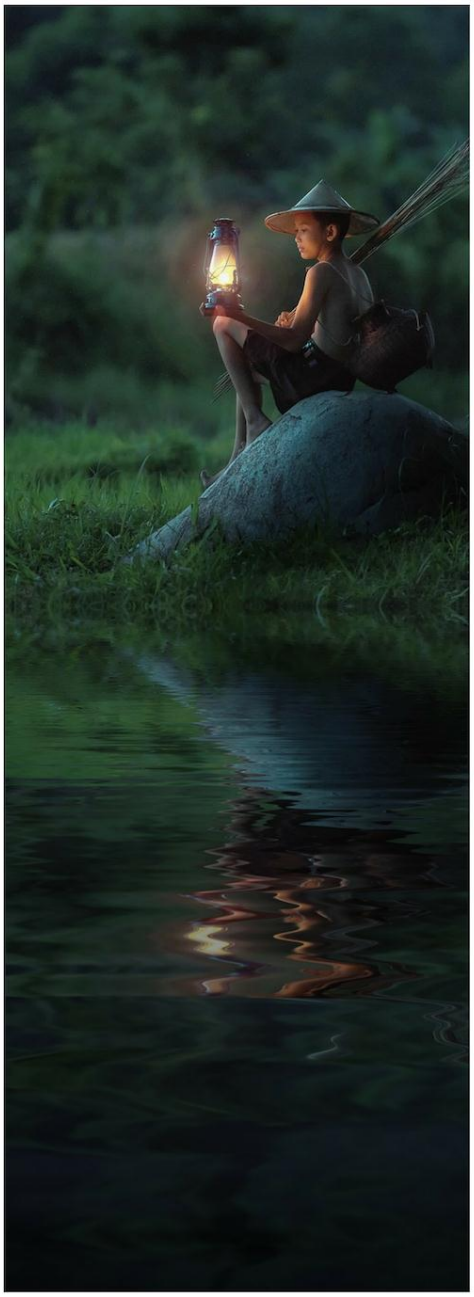

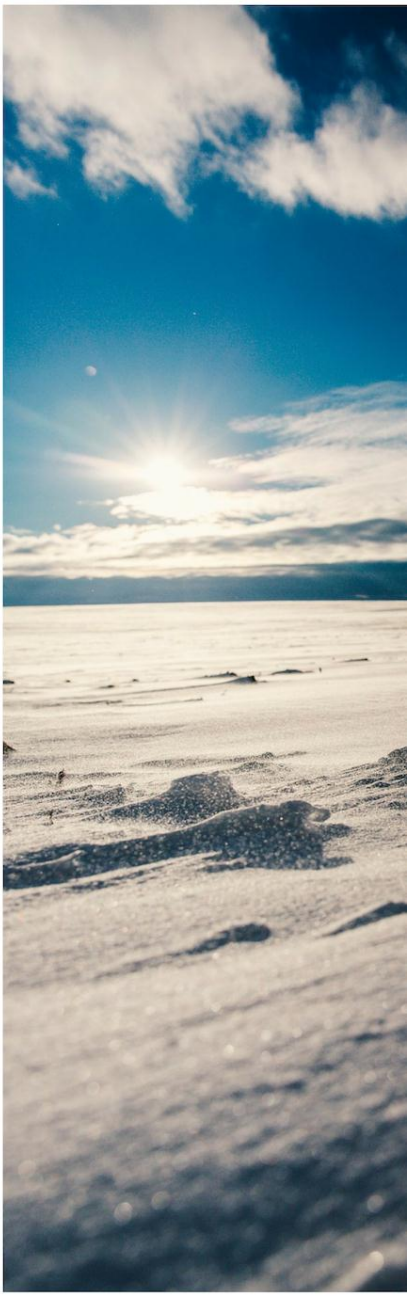

UPM-GIST
JOINT INTERNATIONAL RESEARCH COLLABORATION SYMPOSIUM ON ENVIRONMENTAL SUSTAINABILITY

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ENDOCRINE DISRUPTING COMPOUNDS IN TROPICAL ENVIRONMENT

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ABSTRACT

Endocrine disrupting compounds (EDCs) are contaminants of emerging concern when they were widely detected in global ecosystem, while their nature and extent especially the effects on the ecosystem and human health were not fully understood. With the limited availability of epidemiological studies and experimental toxicology studies, some of their potential environmental impacts are largely known with similar health risks i.e. endocrine dysfunction in living things. Besides the release of EDCs from rapid urbanization, naturogenic factors i.e., physical (altered temperature and wind pattern), chemical (degradation and transformation), and biological (changes in soil and water microbial activity) stressors resulted from climate change had increased the sources and impacts of EDCs on the environment and human health. Moreover, the conventional water treatments that still being used are commonly known for not being efficient in removing the emerging EDCs. Because of the relatively ineffective removal of EDCs in treatment process, the potential human exposure and health risks of EDCs via drinking water intake are of great concern. Notably, the adverse impacts and knowledge gaps of emerging EDCs may be inadequate for governing and mitigating EDCs to protect the environment and ensure access to safe drinking water.

Keywords: Endocrine disrupting compounds (EDCs), emerging contaminants, ecosystem, environmental quality, risk assessment

AWARENESS AND PERCEPTION TOWARDS MANGROVE FOREST CONSERVATION AMONG VISITORS OF TANJUNG PIAI JOHOR NATIONAL PARK

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ABSTRACT

Mangrove forests have served as the habitat of many organisms, especially marine species. However, the destruction of mangrove forests still continues to take place due to economic and political demands. The Tanjung Piai Johor National Park (TPJNP) is one of the important mangrove forest areas that face environmental pollution such as erosion, improper garbage management, and oil spills due to the movement of big ships along the Straits of Malacca. The aim of this study is to test the awareness and perception towards mangrove forest conservation among the visitors of the Tanjung Piai Johor National Park. Each individual was tested on their awareness and perception towards mangrove forest conservation. A total of 403 respondents were selected based on random sampling in the TPJNP which is where the quantitative survey form was distributed. Data were analysed using descriptive analysis, analysis of variance, and cross tabulation chi-square for interpretation. From the analysis, the results revealed that the levels of awareness in terms of knowledge, attitude, and practices of the TPJNP visitors were affected by their age, academic background, employment type, and distance nearest from TPJNP. While for perception, most of the respondents had a positive perception about mangrove forest conservation but their practices and actions for conservation are still low according to the analysis results. Hence, a lot of efforts are needed from policy makers, especially those in the government sector in order to instigate successful conservation efforts in visitors.

Keywords: mangrove forest, Tanjung Piai Johor National Park, awareness, visitors' perception, mangrove forest conservation

SUSTAINABLE CONSUMPTION AND PRODUCTION (SCP) PRACTICES BASED ON THE KITAKYUSHU EXPERIENCE

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ABSTRACT

A survey was conducted to assess Sustainable Consumption and Production (SCP) practices in the dailv lives of 135 local residents in the city of Kitakyushu, Japan. Data was analysed descriptively to identify patterns and practices in the consumption of energy, water, food, waste management, transportation, and housing and buildings. Results from this study will contribute base data on sustainable consumption and production practices and behavior patterns that will function as indicators for measuring progress of SCP related programs and policies. Although an SCP blueprint has been drawn up for Malaysia, there is no framework to measure SCP progress at base level. Kitakyushu is identified as the model green city (OECD, 2013a) to be benchmarked for development of an SCP Framework for Malaysia.

Keywords: Sustainable Consumption and Production (SCP), practices, framework, policy instrument

1. INTRODUCTION

A survey was carried out among local residents in Kitakyushu to identify Sustainable Consumption and Production (SCP) practices in daily life. Kitakyushu City, Japan, which was proclaimed a model green city by the OECD'S Green Cities Programme in 2011 (OECD, 2013b), was identified as the benchmark for developing the SCP framework. Kitakyushu's experience from being a heavily polluted industrial city from the 1950s, and how it emerged and sustained its low carbon city status today should be epitomized. In the 11th Malaysia Plan (2016-2020), Sustainable Consumption and Production is identified as the key strategy in achieving Green Growth (OECD, 2011). In pursuing green growth for sustainability and resilience, the 11th Malaysia Plan identified four focus areas (EPU, 2015). The first focuses on strengthening the enabling environment for green growth through enhancing awareness. The second focus is adopting the Sustainable Consumption and Production concept, which will lead to the creation of green markets. Logically, green consumption demands will generate green production (UNEP,2011). The third focus is conserving natural resources, which could be effected through

sustainable consumption and production. The fourth focus, strengthening resilience against climate change and natural disasters, could be achieved if the first three strategies are in place. To integrate SCP policies into national development plans, practical tools are needed to make progress towards SCP measurable (UNEP, 2010). Therefore, there is a need for an SCP framework with benchmarked targets and indicators so that progress in SCP related programs and policies could be monitored and evaluated. The existence of an SCP framework with indicators will facilitate the implementation of SCP and resource efficiency activities, as well as provide data for policy development. However, there is no report based on a comprehensive SCP framework as yet, although the 11th Malaysia Plan is way past midterm. Reviews were made on major environmental performance indicators and frameworks to identify key indicators and benchmarks for an SCP framework. A baseline study on SCP in Malaysia (Adham et al, 2013) analysed government policies, institutions and practices, which provided useful information in drawing up the National SCP Blueprint for Malaysia (2016-2030). The National SCP Blueprint (2016-2030), a key input document for the 11th Malaysia Plan outlined pathways in which sustainable consumption and production could be achieved in Malaysia through interventions in seven consumption areas: energy, water, wastes, food, transport and mobility, buildings and leisure and entertainment (EPU, 2016). The Global Environmental Performance Index (EPI) framework by Yale University evaluates nine issues areas based on 20 indicators (Hsu et a, 2016). The Malaysia Environmental Performance Index (MyEPI) 2014 assesses environmental sustainability based on one or more indicators in ten policy categories: disease, air pollution, water pollution impact on humans, air pollution impact on ecosystem, biodiversity, forest, fisheries, agriculture, and climate change (Ismail and Abdullah, 2012). In this survey, a questionnaire was developed incorporating practices in the seven consumption areas outlined in the National SCP Blueprint for Malaysia. The objective of this study was to assess SCP practices among local residents in Kitakyushu city. Results from this study provide base data on sustainable consumption and production practices and behavior patterns that will contribute as indicators for development of an SCP framework for Malaysia.

2. METHOD

A survey was carried out to assess SCP practices in daily lives among a local community in the city of Kitakyushu. Respondents were asked on their opinion and practices in the consumption of energy, water, food, waste management, transportation, and housing and buildings. Responses were analysed descriptively to identify significant areas of practices in relation to their environmental disposition.

2.1. Location of Study

Kitakyushu city is located in the southern most island of Kyushu in Japan, with a population of 2 million (City of Kitakyushu, 2011). It is an international industrial and trade city and home to the largest steel industry in Japan. The survey was carried out mainly in the small township of Wakamatsu, and its vicinity.

Fig. 1 Map of Japan

Fig. 2 Kitakyushu City

2.2. Sample Size

Approximately 200 questionnaires were distributed, and 135 completed questionnaires were returned. Respondents consisted of local residents in Kitakyushu city. Since the selected local community includes a university campus, the majority of the respondents consist of students. The criteria for local residents include members of the local community who have resided in Kitakyushu city for more than a year under full-time employment or full-time study. The non-probability sampling method is applied, mainly through judgement and convenience sampling to achieve the minimum sample size required for the survey.

