identified through trials with varying concentrations ( $0.1\text{-}0.9 \text{ mg mL}^{-1}$ ) and a constant volume of  $5 \text{ }\mu\text{L}$  utilized to fully cover the active surface. The PGN concentration of  $0.5 \text{ mg mL}^{-1}$  produced the optimum DPV response. However, PGN at concentrations exceeding  $0.5 \text{ mg mL}^{-1}$  on WEs adversely impacted the electrochemical biosensor performance as it formed an electron transfer barrier on the electrode surface. Subsequently, the optimal durations for probe immobilization ( $5 \text{ h}$ ) and hybridization ( $90 \text{ min}$ ) were identified based on the lowest observed DPV current at  $0.23 \text{ V}$ . This suggests the complete probe attachment and hybridization event had occurred. The reduced DPV current is due to the negatively charged DNA backbone repelling electrons from the electrode surface. These experiments utilized probe and target DNA concentrations of  $1 \times 10^{-5} \text{ M}$  and  $1 \times 10^{-9} \text{ M}$ , respectively. Eventually, the optimized DNA biosensor demonstrates a wide linear detection range ( $1 \times 10^{-6} \text{ M} - 10^{-13} \text{ M}$ ) for complementary target DNA. This study achieved an accurate low detection limit of  $10 \text{ cells mL}^{-1}$ , comparable to other nano-based biosensors for *Alexandrium minutum* detection (Faridah Salam et al., 2017; Oloketuyi et al., 2020).

## 6. CONCLUSION

To conclude, the developed generic DNA biosensor has the potential to be a dependable tool as it can detect a wide variety of HAB species with a single method. This would help to solve the problems of conventional methods in HAB detection. The proposed electrochemical DNA biosensor would serve as a valuable single tool capable of quantifying saxitoxin-producing HAB species, especially the *Alexandrium* spp. and *Pyrodinium bahamense*.

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## INSTITUTIONALISING WASTEWATER RECLAMATION AND REUSE IN ACHIEVING WATER SECURITY IN MALAYSIA

*Ainul Rasyidah Ab Rahim | P106520 | Doctor of Philosophy*

Supervisors:

*Prof. Ts. Dr. Lee Khai Ern*

*Prof. Emeritus Dato' ChM. Dr. Mazlin bin Mokhtar*

### 1. INTRODUCTION

Water scarcity is an economic, sanitation and even security concern on a global scale. The most pressing issue of the 21st century is providing everyone with access to clean and sufficient water. Among the aggravating factors are climate change, accelerated population growth, freshwater pollution and depletion (Fito and Van Hulle, 2021). World Bank study concluded that the world could face a 40% global water deficit by 2030 under a business-as-usual scenario (World Bank 2019) as the world population is expected to increase by nearly 2 billion in the next 30 years, from the current 8 billion to 9.7 billion in 2050 and could peak at nearly 10.4 billion in the mid-2080s (United Nations 2022). Authorities and governments are currently forced to explore for alternative sources of water in lieu of traditional sources of water due to the limited availability of water resources (Brown, Keith & Wong 2009). Reclamation and reuse of wastewater are viewed as viable solutions to the problem as 80 percent of wastewater flows back into the ecosystem without being treated or reused (UNESCO 2017). These alternative solutions have yet been fully explored, particularly in Malaysia.

### 2. PROBLEM STATEMENT

Due to overconsumption, climate change and population growth, global freshwater scarcity is increasing (UN, 2019). Malaysia, despite having abundant of fresh water, is also faced with recurring water shortages (Khalid, 2018). Increasing water scarcity necessitates adequate amount of water from a variety of water sources (Ahmed, Chamhuri & Begum 2014). Wastewater can be utilised as a valuable water resource to increase water security because it is always present and generally accessible throughout the year. The vast amount of wastewater discharge and low reclaimed water production mean that wastewater reuse have great potential in Malaysia (Akademi of Sciences Malaysia 2016). National sewerage company, Indah Water Konsortium Sdn Bhd (IWK), has recorded that the treated wastewater amounts to approximately 6.469 million litres per day (MLD) from 7,000 sewage treatment plants under its maintenance, being discharged back into the waters or rivers (IWK 2021). The advancement of wastewater technology has enabled wastewater to become valuable water resources. However, beyond the technological advancement is the divergences of many complex issues which hinders the implementation of wastewater reclamation and reuse (Gul et al. 2021). The government of Malaysia has actively promoted wastewater reclamation and reuse under its Green Technology Master Plan Malaysia 2017 (GTMP 2017) and aims to produce 1,500 million litres per day (MLD) of reclaimed water from treated effluent. However, there is no policy and legislative framework that holistically covers wastewater reclamation and reuse as an alternative water resource (Oh et al. 2018, Kuok, Mah & Po Chan 2015). This study focuses on analysing the institutional and

organisational arrangements that support the start-up and continued operation of wastewater reuse systems that could aid water security in Malaysia.

### **3. OBJECTIVE**

The study has three (3) main objectives in examining institutional arrangement of wastewater reclamation and reuse. However, only two objectives will be discussed in this colloquium, which include objective (i) To identify the current state of wastewater reclamation and reuse in the context of water security in Malaysia; and objective (ii) To identify the barriers and drivers as well as analyse policy innovation in mainstreaming and institutionalising wastewater reclamation and reuse in Malaysia.

### **4. METHOD**

A qualitative research method was undertaken in this study. In answering the stated objectives, several methods have been utilised which include content analysis of related policies, legislations, studies and master plans concerning water resources and wastewater management to identify and analyse the current practices, policies, regulations and governance framework pertaining to wastewater reclamation and reuse in achieving water security in Malaysia.

In-depth interviews are conducted with stakeholders and key informants related to the management of water and wastewater to collect data on the current status as well as to obtain information on the barriers, challenges and drivers of wastewater reclamation and reuse in Malaysia. Subsequently, the findings from the interviews are also crucial to provide perspective in the implementation of wastewater reclamation and reuse towards water security in Malaysia. A credible interview method is essential for collecting high-quality data (Yeong, 2018) and as such an interview protocol based on the Interview Protocol Refinement (IPR) (Castillo-Montoya, 2016) was constructed to ensure a quality interview finding.

### **5. RESULTS AND DISCUSSION**

Based on the content analysis and interviews, wastewater reclamation and reuse in Malaysia is still at its infancy stage as it has only achieved 4MLD out of 1,500MLD (IWK 2021). Although the National Water Resources Policy (NWRP) 2012 and GTMP 2017 provided a new direction in the water sector by including wastewater reuse as alternative water resources, the lack of regulatory frameworks and governance contributed to the slow growth of wastewater reclamation and reuse (Oh et al 2018). Accordingly, from the analysis and interviews, the government's focus is still in providing and modernisation of sewerage services.

The interviews done with the stakeholders and personnel in the water and wastewater managements has indicated that there are complex issues that hinder the development of wastewater reclamation and reuse in Malaysia. The vast range of different barriers identified are themed into political, environmental, technology, financial, regulatory and institutional framework issues. On the other hand, the barriers were also identified to be the drivers in the implementation of wastewater reclamation and reuse in Malaysia. The political willingness in amending the regulations, forming the right institutional framework and working on public's acceptability would be crucial to the implementation of wastewater reclamation and reuse. Additionally, the involvement of private entity and private financial fundings would immensely turn around the industry and help the expansion of wastewater reclamation and reuse.

## 6. CONCLUSION

From the study, there is high demand for freshwater consumption in Malaysia due to the country's exponential population and economic expansion. Additionally, in view of the impact of climate change, alternative water resource must be promoted to reduce dependency on fresh water. Based on the literature and stakeholder interview data, resorting to wastewater reclamation and reuse in Malaysia is still a work in progress. The current slow-paced development in wastewater reclamation and reuse needs a policy, regulatory and institutional change. High financial cost for wastewater reclamation and reuse could be overcome by encouraging private driven initiative while the government could focus on providing a better sewerage network and services. This private driven initiative would require policy innovations and could overcome financial barriers that is still beleaguering the wastewater industry.

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## MOBILE CONSTRUCTED WETLAND COUPLING WITH SEWAGE TREATMENT PLANT AS SUSTAINABLE WASTEWATER RECLAMATION MEANS FOR WATER SECURITY IN SELANGOR

Noor Zarina Mohd Nazir | P106519 | Doctor of Philosophy

Supervisors:

*Prof. Ts. Dr. Lee Khai Ern*

*Prof. Emeritus Dato' ChM. Dr. Mazlin bin Mokhtar*

### 1. INTRODUCTION

Water is fundamental to life and an absolute necessity for everyone. Over the last few decades, this vital resource has been subjected to numerous anthropogenic pressures. Since the 1990s, many researchers have forecasted that around half of the world's population may experience water shortage by 2025 and will be under water stress by 2030 (Scheierling et al. 2011). Considering that the water demand is growing exponentially as the world population is expected to grow from 7.8 billion in 2020 to 9.5 billion in 2050 (United Nations 2019), the pressure on limited freshwater resources is rapidly becoming unsustainable. Moreover, UNESCO in 2019 also reported that an increase in water demand should be expected for all sectors, especially in the agricultural, industrial and energy sectors.

### 2. PROBLEM STATEMENT

With increasing global water consumption, the protection of vulnerable water systems has become a critical concern, particularly in water-rich Malaysia, where rapid development and population growth amplify the water demand (Department of Statistics Malaysia 2021; Hamid 2020). Despite abundant rainfall, the available water for consumption is limited, jeopardizing water security as demand is predicted to rise significantly by 2050. Pollution from various sources, including human waste, is contaminating water bodies and endangering the nation's water supply which is 98% derived from rivers (Chan 2012). This pollution issue has led to major water crises, unscheduled water cuts and shortages in various regions, highlighting the urgent need to address the pollution problem and improve water management practices (Suruhanjaya Perkhidmatan Air Negara 2021).

Constructed wetlands has been adopted as one of the nature-based solutions in providing a sustainable and environmentally friendly solution for wastewater treatment and have the potential for various applications in water management. By adopting CW systems, we not only address pollution challenges but also contribute to water conservation and security, aligning with the overarching need to manage water resources intelligently in the face of growing global demand (Stefanakis 2020).

However, space constraints and high land values in urban areas hinder the adoption of constructed wetlands, which could offer sustainable wastewater treatment to the current infrastructure. To surmount these barriers, a mobile constructed wetland (MCW) system is proposed as a cost-effective and environmentally friendly solution. This innovative retrofitting solution to current grey infrastructure aims to augment wastewater treatment capacity and

promote water reuse, particularly in urban areas of Malaysia. Collaborating with water authorities, this initiative holds promise in conserving water resources, alleviating pressure on clean water sources and bolstering water security in Malaysia

### **3. OBJECTIVE**

This study focuses on two (2) key objectives related to mobile constructed wetlands (MCWs) for reclaiming treated effluent from sewage treatment plants (STPs) for water security in Selangor, Malaysia. The objectives are as follows:

- i. To design, develop and monitor a mobile constructed wetland in reclaiming treated effluent from STP.
- ii. To assess the quality of reclaimed water by the mobile constructed wetland system, including its compliance with regulatory standards and suitability for various non-potable applications.

### **4. METHOD**

In this study, a lab-scale mobile-constructed wetland was designed and tested. Standard design techniques were used based on Reed's Method, initially developed by the US EPA and Sherwood C. Reed (Reed 1993). Reed's Method was adopted due to its demonstrated efficacy in achieving higher levels of pollutant removal across multiple experimental scenarios (Almuktar et al. 2018). To contextualize the methodology for the specific conditions of Malaysia, indigenous plant species were thoughtfully integrated into the design. This localized approach aimed to enhance the wetland's adaptability and performance within the Malaysian setting (Mahmud et al. 2017; Shahrudin et al. 2015).

The lab-scale mobile constructed wetland experiment aimed to assess the system's efficiency and reliability in reclaiming treated wastewater from the HLT219 Bandar Bukit Mahkota STP. Water Quality Index (WQI) parameters, including pH, Dissolved Oxygen (DO), Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD<sub>5</sub>), Chemical Oxygen Demand (COD) and Ammoniacal Nitrogen (AN), were analysed at different hydraulic retention time (HRT) intervals.

### **5. RESULTS AND DISCUSSION**

The lab-scale mobile-constructed wetland demonstrates impressive rates of pollutant removal. It achieves a reduction of 94.87% in Total Suspended Solids (TSS), 85.12% in Biochemical Oxygen Demand (BOD), and 97.7% in Ammonium Nitrogen (AN). Although the reduction in Chemical Oxygen Demand (COD) is comparatively lower at 45.5%, the final COD level reaches the Class I standard of the National Water Quality Standard (NWQS) at 11 mg/L. A visual comparison between the treated effluent from the HLT219 Bandar Bukit Mahkota STP and the treatment outcomes accomplished by the lab-scale mobile constructed wetland clearly demonstrates a significant enhancement in the water quality of reclaimed water. This provides tangible evidence of the design's reliability and its capacity to achieve substantial improvements in water quality.

### **6. CONCLUSION**

The study's results illustrate the efficient removal of pollutants, including TSS, BOD, and AN, by the lab-scale mobile constructed wetland. This successful treatment process transforms the



reclaimed water into a viable option for non-potable use and diverse applications, aligned with the stringent Class I standards defined by the NWQS classification. These outcomes serve as tangible proof of the design's reliability and its remarkable potential to substantially enhance STP effluent standards. Furthermore, comprehensive bio-toxicity and eco-toxicity assessments affirm the absence of hazardous elements within the reclaimed water produced by the lab-scale mobile constructed wetland. In summation, the mobile constructed wetland lab-scale system has effectively achieved the delivery of Class I reclaimed water. This accomplishment underscores the innovation of employing a mobile constructed wetland with localized plants for wastewater reclamation, particularly within the context of Malaysian setting. This emphasizes the technology's promise as a sustainable and impactful method for achieving water security in Selangor.

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## MENGARUS PERDANA PEMBANGUNAN LESTARI DI UKM: PENENTUAN ELEMEN-ELEMEN ASAS PEMBANGUNAN LESTARI

*Siti Khadijah Imam Supaat | P115825 | Doktor Falsafah*

Penyelia:

*Prof. Madya Dr. Sarah Aziz Abdul Ghani Aziz*

*Prof. Dr. Noor Ezlin Bt. Ahmad Basri*

### 1. PENGENALAN

Kajian ini meneliti pelaksanaan pembangunan lestari di institusi pengajian tinggi atau universiti di mana kajian ini ingin mengkaji bagaimana UKM mengarus perdana penerapan Matlamat Pembangunan Lestari (SDG 2030) di universiti. Penulisan ini akan memfokuskan kepada penentuan elemen-elemen asas pembangunan lestari di universiti. Kajian ini penting kerana pelaksanaan aspirasi pembangunan lestari di universiti adalah berdasarkan elemen-elemen asas yang membentuk aspirasi tersebut. Elemen-elemen ini akan dikenal pasti melalui kaedah kajian analisis dokumen.

*United Nations Conference on the Human Environment 1972* yang diadakan di Stockholm telah menerima pakai *Stockholm Declaration and Action Plan for the Human Environment*, yang menekankan hubungan antara pembangunan dan perlindungan alam sekitar sekaligus menyediakan asas kepada konsep pembangunan lestari sebagai dasar global (Egute et al. 2019). Sejak itu, konsep pembangunan lestari mula berkembang dan dipopularkan melalui siri-siri laporan, persidangan dan simposium seperti *World Conservation Strategy: Living Resources Conservation for Sustainable Development* (IUCN 1980), *Our Common Future* (WCED 1987), dan *United Nations Conference on Environment and Development* (UNCED 1992) (Haque 2000). Sebagai contoh, istilah pembangunan lestari muncul dalam 11 daripada 27 prinsip *Rio Declaration on Environment and Development* 1992 manakala dokumen Agenda 21 merupakan pelan tindakan untuk pembangunan lestari (Egute et al. 2019). Pada tahun 2015, resolusi *Transforming our world: the 2030 Agenda for Sustainable Development* (SDG 2030) telah di terima pakai sebagai kerangka baru pembangunan lestari.

### 2. PERMASALAHAN KAJIAN DAN SOROTAN KAJIAN

Peranan universiti yang sangat signifikan dalam mencorak dan meneraju pembangunan negara dan masyarakat menuntut universiti melakukan transformasi ke arah pembangunan lestari seiring dengan agenda pembangunan global. Menyedari tuntutan itu, UKM telah menggubal Pelan Strategik Kelestarian UKM 2030 dengan iltizam untuk membudayakan, mengamalkan dan memasyarakatkan aspirasi pembangunan lestari menjelang 2030 (UKM 2022). Namun demikian, penunjuk yang digunakan di dalam Pelan Strategik Kelestarian UKM 2030 tidak sama dengan penunjuk yang digunakan di dalam SDG 2030. Berdasarkan perbezaan ini, timbul persoalan beberapa persoalan kajian iaitu (1) adakah penunjuk kelestarian universiti perlu sama dengan penunjuk SDG 2030? (2) bolehkah kelestarian universiti menggunakan penunjuk SDG 2030 yang sama? (3) bagaimana penunjuk SDG 2030 diselaraskan ke peringkat universiti? (4) apakah penunjuk yang diukur? (5) bolehkah penunjuk tersebut diukur? dan (6) bagaimana penunjuk

tersebut diukur dalam rangka untuk menyokong dan menyumbang kepada *Malaysia Voluntary National Review* iaitu Laporan SDG 2030 Malaysia.

*The United Nations Decade of Education for Sustainable Development* (2005-2014) menekankan bahawa peranan utama universiti dalam pelaksanaan pembangunan lestari bukan sahaja untuk menjana dan memindahkan pengetahuan, tetapi untuk mendidik pemimpin masa depan yang akan menyumbang kepada masa depan yang lestari (Barth, 2016). Universiti dituntut untuk memikirkan semula peranan mereka dalam masyarakat dan bagaimana universiti boleh bertindak sebagai pemangkin ke arah kelestarian (UNESCO 2022). UNESCO (2022) mengesyorkan kelestarian harus dipatuhi dan dipantau dalam struktur tadbir urus universiti. Pemantauan membolehkan pihak berkepentingan terlibat secara aktif dalam proses peralihan ke arah pembangunan lestari dan mengenal pasti kemungkinan wujudnya jurang dalam pelan tindakan kelestarian (Kioupi & Voulvoulis 2019).

Menyahut seruan SDG 2030 bahawa kerajaan dan institusi awam akan bekerjasama rapat dengan ahli akademik serta pihak berkepentingan lain dalam pelaksanaan SDG 2030, kerajaan Malaysia telah menyatakan komitmen pembangunan negara akan terus dijarar kepada SDG 2030 dan menekankan kepentingan pendekatan keseluruhan negara atau "*whole of nation*" dalam pelaksanaan SDG 2030 (RMKe-12, 2021). Menyahut seruan yang sama, UKM telah berperanan memulakan inisiatif penerapan konsep pembangunan lestari yang antaranya melalui pengisytiharan Piagam Kampus Lestari (Derahim et al. 2012), penggubalan Pelan Induk Pembangunan Fizikal Kampus UKM Bangi 2007-2020 yang menggariskan lapan objektif kelestarian (Khairul Baharudin & Sarah Aziz 2020) serta penggubalan Pelan Strategik Kelestarian UKM 2030 (UKM 2022).