2.3. Data Collection

Self-completion questionnaires were distributed to local residents in Kitakyushu city between June and July 2018. There are several university campuses in Kitakyushu city, so questionnaires were mainly distributed to students and university staff. Completed questionnaires were returned on the spot, or several days later. Collaboration was also sought from the local community centres to distribute the

questionnaire to its members. Questionnaires were left at the centre's office and given to members who came to the centre. Completed questionnaires were collected about two weeks later.

2.4. Instrument

A survey questionnaire was developed to assess SCP practices and environmental disposition among community members in Kitakyushu. Most of the questionnaire items were adopted and adapted from previous research, namely the Global Survey on Sustainable Lifestyle (Evans and Programme, 2011) and OECD's 2011 Survey on Environmental Policy and Household Behaviour (OECD, 2013c). The survey questionnaire (Table 1) consists of three sections. The first is on socio-demographic background of participants, the second section is on SCP practices, and the last section is on environmental disposition.

Table 1. Questionnaire format

Section	**Variables**		**Number of Items**
A. Socio-demographic Characteristics (Open ended, choice)	Socio-demographic Variables		14
B. SCP Practices (5-point Likert Scale)	I.	Energy	14
	II.	Water	13
	III.	Food	13
	IV.	Wastes	14
	V.	Transport & Mobility	10
	VI.	Homes & Buildings	8
C. Environmental Disposition (5-point Likert Scale)	Environmental Disposition Variable		7

2.5. Validity and Reliability

Self-completion questionnaires were distributed to local residents in Kitakyushu city between June and July 2018. There are several university campuses in Kitakyushu city, so questionnaires were mainly distributed to students and university staff. Completed questionnaires were returned on the spot, or several days later. Collaboration was also sought from the local community centres to distribute the questionnaire to its members. Questionnaires were left at the centre's office and given to members who came to the centre. Completed questionnaires were collected about two weeks later. The questionnaire was first reviewed for suitability of content, and language accuracy by several academic experts and members of the targeted community. Corrections and improvement to the questionnaire items were then made based on feedback from the reviewers. The final questionnaire was then sent to five experts to be validated for its content and accuracy in translation. The questionnaire was submitted to the Kyushu Institute of Technology's research ethics committee which approved the questionnaire for distribution to

the local public. Reliability test on the SCP practices scales (Table 2) returned a standardized Cronbach's Alpha value of above 0.70 except for the environmental disposition scale (0.693). A reliability coefficient of 0.70 and above is acceptable for most social science research situation (Hair et al., 2010).

Table 2. Reliability Statistics

Scale	Cronbach's Alpha Based on Standardized Items	No. of Items
1. Energy	.783	14
2. Water	.816	13
3. Food	.753	13
4. Wastes	.748	14
5. Transport	.756	10
6. Homes & Buildings	.746	8

3. RESULTS AND DISCUSSION

3.1. Socio-Demographic Profile of Respondents

Table 3 shows the socio-demographic background of the respondents. Respondents surveyed consisted 71.9 percent male and 28.1 percent female. Most of them (72.6%) were in the age group between 18 to 25 years. This group consists of mainly students (71.9%), and company employees (13.3%). Respondents also include homemakers (10.5%) and retirees (0.7%).

Table 3. Socio-demographic Profile of Respondents

		Number of Respondents (%)
Gender		
	Male:	97 (71.9 %)
	Female:	38 (28.1%)
Age Group		
	18-25:	98 (72.6%)
	26-45:	16 (11.9%)
	46-65:	15 (11.1%)
	Above 65:	6 (4.4%)
Employment Status		
	Student:	97 (71.9%)
	Employee:	18 (13.3%)
	Self-employed:	4 (3.0%)
	Homemaker:	15 (10.5%)
	Retired:	1 (0.7%)
N= 135		

3.2. Sustainable Consumption and Production (SCP) Practices

Descriptive analysis was performed to identify areas and patterns in SCP practices and environmental disposition among local residents in Kitakyushu city. Descriptive means and frequencies

of prominent SCP practices are presented and discussed. This paper presents results on the most common and prominent practices in six consumption areas: energy, water, food, wastes, transport and mobility, and homes and buildings. The percentages given are number of respondents who said they agree or strongly agree to the given statement.

Majority of the respondents said they try to save electricity at home because they want to save money (80.80%), rather than saving the environment (49.20%). The reason given for saving water is similar to saving energy. Eighty percent (80.00%) of the respondents stated saving money as the reason for saving water, compared to 57.0% who would save the environment. For food consumption, 75.60% said they usually eat home-cooked food for dinner, rather than packed food (24.50%). About 81.4% of respondents separate their household wastes using designated garbage bags purchased from the stores. The reason for separating household wastes is because it is required by the city's regulation (85.9%). Some stated that they would be penalized if they do not do it (42.2%). Some said they do it to save the environment (54.10%). The main mode of getting to work or campus is, by bicycle (55.6%), followed by walking (45.2%), by local train (25.9%), car (18.5%), bus (6.9%), and motorcycle (4.4%). For practices regarding homes and buildings, 37% said their homes use natural lighting during the day. 37% use toxic free paint for their homes.

4. CONCLUSION

Transport and waste separation were the main areas in which the local community displayed remarkable sustainable practices. Solid waste material recycling is the iconic community practice and is institutionalised in Kitakyushu city. These consumption practices are either policy driven, or motivated by the economic factor of cost saving.

5. ACKNOWLEDGEMENT

This study is supported by UPM's grant scheme for sabbatical research. Kyushu Institute of Technology (Kyutech) hosted the sabbatical research, while the Malaysian Super Satellite Campus (MSSC) at Kyutech Wakatmasu Campus provided physical space and administrative support.

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EVALUATING THE INFLUENCES OF URBAN DEVELOPMENT ON GROUNDWATER HYDROCHEMISTRY: A CASE STUDY OF LANGAT BASIN

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ABSTRACT

Groundwater is widely used especially for drinking water. The purpose of this study is to determine the spatial distribution of groundwater quality in Langat River basin and to identify the nutrients contamination in the groundwater. Groundwater samples are taken and collected from 15 wells. The parameters that are analyzed are in-situ (pH, temperature, salinity, conductivity, total dissolved solids and dissolved oxygen), major ions (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, HCO^{3-} and SO_4^{2-}) and nutrients (NO^{3-} and PO_4^{3-}). Sampling station 14 is the station that has high minerals that has concentration beyond the permissible value. The piper diagram shows that the groundwater type is sodium chloride (Na-Cl) and mix of sodium bicarbonate chloride (Na-HCO_3-Cl). The mix water type is due to the mixing of freshwater and salt water. The dominance of sodium ion is due to the ion exchange of calcium and magnesium. Nitrate has concentrations below permissible value except for sampling station 14. All sampling stations have phosphate concentrations within the permissible value. Base on the output produced from multivariate analysis, it is found that the groundwater is controlled by both anthropogenic and natural processes. Frequent monitoring should be done to ensure good public health and safe freshwater supply.

Keywords: groundwater, multivariate statistical analysis, Principal Component Analysis

7. INTRODUCTION

The demand of groundwater increases as the development increases (Isa and Aris, 2015), as well as the growth of human population (Ebrahimi et al., 2016). The demands lead to over pumping of the groundwater that cause lowering the groundwater table (Matiatos, 2016; Nguyen et al., 2014) and depleted its quality (Viaroli et al., 2018). Groundwater also can be polluted by natural and anthropogenic source (Gupta and Misra, 2018; Srinivasamoorthy et al., 2014) such as dissolution-precipitation ions,

oxidation-reduction and groundwater recharge-discharge (Singh et al., 2017). According to Selvakumar et al. (2017), industrial waste and municipal solid waste is one of the main sources of surface and groundwater pollution. The chemicals become runoff or leachate then infiltrate and percolate through the soil and enter the groundwater. Urban area is the contaminants multiple-point source of groundwater as illustrated in Fig. 1 (Alberti et al., 2018).

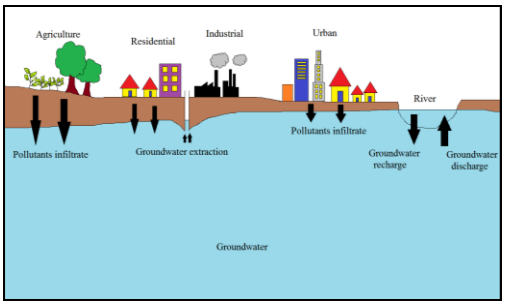

Fig. 1. The groundwater flow in urban area.

Groundwater monitoring is vital for initial investigation as to gather all information in order to sustain the groundwater resources (Kurunc et al., 2016) as well as to have a good groundwater management in agriculture, industry, tourism and also drinking water purposes (Dinka et al., 2015). This study was carried out to: (1) determine the spatial distribution of groundwater quality in Langat River basin and (2) identify the nutrients contamination in the groundwater system.

8. MATERIALS AND METHODS

8.1. Study Area

The study area is conducted within the Langat Basin in Selangor as shown in Fig. 2, which covers an area of 2352 km^2 with the population approximately 200,000 people. Langat Basin typically having a tropical climate with a dry and wet season with humid condition throughout the year. It received an annual rainfall ranging of 1500 and 2900 mm. The average temperature throughout the year is 27°C with the high temperature expected is around the month of April and May while the low temperature is expected occurring in the month of November and December. The landuse of the study area is categorized into urban, agriculture and industrial area as illustrated in Table 1.

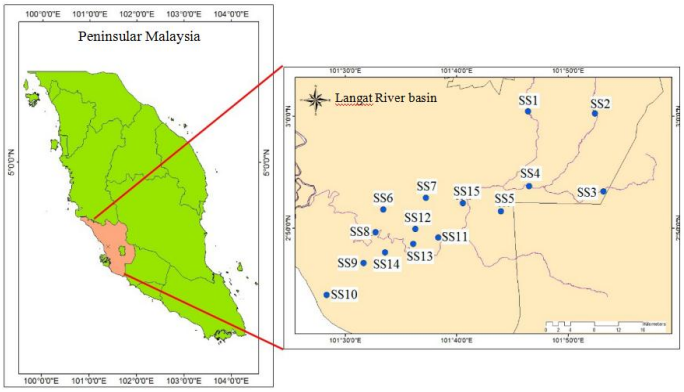

Fig. 2. The study area map and sampling points located in Langat River basin.

Table 1. The location and landuse of each sampling stations.

Sampling station	Location	Landuse
SS1	Kajang	Urban
SS 2	Semenyih	Agriculture
SS 3	Klinik Kesihatan Beranang	Urban
SS 4	Bangi Lama	Urban
SS 5	Jenderam Hulu	Agriculture
SS 6	Jenderam Hilir	Agriculture
SS 7	Paya Indah Wetland	Agriculture
SS 8	Banting	Urban
SS 9	Agensi Angkasa Malaysia	Agriculture
SS 10	Kampung Endah	Agriculture
SS 11	Pondok Bustanul Arifin, Banting	Agriculture
SS 12	Tangki Air Selangor, Olak Lempit	Urban
SS 13	Kampung Sungai Kelambu, Banting	Industrial
SS 14	Maahad Ihya Al-Ahmadi, Banting	Agriculture
SS 15	Kampung Dato Ahmad Razali, Dengkil	Urban

8.2. Groundwater sampling and analysis

Groundwater samples were collected and stored using polyethylene-bottles. The bottles were acid-washed overnight with 5% nitric acid, rinsed with deionized water and dried overnight in the oven. At the field, the coordinate and water level were taken and the groundwater was pumped for 10-20 minutes before collecting the water samples to avoid stagnant (Wang et al., 2017) and polluted water (Annapoorna and Janardhana, 2015). In-situ parameters of pH, temperature, salinity, conductivity (EC), total dissolved solids (TDS) and dissolved oxygen (DO) were measured using multi-parameter probe.

All samples were filtered except for HCO_3^- and Cl^-. For cations analyses, the samples were preserved with concentrated nitric acid after filtration. All samples were kept at 4ºC prior to

transportation. Anions of HCO_3^- and Cl^- were analyzed by titration method based on APHA 2010. While sulphate ($SO_4^{2-)}$ and other nutrients (NO_3^- and PO_4^{3-}) were measured using HACH Spectrophotometer DR2800 by adding reagent powder pillow. Cations (Ca^{2+}, Mg^{2+}, Na^+, K^+) were analyzed with Atomic Absorption Spectrophotometry (AAS). All data were analyzed for ANOVA test, correlation test and multivariate analyses using Statistical Package for Social Sciences (SPSS) Version 20. Meanwhile, the piper diagram was used to determine the groundwater type of Langat basin.

9. RESULTS AND DISCUSSION

3.1. Physicochemical parameters

The physicochemical parameters that were measured in this study were pH, temperature, salinity, conductivity (EC), total dissolved solids (TDS) and dissolved oxygen (DO) as shown in Table 2. One way between group ANOVA tests was carried out and the results show that all in-situ parameters have significant difference between 15 sampling stations, $p < 0.05$. Table 3 shows the descriptive statistics for the physicochemical parameters. The results obtained were compared with the Drinking Water Standard made by World Health Organization (WHO) and Ministry of Health Malaysia (MOH). The pH of the groundwater ranged from 4.40 to 7.42. Most of the sampling stations have pH less than the permissible limit. Sampling station 5 and 15 record the lowest pH value of 4.61 and 4.40. The low pH value might be due to the reaction of water and carbon dioxide that eventually produce hydrogen ions that lower the pH of the water (Isa et al., 2012). Temperature varies from 28.10 to 31.10 ºC. Dissolved oxygen (DO) ranged from 0.62 to 2.19 mg/L.

The result shows that TDS and conductivity increase as salinity increase. The Pearson correlation test conducted revealed that TDS, salinity and conductivity (EC) have strong positive relationship, r = 1.00. Salinity ranged from 0.01 to 8.31 ppt. Conductivity varies from 36.1 to 16106.00 µS/cm. Sampling stations 9, 10, 11, 13 and 14 have exceeded the permissible limit of 500 mg/L (WHO). TDS for sampling stations 9, 10, 11, 13 and 14 also exceeded the permissible value according to the concentrations of salinity and conductivity. Consuming drinking water that contains high TDS cause gastrointestinal irritation in human (Mukate et al., 2017). Sampling station 10 has the highest salinity, conductivity and TDS value because of its location near the sea. While sampling station 9, 11, 13 and 14 are located at the urban and agriculture area.

Table 2. The summary of descriptive statistics for all parameters.

Parameter	Mean	SD	Standard	
			WHO	MOH
pH	6.13	0.89	6.5 - 8.5	6.5 - 9.0
Temperature (ºC)	29.64	0.90	-	-
Salinity (ppt)	1.14	2.22	-	-
Conductivity (µS/cm)	**2286.38**	**4318.75**	**500**	**-**
DO (mg/L)	1.25	0.35	-	-
TDS (mg/L)	**1352.58**	**2534.34**	**500**	**1000**
Bicarbonate (mg/L)	185.93	241.87	500	-
Chloride (mg/L)	74.64	86.77	250	250
Sulphate (mg/L)	38.60	58.22	250	250
Calcium (mg/L)	14.58	22.01	75	-
Magnesium (mg/L)	6.95	6.74	50	150
Potassium (mg/L)	12.85	13.87	200	-
Sodium (mg/L)	24.41	19.64	200	200

3.2. Major ions

The major ions analyzed are categorized into two which is anions and cations. The ions are bicarbonate (HCO_3^-), chloride (Cl^-), sulphate (SO_4^{2-}) for anions and calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^+) and sodium (Na^{2+}) for cations. The one way between group ANOVA shows that all parameters shows significant difference between 15 sampling stations, $p < 0.05$ except for sulphate ($p = 0.073$) and calcium ($p = 0.73$). HCO_3^- ranged from 7.00 to 981.00 mg/L. Cl^- and SO_4^{2-} varies from 19.99 to 499.85 mg/L and 0.00 to 244.00 mg/L. Ca^{2+} varies from 0.05 to 82.65 mg/L. Mg^{2+} and K^+ varies from 0.21 to 25.85 mg/L and 0.31 to 40.51 mg/L. While Na^+ ranged from 2.378 to 59.85 mg/L.

3.3. Groundwater type

The piper diagram shows the groundwater type which is most of the sampling stations has mix of sodium bicarbonate chloride (Na-HCO_3-Cl) and sodium chloride (Na-Cl). The circle labelled (a) is the sodium chloride (Na-Cl) water type while (b) is the mix of sodium bicarbonate chloride (Na-HCO_3-Cl) water type. All sampling stations are dominated by sodium ions due to the cation exchange between Ca^{2+} or Mg^{2+}. Meanwhile, HCO_3^{2-} is the most common anion in the groundwater followed by Cl^-. About 47% of the sampling stations (sampling station 2, 4, 5, 8, 9, 12 and 15) have groundwater type of sodium chloride (Na-Cl).

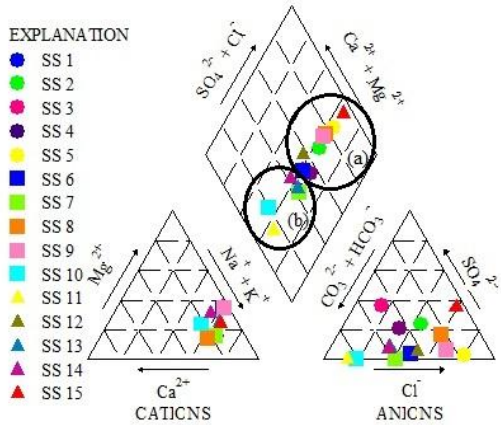

Fig. 3. The piper diagram of groundwater in Langat River basin

3.4. Nutrients

Nutrients of NO_3^- and PO_4^{3-} were analyzed in this study. The one way between group ANOVA shows that there's no significant difference of NO_3^- between all sampling stations, $p > 0.05$. While PO_4^{3-} has statistically significant difference, $p < 0.05$. All data shows that all sampling stations have nitrate concentrations less than permissible value of 50 mg/L (WHO) except for station 14.

3.5. Principal component analysis (PCA)

PCA help in determining the most significant factors that account for the major patterns of groundwater hydrochemistry (Gulgundi and Shetty, 2018). The Kaiser-Meyer-Olkin (KMO) test values of 0.557 and Barlett's test of sphericity (p<0.001) showed the data was sufficient to analyse using PCA (Adelopo et al., 2018). The strength of the physicochemical parameter loading is classified as 'strong' (> 0.75), 'moderate' (0.75 to 0.50) and weak (0.50 to 0.30) (Selvakumar et al., 2017). From PCA, it produced four major components with eigenvalues of the factor explaining 81% of the variance in the data set. PC1 explained 26.97% of the total variance with a strong positive loading found for all major cation which are K^+, Mg^{2+}, Na^+ and Ca^{2+}. According to the Machiwal and Jha (2015), this loading indicates weathering of rock minerals occurred in the groundwater. All of these ions can be found in clay minerals where they might be present in the groundwater through silicate weathering, or carbonate weathering, however this may also attribute by the anthropogenic activity (Voutsis et al., 2015). PC2 accounts for 26.83$ with the loading shows a strong positive loading between TDS, salinity and EC. These represent that these parameters might influence by the same factor. Based on the finding of this study, these parameters show a moderate correlation with HCO_3 and this might suggest that the parameters are actually being influenced by this type of ion (Table 4.3). PC3 exhibit a moderate to strong positive loading of major anions (HCO_3^-, SO_4^{2-} and Cl^-) with a total variance of 17.89% The interaction

between water, soils and rock and weathering of silicate might result in releasing the major anions in the groundwater (Chenini et al., 2015). The presence of this ion can also be due to anthropogenic activities that introduce this ion into the water body mostly through the application of fertilizer in agricultural activities (Khan et al., 2018). The presence of HCO_3^- can be due to the decaying of soil organic matter incorporated with the dissolved of CO_2 reflecting the influence of fertilizer (Zghibi et al., 2014). PC1 until PC3 might imply that these loadings are related to anthropogenic and natural processes. PC4 is considered not important as it explains lower percentage of variance (Zhu et al., 2017). PC4 explains 8.88% of the total variance and characterize by moderate loading of pH and DO and negative loading of temperature. This represents that the high value for DO and pH is more likely in low temperature value. For the pH, the ionization might occur where the H^+ in solution will decrease with temperature and increase in pH. As for the inverse relationship between DO and temperature, this is due to the solubility of oxygen in the water.

Table 3. Principal component loading of measured variables

	Component			
	PC1	PC2	PC3	PC4
Potassium	**0.958**	0.112	0.041	0.024
Magnesium	**0.940**	0.105	0.076	0.139
Sodium	**0.929**	0.147	0.022	0.026
Calcium	**0.814**	0.060	0.057	-0.091
Salinity	0.111	**0.981**	0.097	0.011
Conductivity	0.120	**0.980**	0.102	0.022
TDS	0.123	**0.979**	0.111	0.026
Chloride	-0.037	0.212	**0.882**	0.038
Sulphate	0.146	-0.102	**0.745**	-0.100
Bicarbonate	0.105	0.571	**0.714**	0.096
Dissolved oxygen	0.215	0.121	-0.385	**0.734**
pH	0.042	0.157	0.510	**0.576**
Temperature	0.234	0.373	-0.178	**-0.482**
Eigenvalue	3.505	3.488	2.326	1.154
Total variance	26.965	26.831	17.891	8.880
Total cumulative	26.965	53.796	71.686	80.566

10. CONCLUSION

The groundwater quality in Langat River basin shows the dominance element of HCO_3^- and Na^+ as both of it have the highest concentrations. For anion the order of distribution is $HCO_3^- > Cl^- > SO_4^{2-}$. While for cation $Na^+ > K^+ > Mg^{2+} > Ca^{2+}$. Most of the groundwater type for Langat River basin is sodium chloride (Na-Cl) type followed by sodium bicarbonate chloride (Na-HCO_3-Cl) type. The dominance of Na^+ in the water comes from the ion exchange between Ca^{2+} and Mg^{2+}. The Cl^- was coming from the anthropogenic activities of agriculture activities and wastewater from the urban area. Nutrients of NO_3^- and PO_4^{3-} all complied with the standard made by WHO. Only sampling station 14 have concentration of

NO_3^- beyond 10 mg/L according to MOH. Sampling station 14 also has the highest PO_4^{3-} concentrations of 7.38 mg/L compare to other stations. Meanwhile, the PCA generated show that natural and anthropogenic activities have shown an influence and dominant control toward the groundwater chemistry of Langat Basin.