### 3. OBJEKTIF KAJIAN

Kajian ini mempunyai 3 objektif kajian iaitu (1) mengenal pasti elemen-elemen asas SDG 2030 yang perlu diterapkan di universiti, (2) mengenalpasti tatacara penerapan SDG 2030 di dalam tadbir urus UKM dan (3) mencadangkan kerangka perubahan tadbir urus dan indikator pengukuran bagi penerapan SDG 2030 di UKM. Penulisan ini hanya memfokuskan kepada objektif pertama iaitu mengenal pasti elemen-elemen asas SDG 2030 yang perlu diterapkan di universiti.

### 4. KAEDAH KAJIAN

Kajian ini menjalankan kaedah analisis dokumen bagi menjawab objektif untuk mengenal pasti elemen-elemen asas SDG 2030 yang perlu diterapkan di universiti. Analisis dokumen adalah kaedah kajian untuk menganalisis kandungan dokumen bertulis dengan teliti dan sistematik dan pemilihan dokumen perlu mempertimbangkan: (1) organisasi mana yang akan disertakan, (2) jenis dokumen yang akan disemak dan (3) masa penerbitan dan pengeluaran dokumen tersebut (Wach & Ward 2013). Kajian ini mengkategorikan tiga jenis dokumen yang akan dianalisis iaitu dokumen rasmi antarabangsa dari *United Nation* seperti SDG 2030 dan dokumen UNESCO, dokumen rasmi Malaysia seperti RMK Ke-12 dan Pelan Pembangunan Pendidikan Malaysia 2015-2025 (Pendidikan Tinggi) dan dokumen rasmi universiti seperti Pelan Strategik Kelestarian UKM 2030 dan Pelan Induk Pembangunan Fizikal Kampus UKM Bangi 2007-2020. Analisis dokumen melibatkan pengulangan proses membuat bacaan sepintas lalu (*skimming*), bacaan menyeluruh

dan penafsiran (Bowen 2009). Dokumen dibaca perenggan demi perenggan sambil membuat pertanyaan berkaitan fokus kajian dan membuat tafsiran untuk mengenalpasti tema pada perenggan atau frasa teks dokumen tersebut (Morse 2008).

## 5. KEPUTUSAN DAN PERBINCANGAN

Analisis dokumen mendapati tema-tema berikut; (1) tanggungjawab dan hak asasi manusia (2) perlindungan alam sekitar dan sumber, (3) pembangunan ekonomi dan sosial, (4) perancangan pembangunan, (5) perancangan dan polisi alam sekitar, (6) bantuan kewangan dan teknologi, (7) pendidikan dan komunikasi, (8) mekanisma institusi kerajaan dan (9) Kerjasama antarabangsa.

Analisis dokumen menunjukkan elemen-elemen asas pembangunan lestari. Elemen-elemen asas ini membentuk aspirasi pembangunan lestari di universiti dan SDG 2030. Perbandingan awal mendapati Pelan Strategik Kelestarian UKM 2030 mempunyai elemen-elemen yang selari dengan tema-tema hasil dokumen analisis dan pelan tersebut telah diselaraskan dengan sasaran SDG 2030. Namun pelan tersebut mempunyai penunjuk kelestarian yang berbeza.

## 6. KESIMPULAN

Kajian ini mendapati terdapat perbezaan penunjuk Pelan Strategik Kelestarian UKM 2030 dengan penunjuk SDG 2030. Perbezaan penunjuk kelestarian menghasilkan keputusan dan output yang berbeza. Oleh itu, penunjuk Pelan Strategik Kelestarian UKM 2030 perlu diselaraskan dengan penunjuk SDG 2030 untuk menyokong pencapaian SDG negara.

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## MOBILE GAME AS AN INTERVENTION ON BEACH SUSTAINABILITY AWARENESS FOR PRESCHOOLERS

*Ellena A/P John | P116173 | Master*

Supervisors:

*Dr. Lim Chen Kim*

*Prof. Dr. Sharifah Zarina Syed Zakaria*

### 1. INTRODUCTION

Beaches are vital ecosystems, but litter and plastic pollution threaten their balance (Kershaw et al. 2019). As a solution a mobile game-based intervention tool to raise awareness on beach sustainability. This interactive and adaptable game effectively engages preschoolers aged 5 to 6 years, who are receptive to educational games, fostering a deeper understanding of the importance of protecting beach ecosystems and the impact of littering. Clean My Beach, a game developed by Kayfo Games is used to expose the preschoolers to a mobile game focused on beach cleaning. The game aligns with Sustainability Development Goal (SDG) 4 - Education for Sustainable Development, promoting beach sustainability learning, while also supporting SDG 6 - Clean Water and Sanitation through litter prevention and responsible waste management, and SDG 14 - "Life Below Water" by promoting the sustainable use of marine resources (United Nations 2015). Addressing beach littering is paramount to safeguarding our coastal environments and nurturing a generation of environmentally conscious individuals.

### 2. PROBLEM STATEMENT

Langkawi Island, a popular tourist destination, faces the issue of marine debris as underlined by the Non-Governmental Organization, Reef Check Malaysia, during their coastal clean-up initiative where two beaches, Cenang Beach and Pantai Pasir Hitam, had an overwhelming amount of trash collected and thus putting these two beaches in the top 5 of beaches with high amounts of garbage in Malaysia (Nesha 2022). Although, preschool children are the target subject, it is important to address sources of litter on the beaches. It was found that beach litterers in Langkawi are made up of 60% tourists, 30% local residents, and 10% are from construction (Mehranian et al. 2019). Raman et al. (2019) states that preschool teachers' frequency of environmental sustainability practices is low and at an unsatisfactory level, highlighting the need to bridge the gap between children's sustainability awareness. Whereas, 60% of children in Langkawi visit the beach at least once a year (LADA 2019) and contribute to littering (Jones & Stanis 2017; Saengsupavanich et al. 2021). The summarized problem statements that led to this research problems are as follows:

- I. The problem statement addresses the critical issue of beach littering among preschoolers aged 5 to 6 years due to the lack of awareness and knowledge about beach pollution and proper garbage disposal, leading to environmental challenges (Jay 2022; Sonalitha et al. 2019).
- II. Their limited understanding of waste disposal locations and inability to transport trash to designated bins exacerbate the issue (Norhayati & Norhasimah 2020; Mapotse et al. 2017; Wan Zahari et al. 2017).

- III. The absence of effective interventions in environmental education hinders their awareness and comprehension of beach pollution (Yusoff et al. 2019; Wan Zahari et al. 2017).

### **3. OBJECTIVE**

This research will involve three main objectives to use a mobile game as an intervention for beach littering awareness among preschoolers. Firstly, (I) to identify the existing level of knowledge and awareness regarding beach littering among preschool children. Secondly, (II) to enhance the knowledge and awareness of beach littering among preschoolers through mobile game interventions. Lastly, (III) to evaluate the effectiveness of a mobile game-based intervention in improving the knowledge and awareness of beach littering among preschool children. By accomplishing these objectives, this research contributes valuable insights into the effectiveness of mobile games as an educational approach in promoting beach sustainability awareness among preschool children. The colloquium presentation will focus on all three mentioned objectives of this research.

### **4. METHOD**

The methodology for this research consists of three stages. The first stage, (I) preliminary analysis and review of previous work is conducted to identify the research topic, gather related materials, and formulate research questions and hypotheses. Stage two involves (II) data collection through filtering existing beach cleanliness mobile games, physical site observations, and gathering sample trash data. Existing mobile games are analyzed for relevant features, and real-life observations serve as benchmarks for game design and selection. The third stage is the (III) evaluation stage, where the interventions effectiveness is assessed through pre- and post-testing using a questionnaire to measure preschoolers' baseline and improved knowledge and awareness. The data obtained from both tests are compared using SPSS Analysis to determine the mobile games effectiveness in enhancing children's understanding of beach littering.

### **5. RESULTS AND DISCUSSION**

The total population size of preschoolers aged 5 to 6 in Langkawi is 1479 according to the data provided by the Langkawi District Education Office (PPDL). With the confidence level of 95% and margin error of 5% the ideal sample size is 305 from preschools across Langkawi. All preschools are registered under the Ministry of Education in the Langkawi district. To ensure a representative sample, a stratified sampling approach is employed. Three main evaluation methods are applied, pre-testing, play testing with a questionnaire and post-testing. The participants are randomly divided into two groups, making up the control and experimental groups. Each participant will be awarded a mark based on the answers in the questionnaire. The questions are structured around beach littering and different forms of litter. Following the mobile game intervention, the scores from both groups will be evaluated for effectiveness of mobile game intervention by conducting an Independent Sample t-test by comparing the mean test scores between the two groups. A significant result would indicate that the intervention has a substantial influence on the awareness of beach littering and offering a promising approach to enhance preschoolers' awareness.



## 6. CONCLUSION

By using mobile game interventions for beach littering awareness, it could potentially contribute to the SDG 4 and have secondary contributions to SDG 6 and SDG 14. With focus on the age group of 5 to 6 years the impact of early environmental sustainability education and awareness can have a snowball effect. Mobile games offer a cost-effective approach to environmental education and foster a sense of responsibility towards marine ecosystems. Moreover, the integration of mobile game applications in education is a part of the "Go Green" action, which can have a lasting impact on promoting sustainability in the long run. By addressing the critical issue of beach littering among preschoolers and evaluating the effectiveness of the mobile game-based intervention, this research contributes valuable insights to promote beach sustainability awareness and nurture environmentally conscious citizens from an early age.