11. ACKNOWLEDGEMENT

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EXTREME SEA LEVELS IN THE SOUTH CHINA SEA

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ABSTRACT

Hourly sea level records from 34 tide gauges spanning different periods between 1954 and 2014 are used to analyze spatial and temporal variations of extreme sea level (ESL) in the South China Sea (SCS). Tides are one of the main contributors to ESLs particularly in the Malacca Strait. In the northern SCS, the maximum ESLs mainly observed during the Southwest Monsoon are primarily due to the effect of tropical cyclone. In the southwestern SCS, the maximum ESLs can be associated with the Northeast Monsoon. Significant increases in ESLs were observed at more than half of the stations analysed and were found to be mainly driven by changes in mean sea level. The inter-annual variability in ESLs were found to be significantly correlated with ENSO and the monsoon at the stations in the Malacca Strait. The results from this study will contribute as guidance in modelling future changes of ESL in the SCS.

Keywords: extreme sea level, sea level rise, South China Sea, Malacca Strait, tides

1. INTRODUCTION

The South China Sea (SCS), located in Southeast Asia, has one of the world's most vulnerable coastlines to sea level hazards (Neumann et al., 2015; Brown et al., 2013). Several coastal megacities, such as Guangzhou, Bangkok, Ho Chi Minh City and Manila, are located in low-lying coastal regions. The SCS also experiences significant storm surge and resulting coastal flooding events. There are an average of 10 tropical cyclones and 6 typhoons passing through the SCS each year (Wang et al., 2007). Due to the large density populations and high economic importance, sea level rise and extreme sea levels (ESL) will severely threaten this region.

While there have been extensive studies of changes in relative mean sea level (MSL) in the SCS, relatively little research on ESLs in the SCS and the adjacent water bodies, has been undertaken, apart from in the northern SCS (Feng and Tsimplis, 2014; Feng et al., 2015). The characteristics of ESLs in the

southern SCS and its connection with the regional climate variability associated with ENSO, the IOD and the monsoon are still unclear. Furthermore, little is known about the characteristics of seasonal variations in ESL in the SCS. The overall aim of this study is to assess the spatial and temporal characteristic of ESLs in the SCS and their connection with regional climate variability.

2. MATERIALS AND METHODS

Hourly sea level data from 34 tide gauges around the SCS, having records longer than 12 years were obtained from the Research Quality Database of the University of Hawaii Sea Level Center (UHSLC) (Caldwell et al., 2015; http://www.uhslc.soest.hawaii.edu). This dataset cover different periods between 1954 and 2014, with 29 stations having records longer than 20 years. The quality control was performed via visual inspection to remove spurious values of each time series.

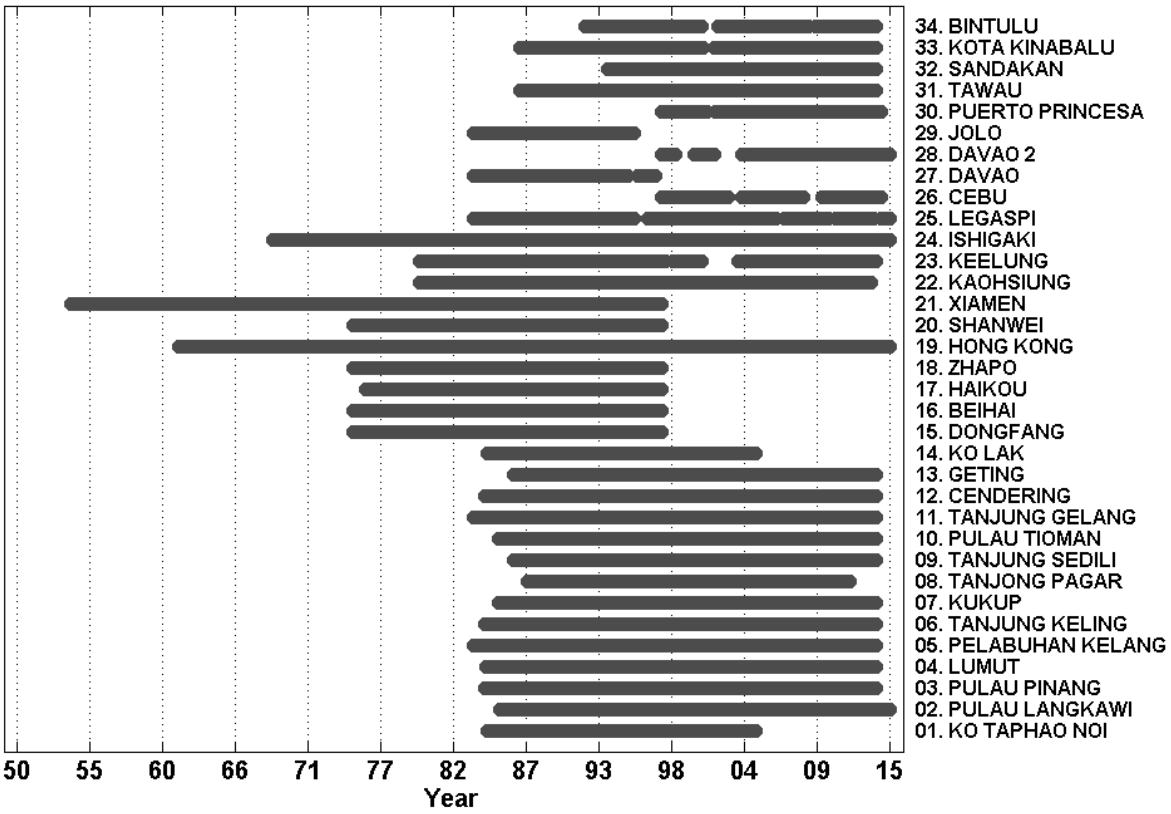

Fig. 1. Duration of the quality controlled hourly tide gauge records available for the study area.

The observed sea level records have been divided into their three main components: MSL, tides and the non-tidal residual (NTR). The MSL component has been estimated on a yearly averaged basis and removed from the observed records. The tidal components were estimated on the basis of harmonic analysis and then removed from the observed sea level at each tide gauge station, thus producing the

NTR. The seasonal variations in sea level extremes in the SCS have been assessed by separating the NTR into four seasons namely the Northeast Monsoon (Dec-Feb), the first Inter-monsoon (March-May), the Southwest Monsoon (Jun-Aug) and the second Inter-monsoon (Sep-Nov).

A percentiles analysis has been used to assess the inter-annual variability and long-term trends in the extreme values. Annual percentiles were computed from the observed sea level and the NTR at the 26 stations containing over 19 years of available data. The inter-annual variability of extremes was correlated with three climate indices (MEI, DMI and WNPMI). Changes in ESL were evaluated by the variation in the 99th percentiles. Trends were calculated using linear regression.

3. RESULTS AND DISCUSSION

The tides, with mean spring tidal ranges up to 5.8 m, are one of the main contributors to sea level extremes particularly in the Malacca Strait. Higher values of maximum extreme sea levels (up to 4 m) (Fig. 2) and maximum non-tidal residuals (up to 1.9 m) are observed in the northern SCS region partly due to the effect of tropical cyclone activity. The seasonal extreme sea level cycle exhibits significant spatial variability in the SCS. Based on the differences of the non-tidal residual with and without the seasonal (annual and semi-annual) component, the largest contribution of the mean seasonal cycle is for the area located in the southwestern SCS and is between 0.2 m and 0.3 m. The southwestern SCS exhibits the most interesting region due to the higher contribution of the mean seasonal cycle and the large differences of maximum NTR between the Northeast Monsoon and the Southwest Monsoon periods.

Significant increases in extreme sea levels were found at more than half of the stations analysed. These changes were found to be primarily driven by changes in mean sea level, in agreement with regional (e.g. Weisse et al., 2014; Feng and Tsimplis, 2014) and global studies (Menéndez and Woodworth, 2010; Mawdsley and Haigh, 2016). The inter-annual variability in extreme sea levels were found to be significantly correlated with ENSO and the monsoon at the stations in the Malacca Strait for the available period 1983-2014. The number of tropical cyclones entering the SCS are found to be connected to the ENSO with greater numbers during La Niña years compared to El Niño period (Goh and Chan, 2010; Feng and Tsimplis, 2014). Interestingly, over the same available period, the monsoon was also significantly correlated to inter-annual variability of the non-tidal residual in the Malacca Strait.

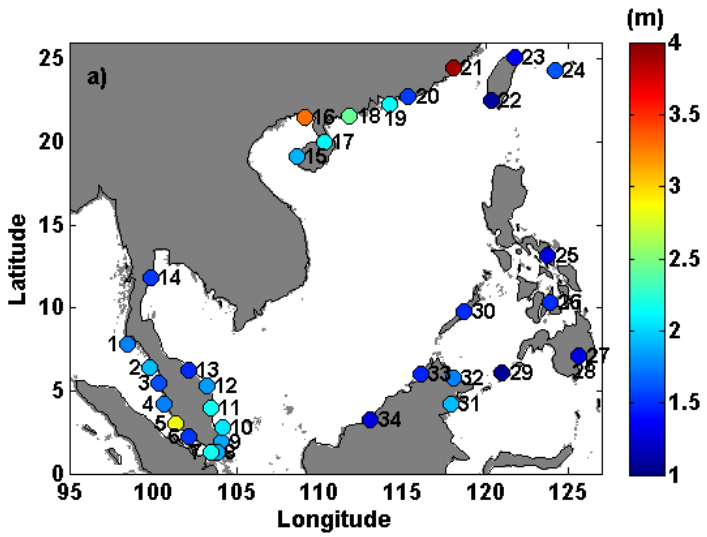

Fig. 2. Spatial distributions of maximum observed sea level at each site. Sites are numbered as in Fig. 1.

4. CONCLUSION

The spatial and temporal variability of ESLs, and the NTR have been explored using hourly data from 34 tide gauge stations in the SCS. Higher maximum values of ESLs and the NTR are observed in the northern SCS due to the effect of tropical cyclones. The seasonal maximum in the northern SCS happens during the Southwest Monsoon, whereas for the southwestern SCS, it occurs during the Northeast Monsoon. This is the period of higher risk to the occurrence of coastal flooding for potentially vulnerable sites, particularly with the combination of maximum mean seasonal sea level cycle, high spring tide, storm surge and heavy rainfall. This result demonstrates the importance and need to identify changes of ESL on a seasonal time-scale in future studies.

In conclusion, this study produced a map of spatial and seasonal patterns of ESL. These maps will be useful in identifying vulnerable periods and coastal areas in the SCS that are exposed to the higher probability of ESLs. This information will provide a valuable insight to the relevant authorities in preparing sufficient mitigation to the risk of coastal flooding.

5. ACKNOWLEDGEMENT

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HABITAT SUITABILITY INDEX OF THE SOUTHERN RIVER TERRAPIN, *Batagur affinis* (Contor, 1847) IN PENINSULAR MALAYSIA

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ABSTRACT

A freshwater turtle species or *Batagur affinis* is listed as a critically endangered species in International Union for Conservation of Nature (IUCN) Red List for Threatened Species. Hence, to achieve the cost effective and well-guided future monitoring and habitat rehabilitation program, the understanding on their optimum physical habitat requirement is highly paramount. One of the main objectives of this research is to understand the physical habitat requirements and preferences of this keystone species to maintain its sustainability inside the lower part of Kemaman River. The habitat suitability index (HSI) for six main physical parameters were constructed. Six sampling stations were selected for the hydraulic-hydrologic survey; while a total of 100 observation points was collected to monitor the roaming area of *B. affinis* during nesting and off nesting season. Based on the developed HSI, the highest preference range for velocity and depth were between 0.1-0.2 m/s and 2.0-3.0 m respectively, for the nesting bay sediment grain size, the highest preference index recorded were between 0.06 – 2.0 mm, which classified as sandy sediment. Next, for degree of nesting bank slope, the highest preference index recorded were between 7-9° with average of 8.55^{o}. In addition, for canopy coverage preferences aspect, approximately about 3 to 4 percent of coverage recorded the highest preference for *B. affinis'* roaming area. However, curve shows no pattern of preference for total suspended solid parameter (TSS).

Keywords: Habitat Suitability Index (HSI), Habitat Suitability Curve (HSC), Southern river terrapin, *B. affinis*

1. INTRODUCTION

Freshwater turtles are among the world's most endangered vertebrates, as they are most at risk of impending extinction compared to avian, amphibians, mammals or even sharks and rays (Auliya, 2007). As one of the freshwater turtle species, the Southern River Terrapin *(Batagur affinis)* or locally known as *tuntung sungai* is listed as a critically endangered in IUCN Red List of Threatened Species and CITES

(Appendix I). On top of that, this species also categorized as one of the top 25 most critically endangered freshwater turtles worldwide (Anderson et al., 2011). As a keystone species, terrapins play a role as a top predator in riverine ecosystem and its function to control a bloom of highly invasive species has made river terrapins are valuable to be conserved (Ernst and Lovich, 2009).

The study intends to investigate the specific habitat adaptation threshold by focusing to the small, localized area within a larger mesohabitat unit used by the species for specific behavior (e.g. nesting and roaming). In the past, HSI had been available mainly for fish species such as brown trout (Muñoz-Mas et al, 2012) and Chilean jack mackerel (*Trachurus murphyi*) in the South East Pacific (Li et al., 2016). In the Central Platte River, Nebraska, the habitat suitability curve were generated for multiple fish species such as red shiner (*Cyprinella lutrensis*), sand shiner (*Notropis stramineus)* and plains killifish (*Fundulus Zebrinus*) (Conklin, 1996). There were a few studies on the HSI development for different aquatic species, including turtles. A study by Raleigh & Zuckerman (1986) had come out with the habitat suitability index for diamondback terrapin in Atlantic Coast, which adopted the Category I in the HSC development according to the IFIM principles.

2. MATERIALS AND METHODS

2.1. The Study Area

The study area (Figure 1) was limited to the lower region of main Kemaman River between Seberang Tayur Village (at 4.265902o N, 103.271038o E) until a river-crossed weir at Pinang Village (4.215707^{o} N, 103.317575^{o} E). A total of 13.67 km river stretches at the main channel and another additional 3 km of Cherul River tributary gave a cumulative of 16.7 km of total river reach for the study area. Six sampling stations were selectively appointed for the hydraulic-hydrologic survey; while a total of 100 observation points was used by considering the most-frequently spotted sites, active nesting points as well as historical points along the study area. The development of Habitat Suitability Index of *B. affinis* in Kemaman River was highly relying on these primary data collected during sampling period from May 2015 to August 2016.

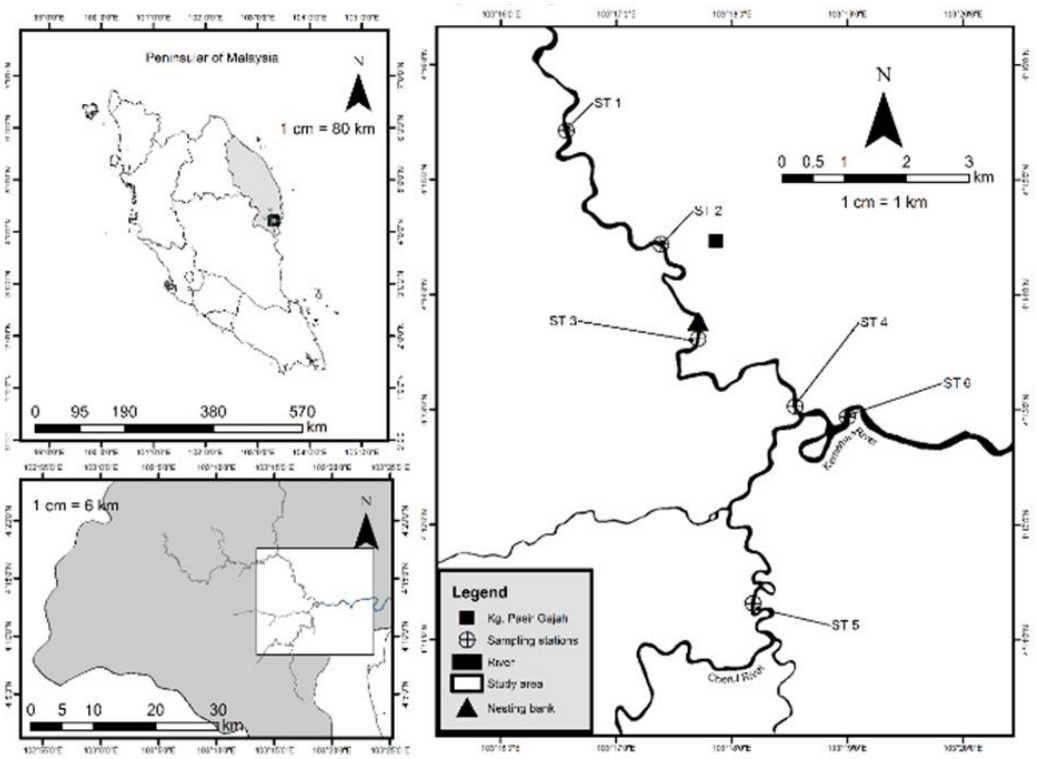

Fig.1. (a) The Kemaman catchment area within the east coast state of Terengganu in Peninsular Malaysia. (b) Location of six sampling stations and two active nesting sites; Pasir Pok Yok and Pasir Long Omar, in the Kemaman River.

2.2. Methods

Radio-telemetry was used to study the spatial and temporal distributions of 12 post-nesting *B. affinis* in the Kemaman River. Twelve radio transmitters (LBP-2140, Wildlife Materials International, Inc., USA) measuring 6 x 3.5 cm and weighing 85-95 gram each, were affixed on the 10th and 11th right marginal scutes of the post-nesting female *B. affinis*. Two small holes (diameter 5 mm) were drilled on the marginal scutes. The transmitters were glued onto the carapace with epoxy and secured with cable ties. The females were released after the epoxy dried, which took about 20-30 minutes. Body mass (BM), straight carapace length (SCL) and straight carapace width (SCW) of all 12 terrapins were recorded.

The spatial distribution of the species is measured based on the number of frequently visited points by the same individual sample terrapin (identified according to their radio transmitter ID), as well as the approximate duration time spent at each spotted point. The number of occurrence and re-occurrence of the same ID-tagged individual terrapin at a point were recorded consistently with the measurement of all six physical parameter afterward.

The movements of the females were observed approximately 10 hours after they were released and were subsequently monitored every two days. Every-two-days monitoring and tracking activities

were conducted during the nesting (between February until March) and off-nesting seasons (between April to August). Each sampling effort took about four hours, between 1500 and 1900 (where the maximum activities of the terrapin can be observed) and no observations were made at night due to safety reasons. The coordinates for each observation made were recorded using GPS Garmin Model Montana 650, which were later pre-processed in GIS-integrated analysis for final spatial and temporal mapping procedures.

Canopy cover at the observed points was measured using the remote sensing techniques by considering the pre- divided stream channel segments along the study area. While the bank slope of a sand bay (Fig.) were measured by using Abney level slope measurement data.

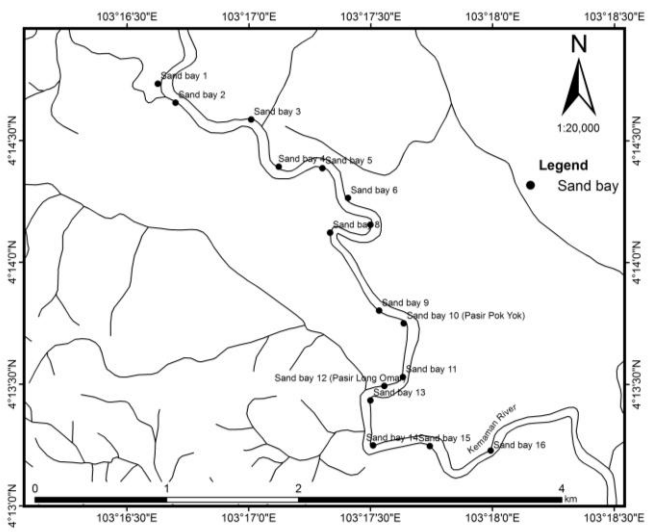

Fig. 2. 16 locations of sand bay (active and non-active nesting point) indicating the observation points for substrate and nesting point slope. Pasir Pok Yok and Pasir Long Omar were the main nesting point within the study area.

The selectivity index is calculated as the ratio of the proportion of habitat used, u_i, with the proportion of habitat available, a_i. The index which also known as the forage ratio, w, or selection index, is calculated based on formula in (1) as proposed by Jowet (2014):

$$wi = \frac{Proportion\ of\ habitat\ used, u}{Proportion\ of\ available\ habitat, a} \qquad (1)$$

Where w_i = forage ratio, i = habitat category, u_i = Habitat used in category i, a_i= Habitat available from category i. Standardized Selectivity Index (SSI) is then calculated by dividing the forage ratio of particular category, w_i with the total forage ratio of all category, $\sum w_i$, and sum all the value to 1, as summarized in following formula (2):

$$Standardized\ Selectivity\ Index = \frac{wi}{\sum wi} \quad (2)$$

Where w_i = forage ratio and i = habitat category. SSI is later being converted to a normalized index of suitability index, by dividing the maximum value to give suitability indices ranging from 0 to 1. The resulting ratio was normalized to the 0 to 1 preference scale, as being simplified in the following equation (3):

$$pi = \frac{pi}{Max\ p} \quad (3)$$

Where P_i = normalized index of preference at the interval of the category, Max P = maximum index of preference for the range of the variables P_i.

3. RESULTS AND DISCUSSION

3.1. Habitat Suitability Index

The *B. affinis* is a specialized, very slow-but-strong swimmer that prefer in shallow water depth, with slow-flowing meandering system accompanied by sandy-dominated reaches. The highest preference for velocity range for this species can be considered as a slow-moving area which was between 0.1-0.2 m/s (Figure 3) and gradually shows a decreasing tolerates level with a higher value but not exceeding 0.6 m/s. This slow velocity characteristic generally been observed to be occurred in an area near to river bank and pool area where velocity shelter is highly present. The pool region within study area can reach up from 7 to 9-meter depth (HSI=0.7) with an average of 0.1-0.2m/s (Figure 3) of velocity (HSI=1). High value of HSI represented by these areas explains why this place recorded a high occurrence of *B.affinis* during nesting and off nesting season. However, other than ideal physical condition the pool can offer, the biological aspect such as food availability in pool area also may contribute to the high occurrence of *B. affinis* in this area. Based on the collected substrate samples, the river bed of these areas is prone to be dominated by silt which is convenient place to sustain periwinkle and other aquatic flora.

In context of nesting bank, the highest index was recorded for sediment grain size between 0.06 – 2.0 mm (Figure 3), which reflects a sandy-dominated reach within the study area and was presumably simply affected by their preference on sandy river bank to lay their eggs. Porous characteristic of sand makes it easier for *B. affinis* to dig their nest and helps hatchlings to climb and resurface after they hatched. The study of suitability of nesting site slope have been conducted by Palmer and Cordes (1988) for diamond back terrapin in Atlantic Coast has shown that the optimum suitability for nesting diamond

back was when the mean slope of open, sandy substrates is less than 7°, while an area with a mean slope of >25° is considered unsuitable and they further mentioned that suitability decreases linearly as mean slope values increase from 7° to 25°.