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**PENGETAHUAN, KEMAHIRAN DAN SIKAP PENJAWAT AWAM SEBAGAI PELAKSANA AKTIVITI  
KESEDARAN ALAM SEKITAR: KAJIAN KES DI LAPAN AGENSI KERAJAAN TERPILIH DI KUALA  
LUMPUR DAN SELANGOR**

*Nik Azyyati Abdul Kadir | P103373 | Sarjana*

Penyelia:

*Prof. Dr. Sharifah Zarina Syed Zakaria*

*Prof. Ts. Dr. Lee Khai Ern*

## **1. PENGENALAN**

Deklarasi Stockholm, Piagam Belgrade, Deklarasi Tbilisi dan Deklarasi Thessaloniki merupakan antara kesepakatan awal di peringkat global yang menekankan mengenai kepentingan usaha penyebaran ilmu mengenai alam sekitar dan usaha penerapan kesedaran alam sekitar. Usaha menyebarkan luas pengetahuan dan kesedaran alam sekitar bagi membentuk masyarakat yang cakna terhadap kelestarian alam sekitar masih diteruskan sama ada di peringkat antarabangsa dan kebangsaan, seiring dengan polisi berkaitan seperti Matlamat Pembangunan Lestari (SDG) 2023 dan Dasar Kepelbagaian Biologi Kebangsaan (DKBK) 2016-2025. Sepertimana yang dilaksanakan negara-negara lain, kesedaran alam sekitar untuk masyarakat Malaysia diterapkan melalui pendidikan formal dan pendidikan bukan formal (Hanim et al., 2019) di mana pendidikan bukan formal adalah pelengkap kepada pendidikan formal (Mohd. Azhar, et al. 2003; Hanifah, et al. 2013). Pelbagai pendekatan diaplikasikan dalam pendidikan tidak formal (Yi-Hsuan Hsu, 2017) yang diterapkan melalui aktiviti pendidikan luar bilik darjah. Pendidikan alam sekitar bukan formal dilaksanakan oleh badan bukan kerajaan (NGO) dan agensi korporat serta agensi kerajaan lain yang berkaitan. Hasrat memperkasa pendidikan alam sekitar di Malaysia dinyatakan di dalam DKBK 2016-2025 melalui salah satu indikator utama iaitu “Menjelang 2025, sekurang-kurangnya 500,000 belia dan kanak-kanak terlibat dalam aktiviti berteraskan alam semula jadi setiap tahun (Kementerian Sumber Asli & Alam Sekitar, 2016) serta melalui pengukuhan Program Rakan Muda, di mana Rakan Bumi merupakan salah satu daripada sepuluh ‘gaya hidup’ yang diperkenalkan (Kementerian Belia & Sukan, 2023). Dalam menyokong pelaksanaan aktiviti berkaitan, agensi-agensinya kerajaan selain daripada institusi pendidikan turut terbabit secara tidak langsung dan ini menggambarkan bahawa penglibatan penjawat awam yang bukan di sektor pendidikan turut relevan dalam memperkasa pendidikan alam sekitar. Kumpulan ini wajar diberi perhatian sama ada dari segi penyelidikan mahupun pembangunan, demi memperkasa usaha ke arah pembentukan masyarakat dan negara yang lestari.

## **2. PERMASALAHAN KAJIAN DAN SOROTON KAJIAN**

Norshariani et al. (2018) mengkelaskan kekangan yang dihadapi oleh kebanyakan guru dalam melaksanakan pendidikan alam sekitar kepada iaitu kekangan masa dan dibebani oleh tugas sekolah. Sehubungan itu penglibatan agensi kerajaan lain dilihat sebagai satu cara mengurangkan beban tugas guru dan perkongsian tanggungjawab. Poonam Dhull & Gunjan Verma (2017) menyimpulkan bahawa dalam usaha melibatkan murid dengan pendidikan berkaitan alam sekitar, guru memerlukan bantuan serta sokongan daripada pelbagai pihak

seperti kerajaan, pengurusan, badan berkanun, pembentuk polisi dan komuniti sekolah. Dalam konteks pelaksana di kalangan agensi kerajaan bukan dari sektor pendidikan, sebahagian penjawat awam di agensi kerajaan terbabit terlibat dalam melaksanakan aktiviti kesedaran alam sekitar bagi pihak agensi. Kumpulan pelaksana berkenaan lazimnya terdiri daripada penjawat awam yang mempunyai latar belakang pendidikan yang berbeza serta tertakluk kepada tugas hakiki jabatan. Jesteru, golongan ini berpotensi berhadapan dengan cabaran sepertimana penemuan oleh Mohamad Saifudin (2018) yang mendapati pengamal media dan badan bukan kerajaan (NGO) bersetuju bahawa mereka menghadapi cabaran dalam memainkan peranan sebagai pendidik alam sekitar. Seiring dengan usaha memperkasa pelaksanaan aktiviti pendidikan alam sekitar menerusi platform pendidikan bukan formal, kajian terhadap pengetahuan, kemahiran dan sikap pelaksana di agensi-agensi kerajaan terbabit juga perlu dijalankan. Di peringkat awal, tahap penglibatan penjawat awam terbabit sebagai pelaksana aktiviti kesedaran alam sekitar bagi pihak agensi perlu dikenalpasti sebelum tinjauan lebih lanjut berkaitan parameter tersebut dilaksanakan.

### **3. OBJEKTIF KAJIAN**

Kajian ini mempunyai tiga objektif namun dalam pembentangan kolokium ini, hanya satu objektif akan difokuskan iaitu objektif pertama iaitu mengenalpasti status penglibatan penjawat awam sebagai pelaksana aktiviti kesedaran alam sekitar bagi pihak agensi. Melalui objektif ini, penglibatan penjawat awam terbabit dikenalpasti khususnya berkaitan aspek peranan dan tahap penglibatan, bentuk dan tema program/aktiviti yang dikendalikan serta kekerapan pelaksanaan aktiviti/program pendidikan alam sekitar oleh agensi.

### **4. KAEDAH KAJIAN**

Kajian dilaksanakan di lapan agensi kerajaan yang terlibat dalam usaha menyebarkan pengetahuan dan kesedaran mengenai alam sekitar iaitu Jabatan Alam Sekitar (JAS) Wilayah Persekutuan, Jabatan Alam Sekitar (JAS) Selangor, Jabatan Perhutanan Wilayah Persekutuan, Jabatan Perhutanan Negeri Selangor, Jabatan Perlindungan Hidupan Liar dan Taman Negara (PERHILITAN) Wilayah Persekutuan dan PERHILITAN Negeri Selangor, PERHILITAN di Paya Indah Wetlands, dan Institut Penyelidikan Perhutanan Malaysia (FRIM). Bagi mengumpulkan data untuk menjawab objektif satu, analisis dokumen dan temubual melalui telefon dengan 14 orang wakil pengurusan jabatan/seksyen/cawangan/unit berkaitan di agensi kerajaan terbabit dilaksanakan. Analisis dokumen adalah prosedur sistematik untuk menyemak dan menilai dokumen sama ada yang bercetak atau material elektronik (Bowen, 2009). Dokumen terbabit adalah merujuk kepada laporan tahunan jabatan terbabit, media sosial rasmi jabatan merangkumi laman sesawang dan Facebook rasmi jabatan bagi mengenalpasti bentuk-bentuk pelaksanaan aktiviti pendidikan alam sekitar oleh agensi. Temubual dengan pihak pengurusan melibatkan wakil bahagian/seksyen/unit terbabit dan berpandukan soalan berkaitan seperti bilangan kakitangan yang terlibat secara langsung dalam pelaksanaan aktiviti kesedaran alam sekitar, bentuk program/aktiviti yang dilaksanakan, tema/topik aktiviti serta kekerapan pelaksanaan.

## 5. KEPUTUSAN DAN PERBINCANGAN

Analisis dokumen dibuat terhadap 20 laporan tahunan yang merangkumi lima laporan tahunan bagi setiap agensi untuk tempoh 2017 sehingga 2021 serta laman sesawang dan sosial media rasmi agensi-agensi terbabit sama ada peringkat persekutuan mahupun peringkat negeri. Berdasarkan laporan tahunan, aktiviti/program pendidikan merangkumi ceramah kesedaran, program bermalam dan program kesedaran harian serta pameran berkaitan kesedaran alam yang bertemakan sumber alam semula jadi atau topik alam sekitar yang lain seperti perubahan iklim dan kitar semula. Tahap penglibatan adalah berbeza mengikut gred perjawatan di mana ada yang terlibat sebagai penceramah, pelaksana aktiviti mahupun petugas pameran dan sebahagian penjawat awam turut terbabit dalam penghasilan bahan aktiviti dan bahan bacaan untuk tujuan pendidikan. Di samping itu, berdasarkan temu bual, didapati penjawat awam yang bertugas di agensi yang mempunyai sumber alam semula jadi setempat seperti PERHILITAN dan Jabatan Perhutanan Negeri turut terlibat dalam mengendalikan aktiviti lawatan. Selain itu, didapati bahawa penjawat awam yang terlibat sebagai pelaksana aktiviti pendidikan alam sekitar turut terlibat dalam skop tugas hakiki yang seiring dengan jawatan seperti pemelihara hutan, pegawai hidupan liar, pegawai kawalan alam sekitar dan penyelidik. Dari segi bilangan, julat penjawat awam yang terbabit secara langsung dalam usaha kesedaran alam sekitar bagi lapan agensi terpilih adalah diantara empat sehingga lapan orang kakitangan yang terdiri daripada kakitangan tetap dan kontrak. Bilangan ini tidak termasuk bilangan kakitangan yang dipinjam dari seksyen/unit lain bagi menyokong pelaksanaan program berskala besar. Hasil dapatan ini, secara tidak langsung menggambarkan bahawa penjawat awam di agensi kerajaan selain di sektor pendidikan, turut terbabit secara langsung dalam aktiviti pendidikan alam sekitar yang juga merupakan salah satu bentuk aktiviti komunikasi, pendidikan dan kesedaran awam.