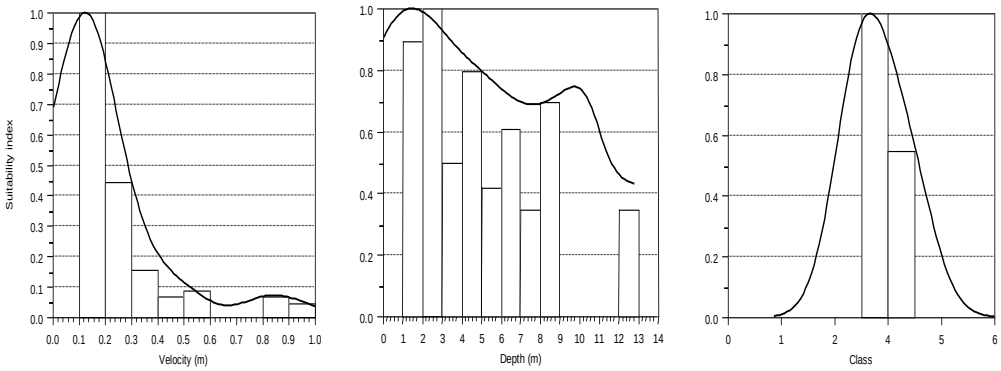

Fig. 3. Frequency histograms of available habitat based on 84 observation for depth and velocity and 151 observations for substrate class of adult female of *B. affinis* in Kemaman River, Terengganu.

Other than that, suitability of nesting bank is related to the degree of slope. Based on developed HSI, the range between 7-9 degree (average: 8.55) (Figure 4) recorded a high value of HSI with less preference of river bank slope that is lower or higher than that range. The specific slope range preference can be related either to the risk of the bank being flooded, or the easy accessibility of the nesting female to climb up during the nesting phase and the slope of nesting bay explicitly affect the ability of this animal to reach the top and flat surface to lay eggs.

For canopy cover (Figure 4), this parameter seems not to be as influential as river velocity, river depth, substrate size and slope degree. However, based on site survey, high canopy cover can be spotted near the pool area and deep river bank. In context of total suspended solid (Figure 4), however, the preference curve shows no pattern of preference of *B. affinis* due to lung-breathing system of *B. affinis* that not been affected by high turbid water.

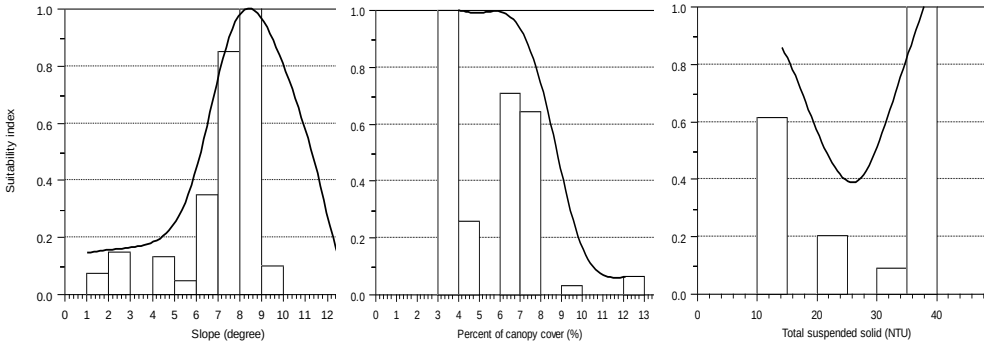

Fig. 4. Frequency histograms of available habitat based on 84 observations for canopy cover and 16 locations river bank at of adult female of *B. affinis* in Kemaman River, Terengganu.

4. CONCLUSION

The HSI and physical habitat in this research were based on intense primary collected data and able to display a fine assessment based on biological and physical information gained onsite rather than only relying on expert's opinion. However, the developed HSI for adult female *B. affinis* is only accurate and applicable to Kemaman River and further validation and sensitivity test shall be conducted prior to the application of this HSI in another river system. Outputs for this model, however, can be used (1) to compare the habitat potential of two areas to support terrapins at a single point in time, or (2) to compare the potential of a single area to support terrapins at future points in time.

5. ACKNOWLEDGEMENT

This research was funded by Universiti Putra Malaysia under GP-IPB/2014/9441101 research grant. A very big appreciation to Turtle Conservation Society (TCS) lead by Pelf Chen Ngok for research support and partially funded this research via Mohamed bin Zayed Species Conservation Fund. The master student for this research was funded by Malaysian Federal Scholarship (Biasiswa Yang-Dipertuan Agong) the under the Ministry of Services, Government of Malaysia.

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MASS RAPID TRANSIT (MRT) FEEDER BUS SERVICE CATCHMENT OPTIMIZATION: A CASE STUDY OF T461 ROUTE TAMAN KAJANG UTAMA

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ABSTRACT

Planning and development of rail services required various considerations. Land availability, landuse, catchment, route matching, infrastructure fitting, barrier free and micro-climate friendly design are some of the factors heeded prior to such installations. Deviation between designated and highly demanded service area in urban sprawl zone of city has been occurring many Malaysia cities. These gaps have led to the mismatch between origin/destination of passengers' and planned locations of train stations and its feeder bus stops. As such, rail services become less accessible to most demanded population. This study assesses with the current system of feeder bus services in supplementing the rail services in urban areas of Malaysia. Using GPS/GIS and onboard survey methods are used to ascertain the gaps in the levels of services. This paper discusses the spatial and earth observation analysis for the purpose of determining service catchment of the T461 feeder bus in Kajang MRT Station. The Garmin GPS device acts as the research instrument to obtain coordinates of locations where passengers board and alight the feeder bus. On-board survey and comparison analysis are methods that have been used to obtain the optimum GPS coordinates of the bus stop locations.

Keywords: Feeder bus, service catchment, urban rail transit

1. INTRODUCTION

This research study is to address an evaluation of service catchment of the T461 feeder bus in Kajang Mass Rapid Transit (MRT) Station. The evaluation of service catchment involves identifying the designated bus routes and its catchment areas, and also bus stop facilities provided along the bus routes. The frequency of use of the feeder bus service, and the location of passengers' access and egress points along the bus routes are also recorded. This study focuses on the service catchment of the feeder bus

routes and stops by utilizing Geographical Information System (GIS) and Global Positioning System (GPS) for data analysis.

AUTHOR	TITLE	METHOD	FINDINGS	RECOMMENDATION
El-Geneidy et al. (2014)	New evidence on walking distances to transit stops: Identifying redundancies and gaps using variable service areas	Detailed origin-destination survey information	Service areas generated using rules of thumb greatly underestimate effective service areas around transit stations	Stop spacing should be investigated as a variable value instead of standard-given number
Bachok & Mohd Zin (2017)	Feeder mode choice selection behavioural modelling: The case of KTM Komuter, Kuala Lumpur	On-board intercept survey method	76% of the passengers did not prefer to use the feeder. Only 17 out of 53 KTM rails stations provide feeder service	Provide feeder bus service at all KTM stations Establish partnership with feeder bus service providers Provide supporting facilities for feeder service
Almasi et al. (2018)	Optimal coordination strategy for an integrated multimodal transit feeder network design considering multiple objectives	Single & multi-objective approaches (metaheuristic optimization algorithms)	Strategy for optimum transit networks that give multimodal services at each stop have been suggested	Future research can include the social cost term in the objective function

2. MATERIALS AND METHODS

2.1. On-Board Transit Survey

To determine the service catchment of the T461 feeder bus service, data collection involves identifying the locations of the designated bus stops along the bus route by utilizing the Garmin Global Positioning System (GPS) device. This is conducted to analyse the service catchment areas of each bus stop through spatial analysis, which requires exact locations of the bus stops.

2.2. GPS Points Recording

The GPS of passengers' access and egress points will be recorded during the rides for the on-board survey. The use of GPS for the coordinates recorded and GIS for the spatial analysis will offer the advantages on graphical and attribute data input. For this study, the coordinates/ GPS points of passenger's access and egress are recorded through the on-board survey where the points are plotted on the projected map using GIS.

2.3. GIS Spatial and Earth Observation Analysis

Spatial analysis is conducted by utilizing software that utilizes GIS such as MapInfo Professional, Google Earth and Basecamp. The service catchment area, types of land use surrounding the feeder bus stops and comparison of GPS coordinates were identified through GIS spatial analysis.

3. RESULTS AND DISCUSSION

The service catchment of the T461 feeder bus route consists of 19 bus stops and covers approximately 794.35 acres, assuming a catchment zone of 400 m radius from each bus stop. The catchment areas are illustrated in Fig. 1 below.

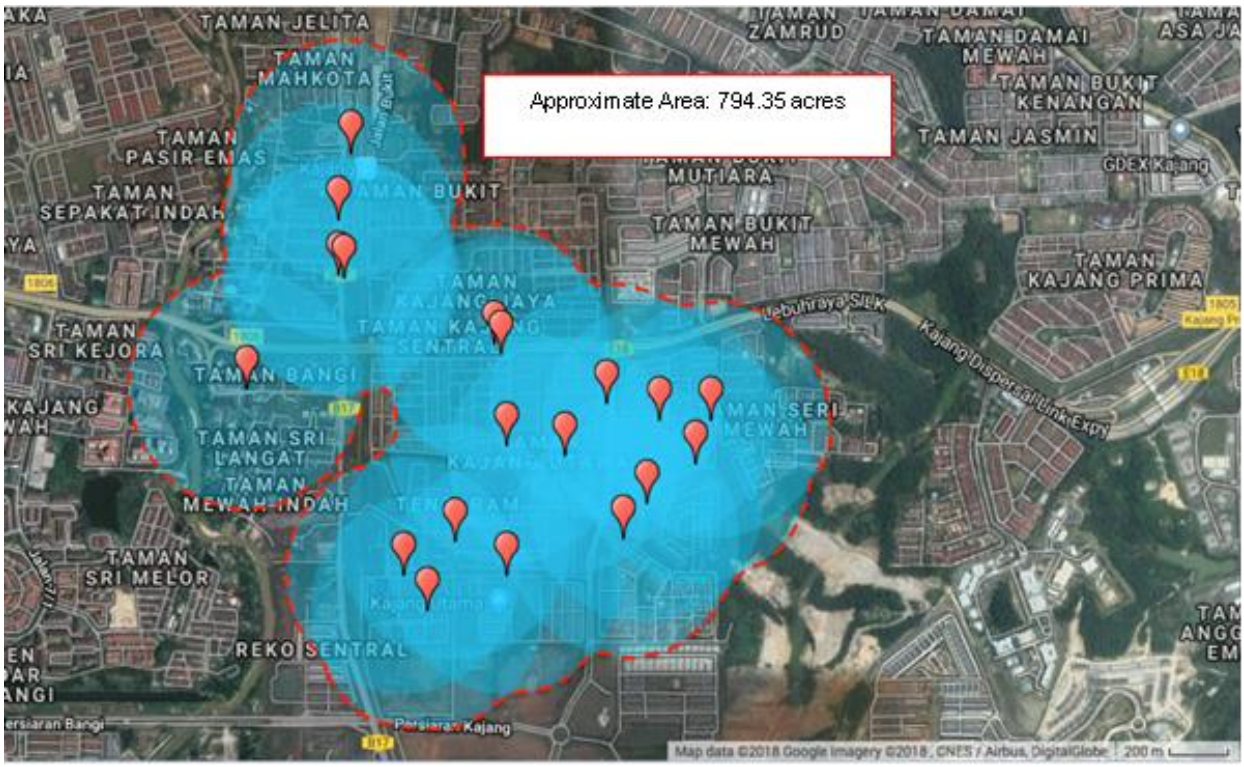

Fig 1. Service catchment of T461 feeder bus route and approximate area coverage
Source: Google Maps Satellite Imagery

Spatial analysis shows that the T461 feeder bus service catchment is concentrated mainly on the Taman Kajang Utama region as the catchment zones overlap densely, indicating that there are at least two bus stops within the walkable catchment of a certain area. Whereas, the Taman Bangi bus stop (far left) is the only bus stop within its walkable catchment

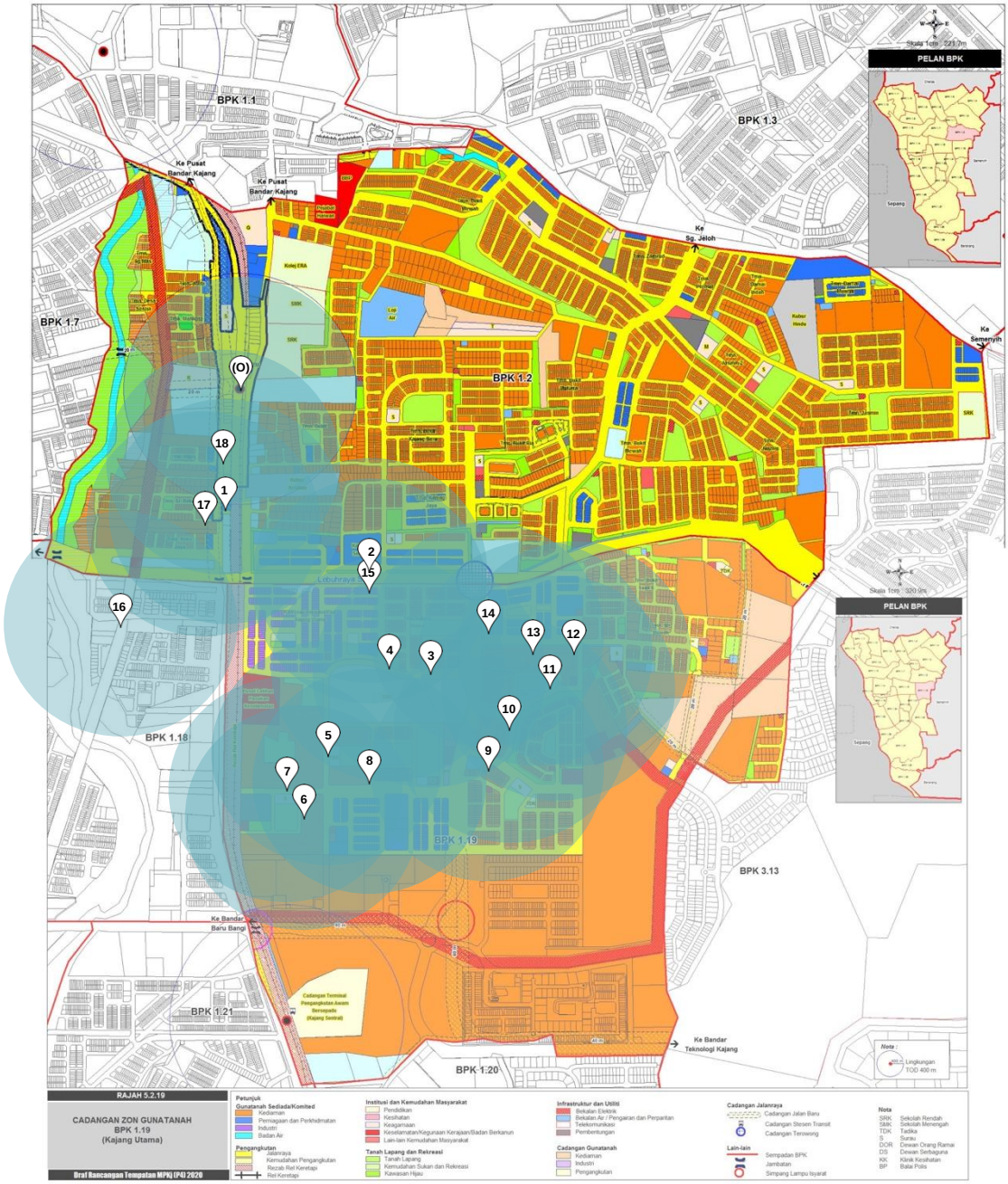

Fig 2. Service catchment of T461 feeder bus route and approximate area coverage

3.1. Estimated Population

The estimated population within the service catchment area of the T461 feeder bus route can be predicted based on the secondary data available from the Local Plan of the Kajang Municipal Council. Table 1 below shows the area of each planning block under the governance of the Kajang Municipal

Council and Table 2 shows the estimated population (Department of Statistics, Malaysia, 2020) within each planning block.

Table 1: Area of each planning block under MPKj

Planning Block (BP)	Area (hectare)
Hulu Langat	29,448
Cheras	5,931
Kajang	9,298
Hulu Semenyih	18,337
Semenyih	9,557
Beranang	6,190
Area under MPKj	78,761

Source: Rancangan Tempatan Majlis Perbandaran Kajang (Pengubahan 4) 2020

Table 2: Resident population (2007) and estimated resident population (2020) for each planning block under MPKj

Planning Block (BP)	Resident Population (2007)	Estimated Resident Population (2020)
Hulu Langat	54,924	69,788
Cheras	214,466	287,877
Kajang	300,775	404,772
Hulu Semenyih	3,858	4,798
Semenyih	63,424	83,746
Beranang	16,346	21,373
Area under MPKj	653,793	872,354

Source: Rancangan Tempatan Majlis Perbandaran Kajang (Pengubahan 4) 2020

The Kajang planning block, which is where the research study area is located, covers an area of 9,298 hectares or 22975.86 acres. The estimated total population in 2020 for the Kajang planning block is 404,772 residents. The approximate area of the service catchment of the T461 feeder bus is 794.35 acres. Hence, the estimated population within the service catchment area is 13,994 residents.

A higher level of residential density within walking distance of transit stations is considered desirable for a successful TOD (as cited in Nawaz, Somenahalli & Allan, 2016). The existing service catchment of the T461 feeder bus may be deemed as a ‘neighbourhood center’ pattern, where transit stations are integrated into the residential landscape. Unlike an urban core TOD, the population density surrounding the Kajang MRT Station is not as high and concentrated as a typical central business district (CBD). Nevertheless, since the completion of the Kajang MRT Station, many property developers such as Sunway Property and Metro Kajang Holdings Berhad have taken on TOD projects in the Kajang area (Lee, 2018), in hopes to encourage residents to use public transportation as a good foundation for urban sustainability.

4. CONCLUSION

It is found that the approximate service catchment for the T461 feeder bus route covers an area of 794.35 acres, with an estimated catchment population of 13,994 residents. This took into account the 400m buffer zones for each bus stop as the walkable catchment for pedestrians to use the feeder bus service. The spatial analysis also showed that there were many overlapping catchment areas within the Taman Kajang Utama area, with at least 2 bus stops within each buffer zone. The overlapping of catchment areas may have produced some redundancies in the bus service depending on where the locations of the residential areas are. However, having more than one bus stop within the same buffer zone increases the probability of pedestrians to use the bus service, as it gives pedestrians the flexibility of choice to board and alight the feeder bus at the bus stop that is nearest to them. Based on the results and findings, there are several recommendations that can be proposed to improve the feeder bus system in an urban area. These recommendations include:

- **Modification of bus stop locations according to residents' accessibility**

The T461 feeder bus route caters mostly to the residents who live in the Taman Kajang Utama region. The feeder bus acts as a mediator to commute the residents either from residential areas to the MRT Station, or from residential areas to other stops along the route that allow them to travel to their workplaces, commercial areas, religion related buildings or educational institutions. The difference in the designated and observed locations of the bus stops shows that there is a need to modify some of the bus stop locations. The local authority could review the location of the bus stops and experience the feeder bus service from a resident's perspective so that the best location for the bus stop can be determined in terms of maximizing the service catchment area, and at the same time, satisfying the users of the feeder bus service.

- **Optimization of feeder bus services**

The feeder bus services could be optimized by increasing the frequency of buses during peak hours and reducing the frequency of buses during off-peak hours. By doing so, overall costs can be minimized through saving fuel, while maximizing the effectiveness of the feeder bus service especially during the morning and evening peak hours.

5. ACKNOWLEDGEMENT

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FISHERMEN COMMUNITY PERCEPTION ON CLIMATE CHANGE TOWARDS ADAPTATION: CASE STUDY PANGKOR ISLAND, PERAK, MALAYSIA

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ABSTRACT

Climate change is an important concern to all types of communities worldwide, and in particular, those in coastal areas. Coastal Communities are especially vulnerable due to their proximity to the sea which exposes them to impacts from sea level changes as well as other climate change impacts. The present study took place in Pangkor Island, Malaysia. The main purpose was to assess the fisherman community's perception and knowledge of climate change, weather variability, impacts on their livelihood and current adaptation measures. Questionnaires were distributed to fishermen on the island to gather primary data while secondary data concerning temperature, rainfall, wind speed, relative humidity and fish landing was gathered from the Meteorological Department and Fishery Department Malaysia. Primary and secondary data were characterised and analysed with descriptive statistics, Chi-square, Spearman Correlation. The results suggest a certain level of climate change awareness among the community but no real knowledge of the phenomenon. The fishermen community perception of heat intensity is consistent with secondary data however; perception of rainfall and wind speed was in consistent. Fishermen have perceived some impacts on their livelihood such as less fish stock, higher fish product prices, lost days of work and damages to property and work equipment. Most of fishermen in the study area are open and willing to undertake adaptation measurements to assure their wellbeing.

Keywords: climate change, perception, impacts, adaptation, fishery community, Pangkor Island

IMPACT OF OZONE PRECURSORS ON OZONE LEVELS NEARBY SCHOOLS WITH DIFFERENT WALKABILITY INDEXES

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ABSTRACT

Ground level ozone (O_3) negatively affects human health and the environment while having linear influence by its precursors. This research aimed to determine the impact of O_3 precursors on O_3 levels, which were conducted nearby two schools with different walkability levels due to the growing concern over the exposure of schoolchildren to these pollutants. Results showed that the 10-minutes mean concentration of O3 was higher at SJK (C) Sin Hwa (SSH) (34.29 ± 19.32 ppb) than at SMK Tunku Abdul Rahman (SSN) (31.64 ± 15.64 ppb). All of O_3 precursors i.e. NO2, TVOC and CO were also higher at SSH. Meteorological condition plays the major role especially the solar radiation as it encourages the production of O_3. Even though ozone level seems significantly lower if compared to the allowable limit (100ppb hourly), repeated short-term exposure of schoolchildren to this pollutant has found to give adverse effects especially during afternoon where high precursors and high incoming solar radiation are expected. Therefore, attention should be given in terms of providing properly designed and built of pedestrian facilities in order to encourage walking, thus reducing the exposure to O_3 as well as emission of its precursors.