## 6. KESIMPULAN

Aktiviti pendidikan alam sekitar oleh agensi terbabit dilaksanakan oleh penjawat awam di bahagian/seksyen/unit tertentu dan pelaksanaan aktiviti berkenaan merupakan skop tugas sampingan di samping skop tugas hakiki. Namun, dalam menyokong dasar-dasar kerajaan berkaitan pembangunan lestari dan konservasi sumber alam semula jadi, bahagian/seksyen/unit berkenaan sentiasa bersedia untuk terlibat sebagai pelaksana aktiviti pendidikan alam sekitar, yang mana merupakan salah satu daripada bentuk pemindahan teknologi kepada orang awam. Walaubagaimanapun, terdapat faktor yang mempengaruhi penglibatan penjawat awam terbabit dalam aktiviti berkaitan alam sekitar seperti kesediaan sumber di lapangan, bilangan penjawat awam bahagian/seksyen/unit serta peruntukan kewangan.

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**KOMPONEN PENDIDIKAN UNTUK PEMBANGUNAN LESTARI (ESD) DALAM  
“MODUL TEMATIK, PRAKARYA DAN BUDAYA MELAYU RIAU BERBASIS MUATAN LOKAL  
KUANTAN SINGINGI”**

*Gianini Sonnevil | P108253 | Sarjana*

Penyelia:

*Prof. Dr. Sharifah Zarina Syed Zakaria*

*Prof. Dr. Muhammad Rizal Razman*

## 1. PENGENALAN

Pendidikan untuk Pembangunan Lestari (ESD) lahir selepas Pertubuhan Bangsa-Bangsa Bersatu (PBB) menekankan hubungan antara manusia dan alam sekitar dalam laporan Brundlant (1987). Pada masa ini, panduan ESD yang dipromosikan oleh PBB ialah *ESD for 2030* yang memberi tumpuan untuk merealisasikan 17 Matlamat Pembangunan Lestari (SDG). Di Indonesia, integrasi bahan pengajaran berdasarkan pada prinsip dan kandungan di dalam ESD turut diimplementasikan. Salah satu daripada bahan tersebut ialah *Modul Tematik Prakarya, Seni Budaya dan Budaya Melayu Riau Berbasis Muatan lokal* yang dibangunkan oleh pelbagai entiti di Kuantan Singingi, Riau. Beberapa tujuan modul ini ialah untuk meningkatkan pengetahuan guru tentang ESD, memberi bimbingan kepada guru di Kuantan Singingi dalam proses pembelajaran ESD serta melahirkan murid yang memiliki pengetahuan dan kecakapan dalam mengatasi isu kelestarian (WWF Riau: 2022). Terdapat banyak kajian yang menjelaskan bahawa bahan pengajaran tematik yang berorientasikan ESD dan guru yang terlatih untuk mengajar ESD menjadi amat penting bagi menjayakan hasrat tersebut (Sahin, E: 2016, R.A.S Jhonston: 2018 dan UNESCO: 2020). Oleh itu, modul pengajaran hendaklah dirancang agar ia sesuai dengan prinsip dan kriteria ESD supaya implementasi ESD didalam aktiviti pembelajaran dapat dilaksanakan dengan optimum dan memberikan impak positif kepada pelajar.

## 2. PERMASALAHAN KAJIAN DAN SOROTON KAJIAN

Sumber pembelajaran seperti modul banyak membantu institusi pendidikan untuk melaksanakan ESD dalam bilik darjah (Mohamadnia & Moghadam, Farzane:2019). Saat ini, di Kuantan Singingi, sumber pembelajaran yang disepadukan dengan ESD masih sangat kurang (WWF Riau :2022) kerana ramai penulis dan penerbit mengalami kesukaran menterjemahkan karakter abstrak, holistik, dan multidimensi ESD dalam sebuah bahan pembelajaran (R.A.S Jhonston: 2018). Walau bagaimanapun, menurut laporan UN-ESD, modul ESD mempunyai pendekatan yang lemah kerana ia tidak memberi jaminan pihak berkepentingan melaksanakan ESD pada peringkat pengurusan (UNESCO 2014:8). Hal ini selari dengan SEAMEO (2018) yang menyatakan bahawa banyak panduan ESD dibuat agar para guru dan pelajar tidak kekurangan bahan pembelajaran dan pengajaran. Walau bagaimanapun terdapat perbezaan pendapat tentang peranan modul, memastikan prinsip dan kriteria ESD dalam modul yang digunakan amat penting kerana ia memberikan pengaruh pada pengajaran. Justru itu, kajian ini meninjau komponen ESD yang terkandung dalam *“Modul Tematik Prakarya, Seni Budaya dan Budaya Melayu Riau Berbasis Muatan lokal Kuantan Singingi”*, menentukan tingkah laku pelajar yang berkaitan ESD dan menganalisis pengetahuan para guru terhadap komponen ESD.

### 3. OBJEKTIF KAJIAN

Secara keseluruhan, kajian ini memiliki tiga objektif utama yang memfokuskan untuk mengenal pasti komponen pendidikan bagi pembangunan lestari (ESD). Walau bagaimanapun, didalam pembentangan ini hanya dua objektif yang akan dibahas iaitu objektif pertama untuk mengenal pasti komponen ESD yang terkandung dalam “*Modul Tematik Prakarya, Seni Budaya dan Budaya Melayu Riau Berbasis Muatan lokal Kuantan Singingi*” dan objektif ketiga ialah menentukan tahap pengetahuan para guru terhadap ESD.

### 4. KAEDAH KAJIAN

Kajian ini ialah kajian kualitatif. Bagi menjawab objektif kajian pertama, analisis dokumen *Modul Tematik Prakarya, Seni Budaya dan Budaya Melayu Riau Berbasis Muatan lokal*” gred 7, 8, dan 9 dilakukan secara tematik menggunakan kerangka kerja UNESCO Asia dan Pasifik (2005). Kerangka kerja UNESCO Asia dan Pasifik (2005) menjelaskan 11 elemen ESD iaitu: Maklumat dan kesedaran, Sistem Pengetahuan, Perlindungan dan Pengurusan Alam Sekitar, Keamanan dan Keseksamaan, Konteks Tempatan, Transformasi, Budaya, Kesihatan, pendidikan alam sekitar dan Penglibatan Pemimpin. Kemudian, kaedah temu bual semi berstruktur (*semi-structure interview*) dilaksanakan untuk mendapatkan data mengenai pengetahuan guru-guru terhadap komponen ESD setelah proses pengajaran modul tersebut. Soalan temu bual terdiri dari 2 bahagian iaitu Bahagian A dan Bahagian B. Bahagian A mengandungi maklumat demografi informan manakala bahagian B merupakan pengetahuan informan mengenai ESD. Populasi kajian ini adalah guru-guru yang berasal dari 14 sekolah. Seramai 3 informan dalam kajian ini dikaji secara mendalam dengan menggunakan kaedah persampelan mudah (*convenience sampling*). Informan ialah guru yang menggunakan modul tersebut untuk mengajar, sehingga daripada populasi 14 sekolah hanya terpilih 3 guru. Semua maklumat kemudiannya dianalisis secara tematik menggunakan perisian NVIVO.

### 5. KEPUTUSAN DAN PERBINCANGAN

Berdasarkan hasil analisis dokumen, keseluruhan modul mengandungi 9 elemen ESD daripada 11 elemen. Tiga elemen tertinggi ialah konteks tempatan, sistem pengetahuan dan perlindungan pengurusan alam sekitar. Sementara, 2 elemen yang tiada ialah elemen keamanan dan transformasi kerana modul tersebut direka khas untuk penilaian tempatan Kuantan Singingi (WWF Riau:2022). Modul gred 7 mempunyai 1196 kod; modul gred 8 mengandungi 1371 kod manakala modul gred 9 mempunyai 1221 kod. Daripada hasil analisis modul gred 7, tiga elemen ESD paling dominan ialah sistem pengetahuan 350, konteks tempatan 327 dan perlindungan dan pengurusan alam sekitar 194. Elemen sistem pengetahuan dalam tema menganyam modul gred 7 menunjukkan proses pembelajaran tentang kraf tradisional kuantan singingi yang berasal dari bahan semula jadi di sekolah. Selain itu, pelajar juga digalakan untuk mengamalkan kemahiran ini. Hasil tinjauan kepada amalan ini menunjukkan kesemua modul mengandungi elemen ESD. Jadual 1 menerangkan contoh elemen ESD yang terkandung dalam modul gred 7.

Jadual 1 contoh elemen ESD yang terkandung dalam modul gred 7

Modul	Tema:	Elemen ESD:	Rujukan ditemukan pada bahagian kompetensi inti:
Gred 7	Menganyam	Sistem Pengetahuan	Memahami prosedur pengaplikasian ragam hias pada bahan semula jadi

Sumber jadual: Analisis dokumen 2023

Berdasarkan hasil temu bual semi berstruktur yang diperolehi, kesemua informan mempunyai asas pengetahuan tentang ESD. Walau bagaimanapun, mereka hanya memfokuskan pilar alam sekitar sebagai pilar utama ESD. Penggunaan terminologi ESD di Indonesia cenderung bersilih ganti dengan pendidikan alam sekitar. Usaha tambahan diperlukan agar guru dapat memahami perkaitan antara pilar ekonomi dan sosial di dalam amalan ESD (Kelompok kerja NGO-ESD di Indonesia: 2014). Selain itu, dari pada data temu bual, seluruh informan menjelaskan bahawa tema dalam modul seperti *Pacu Jalur*, dan *Lopek Boruak*, mengandungi elemen ESD. Informan B menjelaskan bahawa tema *pacu jalur* mempunyai elemen budaya, konteks tempatan dan alam sekitar. Giliberto F (2021) menjelaskan bahawa warisan budaya memiliki kaitan rapat terhadap pembangunan lestari. Selain pendidikan, budaya menjadi alat yang dapat merealisasikan matlamat pembangunan lestari.

## 6. KESIMPULAN

Kajian ini menunjukkan elemen ESD yang terkandung pada “*Modul Tematik Prakarya, Seni Budaya dan Budaya Melayu Riau Berbasis Muatan lokal Kuantan Singingi*”. Tiga elemen tertinggi ialah konteks tempatan, sistem pengetahuan dan perlindungan pengurusan alam sekitar. Hal ini kerana modul tersebut direka untuk membantu guru dalam mengajar ESD sekaligus memelihara budaya dan alam sekitar Kuantan Singingi.

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**PEMBANGUNAN BIOSENSOR ELEKTROKIMIA BERASASKAN DNA G-KUADRUPLEKS  
TELOMERIK MANUSIA SEBAGAI UJIAN BERDEKATAN PESAKIT (POC) UNTUK PENGESANAN  
RNA VIRUS SARS-CoV-2**

*Nadiah Ibrahim | P110052 | Doktor Falsafah*

Penyelia:

*Prof. Madya ChM. Dr. Tan Ling Ling*

*Dr. Nurul Yuziana Mohd Yusof*

*Prof. Madya ChM. Dr. Goh Choo Ta*

## 1. PENGENALAN

Kemunculan sindrom pernafasan akut teruk 2 (SARS-CoV-2) yang mula dikesan di China pada akhir Disember 2019, telah mencetuskan satu pandemik yang berterusan secara global (Zhu et al. 2020). Penjujukan daripada daya pemprosesan tinggi mendedahkan bahawa ianya adalah koronavirus sindrom pernafasan akut teruk 2 (SARS-CoV-2) yang kemudian ditetapkan sebagai penyakit koronavirus baru 2019 (COVID-19) pada Februari 2020 oleh Pertubuhan Kesihatan Sedunia (WHO) (Wang et al. 2020). Walaupun virus ini berasal daripada keluarga yang sama dengan SARS, penularan dan keparahan penyakit COVID-19 jauh lebih tinggi dalam kalangan masyarakat. Sehingga 5 Julai 2023, sejumlah 5 122 019 kes positif COVID-19 dengan 37 152 kes kematian telah dilaporkan di Malaysia (WHO, 2023). Kegagalan untuk mendiagnosis jangkitan virus COVID-19 pada saluran pernafasan dengan cepat dan tepat akan mengakibatkan penularan wabak dengan lebih teruk dan peningkatan jumlah kes yang lebih banyak.

## 2. PERMASALAHAN KAJIAN DAN SOROTON KAJIAN

Terdapat beberapa jenis kit ujian sedia ada untuk mengesan COVID-19. Antaranya ialah kit ujian pantas antigen (RTK-Ag) dan kit ujian pantas antibodi (RTK-Ab) yang telah dibangunkan sebagai teknik alternatif yang mudah, murah dan mengambil masa yang cepat untuk mendapatkan keputusan ujian iaitu di antara 15 hingga 30 min sahaja. Walau bagaimanapun, RTK-Ag dan RTK-Ab tidak sesuai untuk dijadikan sebagai ujian pengesanan COVID-19 pada peringkat awal jangkitan kerana ujian RTK-Ag kurang peka terhadap virus pada kepekatan yang rendah (Al-Alawi et al. 2021) dan bagi ujian RTK-Ab memerlukan kepekatan antibodi yang tinggi untuk pengesanan, di mana penghasilan antibodi mengambil masa beberapa hari sehingga beberapa minggu (Saberian et al. 2020). Tindak balas berantai polimerase masa nyata (qRT-PCR) tetap menjadi teknik piawai semasa disebabkan kepekaan yang tinggi serta keupayaan untuk menghasilkan banyak salinan jujukan DNA daripada sejumlah kecil bahan genetik. Walau bagaimanapun, teknik ini tidak dapat dilaksanakan dengan baik di semua hospital, kerana ia memerlukan makmal diagnostik molekul, kakitangan khas, peralatan yang mahal dan masa yang agak lama untuk mengesahkan sampel klinikal (Pillet et al. 2013). Oleh itu, ujian berdekatan pesakit atau dikenali sebagai alat POC yang mudah, cepat dan menjimatkan kos untuk mengesan RNA virus SARS-CoV-2 sangat diperlukan untuk mengatasi kekurangan qRT-PCR. Kebelakangan ini, biosensor elektrokimia telah menarik banyak perhatian kerana kepekaan yang tinggi, lebih spesifik, kesederhanaan fabrikasi, kemudahan operasi dan keberkesanan kos (da Silva et al. 2017). Biosensor RNA elektrokimia digunakan untuk amplifikasi isyarat transduksi daripada

tindak balas hibridisasi DNA, yang membolehkan pengesanan kuantitatif RNA/DNA. Beberapa kajian pembangunan biosensor elektrokimia telah dilakukan untuk pengesanan RNA virus SARS-CoV-2 yang menggunakan nanopartikel untuk meningkatkan isyarat biosensor (Alafeef et al. 2020; Chaibun et al. 2021; Heo et al. 2022). Walau bagaimanapun, terdapat beberapa isu dalam kajian terdahulu seperti fabrikasi yang agak rumit dan memerlukan kos yang lebih mahal. Dalam kajian ini, biosensor berasaskan DNA G-kuadrupleks dibangunkan untuk pengesanan RNA virus SARS-CoV-2 yang lebih mudah dari segi fabrikasi dan lebih kos efektif kerana hanya menggunakan metilena biru sebagai penunjuk redoks berbanding penggunaan nanopartikel yang digunakan dalam kajian yang terdahulu tetapi masih lagi dapat memberikan nilai had pengesanan yang rendah.

### 3. OBJEKTIF KAJIAN

Untuk mengoptimumkan ransangan biosensor elektrokimia berdasarkan kekuatan ionik, kesan pH dan masa rangsangan RNA biosensor dengan menggunakan teknik voltametri denyutan pembezaan (DPV) bagi memperolehi had pengesanan yang rendah.

### 4. KAEDAH KAJIAN

Fabrikasi biosensor RNA elektrokimia dilakukan melalui modifikasi ke atas permukaan elektrod karbon bercetak skrin (SPCE) dengan lapisan 4-karboksifenil menggunakan teknik *electrografting* dan diaktifkan dengan campuran agen taut-silang N-(3-Dimetilaminopropil)-N'-etilkarbodiimida (EDC) dan N-hidroksisuksinimida NHS untuk mengikat prob DNA G-kuadrupleks melalui ikatan amida. Beberapa faktor yang mempengaruhi prestasi isyarat voltametri biosensor berasaskan rangsangan penunjuk redoks MB adalah seperti kekuatan ionik (ion  $K^+$  dan  $Na^+$ ), pH larutan penimbal prob dan tempoh masa penghibridan DNA/RNA telah dioptimumkan untuk pengesanan RNA virus SARS-CoV-2.

### 5. KEPUTUSAN DAN PERBINCANGAN

Parameter pencirian biosensor elektrokimia RNA seperti kesan kepekatan kation  $K^+$  dan  $Na^+$ , pH larutan penimbal prob dan tempoh penghibridan RNA ke atas kompleks DNA G-kuadrupleks/MB telah dioptimumkan untuk memperolehi prestasi biosensor RNA elektrokimia yang tinggi. Kepekatan KCl ditetapkan pada 350 mM bagi pembentukan kompleks DNA G-kuadrupleks/MB yang stabil. Manakala 0.25 M ion  $Na^+$  telah dipilih sebagai kepekatan optimum untuk hibridisasi di antara jujukan pelengkap pada gelung DNA G-kuadrupleks dengan RNA sasaran. pH 7 dipilih sebagai pH optimum untuk perubahan konformasi G-kuadrupleks sewaktu hibridisasi dengan RNA sasaran menjadi struktur bebenang ganda dua (dsDNA). Masa penghibridan DNA G-kuadrupleks dan RNA yang optimum ialah selama 30 min. Kepekaan biosensor RNA elektrokimia berasaskan rangsangan arus redoks MB yang mengikat pada dsDNA diukur apabila kompleks DNA G-kuadrupleks/MB diuji dengan kehadiran RNA sasaran sintetik pada kepekatan yang berbeza (1 zM-1  $\mu$ M). Pembukaan kompleks DNA G-kuadrupleks/MB yang responsif terhadap RNA sasaran membentuk kompleks dsDNA/MB, dan meningkatkan arus redoks ligan MB pada permukaan transduser. Had pengesanan (LOD) biosensor merupakan kepekatan RNA sasaran terendah yang boleh dikesan ditentukan berdasarkan persamaan:  $3.3 \sigma/s$  di mana  $s$  ialah kecerunan lengkung kalibrasi dan  $\sigma$  ialah sisihan piawai ransangan latar belakang sampel kawalan diperolehi pada 0.59 zM.



## 6. KESIMPULAN

Biosensor elektrokimia yang dicadangkan melibatkan pengesanan bebas amplifikasi asid nukleik berdasarkan arus redoks MB-terjerap dsDNA apabila kompleks G-kuadrupleks/MB menjalani peralihan struktur ke dsDNA yang menghasilkan isyarat redoks MB yang lebih tinggi pada antara muka elektrod-elektrolit setelah berlaku hibridisasi dengan RNA sasaran. Pengesanan RNA sasaran pada kepekatan yang berbeza menunjukkan rangsangan linear yang baik dalam julat 1  $\mu\text{M}$ -1  $\text{zM}$ . Nilai LOD yang diperolehi membuktikan biosensor yang dibangunkan dapat mengesan RNA virus SARS-CoV-2 pada kepekatan yang sangat rendah. Justeru itu, kajian pembangunan biosensor elektrokimia ini dapat digunakan sebagai alat POC yang tepat, cepat, mudah difabrikasi dan kos efektif untuk pengesanan RNA virus SARS-CoV-2 dan seterusnya juga dapat mengatasi masalah kekangan alat diagnosis pada masa kini.

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## PM<sub>2.5</sub> COMPOSITION AND HEALTH IMPACT ASSESSMENT OF LOW-COST RESIDENTIAL INHABITANTS IN KUALA LUMPUR

*Intan Nuramera Yusaini | P115841 | Master*

Supervisors:

*Ts. Dr. Murnira binti Othman (UKM)*

*Prof. Dr. Mohd Talib bin Latif (UKM)*

*Assoc. Prof. Tomoki Nakayama (Nagasaki University)*

### 1. INTRODUCTION

Areas of rapid urbanization are often associated with increased economic activities and Kuala Lumpur has grown significantly as a prominent city since the Asian Economic Boom in the early 1990s (Federal Territories Election Office Kuala Lumpur / Putrajaya, 2023). Therefore, migration from rural areas was mainly driven by a desire to increase their income and earn a better life. As a result, there is a huge need for urban housing due to the enormous number of migrations from the countryside to the city each year (Wahi et al., 2018). Referring to the World Health Organization, during the year of 2020, household air pollution was thought to be the cause of 3.2 million annual deaths, including approximately 237,000 deaths of children under the age of five and 6.7 million premature deaths per year are attributed to the impacts of household and ambient air pollution combined (2023). For instance, during pandemic Covid-19, the concurrent outbreaks of infectious and air pollution-mediated disease was promptly recognised as having potentially disastrous public health ramifications by Nwanaji-Enwerem et al. (2020). The inhabitants mostly stayed indoors during lockdown as opposed to outdoors, and the interior conditions with poor outside air ventilation also plays a crucial role. It is importance to monitor indoor air pollution particularly related to the Particulate Matter (PM<sub>2.5</sub>) composition which affected the health of residents.

### 2. PROBLEM STATEMENT

The issue of inadequate indoor ventilation system quality, especially in low-cost housing, affects the rate of infiltration and accumulation of suspended particles with an aerodynamic size of <2.5 µm (PM<sub>2.5</sub>) which affects indoor air quality. The air quality of the housing environment is also a key issue that needs to be evaluated because low-cost housing in the city has a high rate of exposure to vehicle fumes. The PM<sub>2.5</sub> can irritate and erode the alveolar wall, which in turn affects lung function (Xing et al., 2016).

### 3. OBJECTIVE

The main objective of this research is to determine the composition of PM<sub>2.5</sub>, the concentration level of PM<sub>2.5</sub> between indoor and outdoor as well as indoor particle concentration in low-cost housing areas and to analyze the assessment of health risk burden through PM<sub>2.5</sub> exposure.

#### 4. METHOD

A total of 32 housing units were used as study areas located in 11 different Parliamentary constituencies of the Federal Territory of Kuala Lumpur, namely Kepong Parliament, Batu, Wangsa Maju, Segambut, Setiawangsa, Titiwangsa, Bukit Bintang, Lembah Pantai, Seputeh, Cheras and Bandar Tun Razak (Federal Territories Election Office Kuala Lumpur / Putrajaya). The characteristics of the selected area are located near major roads, toll plazas, federal highways, hospitals, light rail and monorail transit stations, and shopping malls. PM<sub>2.5</sub> sampling was carried out using low volume air samplers in indoor and outdoor air throughout May to September 2022. The determination of water-soluble inorganic ionic composition in PM<sub>2.5</sub> was determined using ion chromatography while trace elements were determined using inductively coupled plasma beam mass spectroscopy (ICP-MS). In fact, the use of PM<sub>2.5</sub> sensors and condensing particle counters (CPC) are applied to identify the concentration of PM<sub>2.5</sub> and the number of air particles in residents' homes as well as using the AirQ+ software to detect both short-term and long-term changes in ambient air pollution, as well as measuring the health burden and consequences of air pollution (World Health Organization, 2023).

#### 5. RESULTS AND DISCUSSION

The results of ionic findings obtained in low-cost housing areas such as chloride (Cl<sup>-</sup>), sulfate (SO<sub>4</sub><sup>2-</sup>), nitrate (NO<sub>3</sub><sup>-</sup>), bromide (Br<sup>-</sup>), nitrite (NO<sub>2</sub><sup>-</sup>), phosphate (PO<sub>4</sub><sup>3-</sup>), calcium (Ca<sup>2+</sup>), magnesium (K<sup>+</sup>), sodium (Na<sup>+</sup>) and trace elements such as aluminum (Al), zinc (Zn) and plumbum (Pb). Additionally, the average indoor PM<sub>2.5</sub> concentration was 50.0 ± 2.0 µg/m<sup>3</sup> and the average outdoor concentration recorded 135.0 ± 2.0 µg/m<sup>3</sup>. Overall, residents of low-cost housing in Titiwangsa Parliament are the most affected by the impact of particle exposure on health.

#### 6. CONCLUSION

Therefore, monitoring and mitigating plans for housing inhabitants of air indoor and outdoor air quality need to be done to encourage sustainable development towards improving the health and well-being of the population, especially in the central areas of the city.

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## ASSESSMENT OF PHYSICO-CHEMICAL AND BIOLOGICAL PARAMETERS OF GROUNDWATER IN NORTHERN WEST BANK, PALESTINE, AND MANAGEMENT OF GROUNDWATER SOURCES

*Ashraf M M Zohud | P110470 | Doctor of Philosophy*

Supervisors:

*Assoc. Prof. ChM. Dr. Goh Choo Ta*

*Dr. Lubna Alam*

### 1. INTRODUCTION

Groundwater remains a major and an essential source of drinking water around the world. Groundwater becomes increasingly vital in arid and semi-arid regions that are already suffering water scarcity and unevenly distributed (Wu et al. 2017; Singhal et al. 2020). In West Bank, Palestine groundwater from wells and springs is the main source of drinking water. This groundwater is highly vulnerable to pollution given the karstic nature of the aquifer and due to various human activities (Jonoski et al. 2023; Tal-Spiro 2011; Campanale et al. 2022). Groundwater pollutants include mainly inorganic salts (TDS), toxic metals, cations (e.g., potassium (K), sodium (Na), calcium (Ca), and magnesium (Mg)), anions (e.g., chloride (Cl), bicarbonate (HCO<sub>3</sub>), nitrate (NO<sub>3</sub>) and sulfate (SO<sub>4</sub>)), and pathogen microorganisms (e.g., bacteria, viruses, and parasites) (Karakuş 2019). Nitrate in drinking water may cause an adverse health risk when the levels exceed the maximum permissible limit of 50 mg/L (WHO 2017) and in West Bank 18% of groundwater exceed the maximum permissible limit of 50 mg/L. To provide essential information for groundwater quality protection and management in the study area, it is important to evaluate the groundwater quality and analyse the hydrogeochemical characteristics and hydrochemical facies of the groundwater and their formation mechanisms, and appraise the groundwater quality for drinking purposes using water quality index (WQI).

### 2. PROBLEM STATEMENT

There is a global shortage of potable water, and Palestine is no exception (Hejaz et al. 2020). Palestinian in the West Bank use groundwater as the main source of water with approximately more than 90% of the total water supply (Trottier 2019). Due to the karstic character of the aquifer and various human activities including untreated wastewater, pesticides, and chemical fertilizers, animal farm waste, and unsanitary landfills, this groundwater is extremely susceptible to contamination (Mahmoud et al. 2022; Campanale et al. 2022). Importantly, an elevated of chemical and/or biological pollutants exceed the acceptable limits, it will increase the risks to human health (Yadav 2016). Several studies in Palestine have shown that some chemical concentrations in groundwater are rising, such as nitrate (Hejaz et al. 2020; Ahmad and Ghanem 2021). Monitoring the sources of pollution in the water recharge areas of the aquifers is extremely important and would help in managing the water resources in a highly effective way (Judeh et al. 2017). The lack of Palestinian control over their water resources due to political circumstances has affected the essential quantities of water needed by Palestinians, who are already suffering a shortage in water supplies. For this end it has become necessary to protect water sources from pollution in order to maintain the quality and sustainability of these sources. This research therefore attempts to assess water quality in the northern West Bank, Palestine

and estimate potential health risks, and identify vulnerable zones considering the pollution sources and propose recommendation for the groundwater management.

### **3. OBJECTIVE**

The study has four main objectives around the issue of groundwater quality of in terms of physico-chemical and microbiological properties, and heavy metals concentrations, to discover the health risks and management of groundwater, in the northern West Bank, Palestine including: (i) To examine the concentration of selected physico-chemical and biological parameters in groundwater collected from the northern West Bank in Palestine; (ii) To identify vulnerable zones considering the pollution sources; (iii) To estimate potential health risk associated with groundwater contamination; (iv) To propose recommendation for the groundwater management in the Northern West Bank of Palestine. Presentation for the colloquium focuses on the first objective of the study, which is to examine the concentration of selected physico-chemical and biological parameters in groundwater collected from the northern West Bank in Palestine.

### **4. METHOD**

Total of 63 groundwater (49 wells out of 100 existing wells and 14 of the most utilized drinking water springs) sample spatially distributed in the Northern part of West Bank were selected in this study to represent different governorates (Nablus, Qalqilya, Jenin, Tulkarm, Tubas and Salfit) and basins (Western Aquifer Basin, and North-eastern Aquifer). Groundwater samples from the 63 groundwater wells and springs were taken during the year 2021 covering dry and wet seasons. The methodology of this study involves sampling through field work and laboratory testing of water quality parameters using standard procedures based on the guidelines by WHO (WHO 2017). Determine of EC, Salinity, and pH by using HQ40 Portable Meter, HACH (APHA et al. 1995). TDS is determined by filtering a measured volume of sample through a standard glass fiber filter (CFR 1996). The concentration of nitrate, sulfate and fluoride in water will be determined using an UV Spectrophotometer (APHA et al. 1995). The concentration of Ca, Mg, Na, K, Zn, Ba, Cd, Cr, Al, Pb, Ni, Cu, As. in water will be determined using optical emission spectrometer (optima 7300 dv) (APHA et al. 1995). TH of water was determined by titrating with a standard solution of ethylene diamine tetra acetic acid (EDTA) which is a complexing agent (APHA et al. 1995). Chloride was estimated by AgNO<sub>3</sub> titration (APHA et al. 1995). The HCO<sub>3</sub> was estimated by the volumetric method, using hydro sulfuric acid (H<sub>2</sub>SO<sub>4</sub>), phenolphthalein and methyl orange indicator (APHA 1995).

Piper's trilinear diagrams is a useful visual tools for classifying groundwater and explains the association and variation among different kinds of groundwater (Piper 1944). Moreover, Water Quality Index (WQI) was used to evaluating groundwater quality (Zeidan 2017; Ahamad et al. 2019). In addition, statistical analysis was used, and data were processed and examined using Excel and the R program (Team 2020). To explain the fundamental characteristics of the data in the study area, a collection of descriptive statistics was performed after the data had been preprocessed.

## 5. RESULTS AND DISCUSSION

All groundwater samples which collected in wet and dry season in the study area have electrical conductivity (EC), total dissolve solid (TDS), sodium (Na), chloride (Cl), sulphate (SO<sub>4</sub>), fluoride (F), and heavy metals values within the PSI and WHO. In contrast, nitrate (NO<sub>3</sub>), calcium (Ca), magnesium (Mg), and potassium (K) are exceeding the permissible limit Table 1. Total hardness (TH) shows that 87.7% are fall in the very hard water category. The following trend was observed for the anion concentrations: HCO<sub>3</sub> > Cl > NO<sub>3</sub> > SO<sub>4</sub> > F, while the cation concentrations were found to follow the order of Ca > Na > Mg > K. Moreover, faecal coliform in wells < springs. In classification of groundwater wells and springs based on Piper diagram, 65% of the groundwater well were normal earth alkaline water with prevailing bicarbonate (Ca-Mg-HCO<sub>3</sub>), 33% earth alkaline water with increased portions of alkalis with prevailing bicarbonate (Ca-Mg-HCO<sub>3</sub>-Cl), (Ca-Mg-Na-HCO<sub>3</sub>-Cl), (Ca-Na-HCO<sub>3</sub>-Cl) and 2% alkaline water with prevailing chloride (Na-Ca-Mg-Cl-HCO<sub>3</sub>) (Na-Ca-Cl-HCO<sub>3</sub>). Likewise, the WQI values indicated that the majority of the analysed samples were of good quality with only one spring showing poor quality.

Table 1. Statistical summary of chemical composition of groundwater in the study are

Parameters /Unit	Season	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	PSI	WH O
		Wells				Springs					
pH	dry	7.47	0.18	7.1	8.3	7.72	0.25	7.3	8.21	6.5-8.5	6.5-8.5
	wet	7.5	0.22	7.04	8.3	7.59	0.21	7.3	7.95		
EC $\mu$ S/cm	dry	829.6	175.1	504	1261	619.6	197.3	346	1069	-	-
	wet	819	173.6	521	1232	658.6	214.8	390	1053		
TDS mg/L	dry	477.4	100.2	292	731	363.5	110.2	210	620	1000	1000
	wet	474.4	100.2	302	714	381.8	124.4	226	669		
NO <sub>3</sub> mg/L	dry	40.6	27	0.5	110	35.3	35.7	2.57	139.1	50	50
	wet	38.7	26.2	0.3	107	37.5	37.3	2.57	139.9		
F mg/L	dry	0.28	0.12	0	0.7	0.11	0.076	0	0.2	1.5	1.5
	wet	0.28	0.12	0	0.74	0.13	0.065	0	0.21		
SO <sub>4</sub> mg/L	dry	25.5	12.6	0	65	22.94	16.1	0.5	58.6	200	250
	wet	26.5	13.4	0.5	67.1	23.4	15.3	8.31	58		
Cl mg/L	dry	71.2	39.9	26	249	48.7	22.3	23.5	101.1	250	250
	wet	72.7	39.7	24.4	246.1	46.6	23.16	22	102.9		
Ca mg/L	dry	86.8	17.9	53	135	80.1	19.2	53.5	117.2	100	75
	wet	90.1	18.5	54.5	143.8	86.6	19.95	58	129		
Mg mg/L	dry	32.6	6.6	14.6	54	20.3	12.7	3.9	44.5	100	30
	wet	33.2	6.7	14	52.4	20.4	13.1	2.6	45		
K mg/L	dry	4.2	5.6	0.1	27.7	3.1	5.5	0.152	17.6	10	-
	wet	4.3	6.1	0.1	31.6	3.3	5.88	0	18		
Na mg/L	dry	39.9	21.1	15.5	131	25.4	15.2	11.7	66.11	200	200
	wet	39.3	20.4	15	129.9	24.1	15.4	11	66		
TH mg/L	dry	358	61.8	260	540	288.5	75.3	221	435	500	500
	wet	356.3	62	255	533.5	293.9	80	199.7	453.2		
TA (HCO <sub>3</sub> ) mg/L	dry	312.5	46	165	420	246.5	48.3	189.1	340	-	-
	wet	308.5	50.4	164.4	434.9	254.7	49.8	194	350.5		



## 6. CONCLUSION

Groundwater monitoring is crucial to protect it from pollution and thus maintain its sustainability. The groundwater in the study area is potable. While the high concentration of nitrates is a problem. According to the WQI in wells and springs, 98.4% of groundwater samples is suitable for drinking.

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# PENGHARGAAN

Jawatankuasa Kolokium Siswazah LESTARI 2023 merakamkan setinggi-tinggi penghargaan kepada semua yang terlibat secara langsung mahupun tidak langsung dalam menjayakan Kolokium Siswazah LESTARI 2023. Semoga keterlibatan, kerjasama dan komitmen yang diberikan dapat dikekalkan dalam penganjuran Kolokium Siswazah LESTARI di masa hadapan.

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## AHLI JAWATANKUASA KOLOKIUUM SISWAZAH LESTARI 2023

### Penasihat

Prof. Madya Dr. Sharina Abdul Halim

### Pengerusi Kolokium

Gs. Dr. Nurfashareena Muhamad

### Setiausaha

Puan Nur Amira Ahmad

### Jawatankuasa Penilaian Saintifik

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Prof. Dr. Sharifah Zarina Syed Zakaria (SZSZ)  
Prof. Dr. Muhammad Rizal Razman (MRR)  
Prof. Dr. Ahmad Fariz Mohamed (AFM)  
Prof. Madya ChM. Dr. Goh Choo Ta (GCT)  
Prof. Madya Ts. Dr. Lee Khai Ern (LKE)  
Prof. Madya ChM. Dr. Tan Ling Ling (TLL)  
Prof. Madya Dr. Saiful Arif Abdullah (SAA)  
Prof. Madya Dr. Tanot Unjah (TU)  
Dr. Rospidah Ghazali (RBG)  
Dr. Ahmad Aldrie Amir (AAA)  
Ts. Dr. Murnira Othman (MBO)  
Gs. Dr. Nuriah Abd Majid (NAM)  
Dr. Nor Diana Mohd Idris (NDI)  
Ts. Dr. Lim Chen Kim (LCK)  
Dr. Mir Sujaul Islam (MSI)  
Dr. Aziemah Zulkifli (ABZ)

**Moderator :** Prof. Madya Dr. Sharina Abdul Halim (SAH)  
Gs. Dr. Aida Soraya Shamsuddin (ABS)  
Dr. Minhaz Farid Ahmed (MFA)

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**Jawatankuasa Teknikal**

Encik Bisharuzi Omar

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Puan Noor Shafirah Ramli

Puan Nurhayati Abdul Rahim

Encik Mohd Redzuan Zulkipli

**Wakil Pelajar**

Puan Ellena A/P John – Presiden Persatuan Pelajar Siswazah LESTARI

Encik Navakanesh M. Batmanathan – Pengacara Majlis



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UNIVERSITI KEBANGSAAN MALAYSIA

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**INSTITUT ALAM SEKITAR DAN  
PEMBANGUNAN (LESTARI)  
UNIVERSITI KEBANGSAAN MALAYSIA (UKM)**

**T : 03 8921 4149  
E : siswazah\_lestari@ukm.edu.my**