Keywords: vehicle emissions, ozone precursors, distribution behavior, photochemical reaction, pedestrian facilities

1. INTRODUCTION

Air pollution has been associated with many adverse effects on human health and the environment. Ground level ozone (O_3) is a secondary pollutant and a major component of photochemical smog, which affects lung capability. Exposure to high O_3 concentrations may cause inflammatory responses and lung damage, which can, in turn, cause bacterial respiratory infections (Gryparis et al., 2004). Nitrogen dioxide (NO_2), total volatile organic compounds (TVOCs) and carbon monoxide (CO),

which are major pollutants emitted by vehicle exhausts, are known to be O_3 precursors (Reddy et al., 2012). O_3 is formed by the series of complex photochemical reactions of these precursors with sufficient amount of incoming solar radiations (Duenas et al., 2004; Seinfeld and Pandis, 2006; Ghazali et al., 2010; Awang et al., 2016; Yahaya et al., 2017). Jenkin and Clemitshaw (2000) stated that this secondary pollutant has more potential to affect human health than its precursors. The effects are more severe in children than in adults because children are still developing organs and breathe more air relative to their body feature (Buonanno et al., 2012; Zhang et al., 2012; Demirel et al., 2014; Wangchuk et al., 2015).

Reducing these O_3 precursors will end up in decreasing O_3 formation as well as its concentrations. Non-motorized mode such as walking and cycling can assist to reduce emission from motor vehicles. Availability and proper design of pedestrian path give a significant effect on travel behavior of pedestrians and also to the environment (Rodríguez and Joo, 2004). The quality of the walkway/ footpath is an important criterion which may affect the likelihood of walking. People tend to frequently walk if there are well-built pedestrian facilities provided nearby their area (Sisiopiku and Akin, 2003). Elements such as continuity of walkway, condition of the walkway surface, physical obstruction, availability of facilities for elderly and mobility impairments, protection against weather condition, safety measure on walkway, aesthetic and amenities, walkway cleanliness, walkway maintenance and overall travel experiences gave high impact to people in order to encourage them to walk (Bahari et al., 2012). Thus, this research focused on potential exposure of ozone and its precursors onto schoolchildren at different walkability index schools. This study contributes to current literature as it specifically monitored the repeated short-term exposure of schoolchildren to these pollutants in two different locations within average waiting time of the schoolchildren for their parents or guardians to pick them up after school.

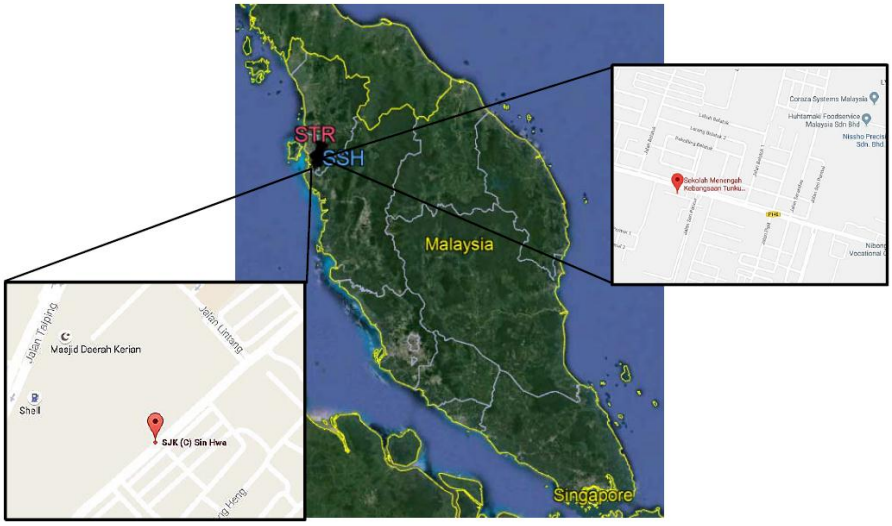
2. MATERIALS AND METHODS

2.1. The Study Area

This research focused on educational areas, mainly primary and secondary schools. It was conducted at the roadside of two selected schools in different states, namely, SJK (C) Sin Hwa (SSH) and SMK Tunku Abdul Rahman (STK), representing a primary and a secondary school, respectively. SSH is in Parit Buntar, Perak, whereas SSN is in South Seberang Perai, Penang (Fig. 1). Parit Buntar is a small town located in the north of Kerian District of Perak, and bordered by Bandar Baharu, Kedah and Nibong Tebal, Pulau Pinang. Parit Buntar is currently developing, especially in terms of transportation. Meanwhile, South Seberang Perai is a district in Pulau Pinang which covers an area of 243 km2. This district is a developing industrialized area that thrives mainly on fishing and agriculture industries.

Concerns regarding pollutant levels near these areas are taken seriously because of their adverse effects on human health and the environment.

SSH and STR were selected because of the high pedestrian density and activity levels near roads in these areas. SSH and STR also have different walkability index nearby these areas which were reported elsewhere. Walkability index is a scoring value that can be used to understand the condition of selected sites whether the pedestrian facilities are well-designed or under-designed. Based on the classification of walkability index suggested by Leslie et al. (2005), neither did the SSH nor STR have high walkability index (higher than the third quartile of total walkability score). However, SSH has found to have slightly higher index (more than the mean of total walkability score) if compared to STR (less than the mean of total walkability score). Higher vehicle volume and pedestrians density were much likely the reason of the difference in terms of walkability index as SSH is located in urban area, while STR is located in industrial area. Much attention has been given in terms of geometric designs of pedestrian facilities in urban area than other areas.



Site Location	School ID	Coordinate	Location	Session
SJK (C) Sin Hwa	SSH	N5.126456 E100.491983	Urban	Morning & Afternoon
SMK Tunku Abdul Rahman	STR	N5.168956 E100.486342	Industrial	Morning & Afternoon

Fig. 1. Site distribution and description of the selected schools (Wikipedia, 2011) (not to scale)

2.2. Data Sampling

Data samples were collected by roadsides near the selected schools to observe the air pollutant concentrations that the schoolchildren were exposed to. Six pollutant parameters were considered in this research, namely, O_3, NO_2, TVOC, CO and PM_{10}. O_3 and NO_2 were measured using two Aeroqual S500

units with different sensors, TVOC and CO were measured using Graywolf IAQ-610, and PM_{10} was measured using Metone E-Sampler 9800. Data were collected for five days on weekdays (Monday to Friday) during school hours ((6.30 a.m. (children coming to school), 11.30 a.m until 3.30 p.m. (children leaving school session 1) and 5.30 p.m. until 7.30 p.m. (children leaving school session 2)). According to a previous survey (Zainordin, et al., 2017), the average time students stay by roadsides before they are picked up by their parents or guardians after school is 10 minutes. Short-term exposure to high O_3 concentrations may seem insignificant. However, repeated exposure to this pollutant has adverse effects on human health, as reported by Atkinson et al. (2012). Therefore, 10-minutes average data were analysed to observe the short-term exposure of the schoolchildren to the aforementioned gaseous pollutants. Descriptive statistics (mean and standard deviations) was used to describe and summarize the data to simplify their interpretation. The daily 10-minutes trends of pollutant concentration at both schools were then illustrated to show the distribution behaviour and relationship between O_3 and its precursors.

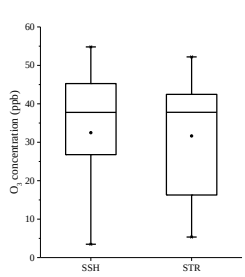
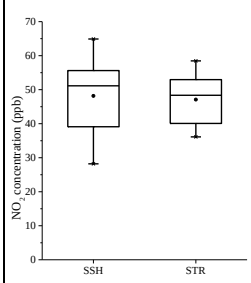
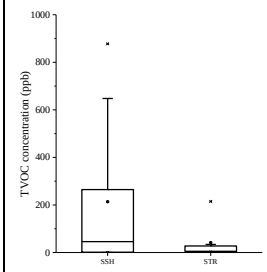
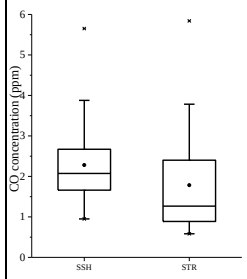
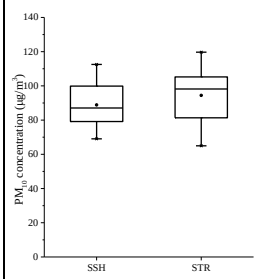
3. RESULTS AND DISCUSSION

3.1. Descriptive Statistics

The box-and-whisker plots (boxplots) of 10-minutes mean concentrations of all pollutants at both schools are illustrated in Fig. 2. O_3 concentrations were slightly higher at SSH with a 10-minutes mean concentration of 32.48 ± 15.97ppb than at STR which had a 10-minute mean O_3 concentration of 31.64 ± 15.64ppb. 10-minutes mean for all O_3 precursors i.e. NO_2, TVOC and CO were also higher at SSH, where the values are 48.18 ± 10.29 ppb, 213.53 ± 311.77 ppb and 2.28 ± 0.90 ppm, respectively. As for STR, the 10-minutes mean for NO_2, TVOC and CO were 47.10 ± 7.02 ppb, 41.43 ± 66.81 ppb and 1.78 ± 1.31 ppm, respectively. However, PM_{10} concentrations were higher at STR (94.45 ± 15.18 µg/m^3) rather than at SSH (88.88 ± 12.23 µg/m^3).

The O_3 concentrations measured at SSH were significantly higher due to photochemical reactions of O_3 precursors with the presence of sufficient incoming solar radiation (Awang et al., 2016). In addition, the movement of O_3 from other areas may contribute to the high O_3 concentrations observed at SSH. Tiwary and Colls (2010) explained that the transportation of pollutants from originated area to a monitoring area due to the downwind effect may cause higher-than-normal pollutant levels to be recorded in the monitoring area. NO_2 that observed at SSH were higher due to nearby anthropogenic sources near monitoring area. Higher traffic vehicles located in a close proximity to the monitoring area were found to be major reasons on higher concentrations of these pollutants. Meanwhile, other pollutants which are TVOC and CO concentrations at SSH were due to the idling engines of the parked vehicles near the school. It was observed that most parents who picked their children back from this school let their engine

running while waiting for the school to end. However, different case was found for PM_{10}. This pollutant was recorded higher at STR than SSH. Due to the location of this school which is located at industrial area, STR was observed to have higher number of heavy vehicles i.e. lorries and trailers that used this school road. Fugitive dust was found to be the contribution to the higher level of this pollutant because of the movement of these types of vehicles (Wang et al., 2015 and Zhao et al., 2017).

O_3 (ppb)		NO_2 (ppb)		TVOC (ppb)		CO (ppm)		PM_{10} (μg/m^3)	
									
SSH:	32.48 ± 15.97	SSH:	48.18 ± 10.29	SSH:	213.53 ± 311.77	SSH:	2.28 ± 0.90	SSH:	88.88 ± 12.23
STR:	31.64 ± 15.64	STR:	47.10 ± 7.02	STR:	41.43 ± 66.81	STR:	1.78 ± 1.31	STR:	94.45 ± 15.18

Indicator: Value shows mean ± standard deviation of each of the parameters

Fig. 2. Box-and-whisker plot (boxplot) of 10-minutes average concentrations of pollutants at SSH and STR

3.2. Daily Trends

The daily average 10-minutes trends of the aforementioned pollutants at SSH and STR are illustrated in Fig. 3 and 4, respectively. O_3 concentrations exhibited a similar pattern in both schools, with maximum concentrations occurring approximately from 1 p.m. to 4 p.m. O_3 concentrations have a typical O_3 variation that peaks in the afternoon because incoming solar radiation also peaks at approximately the same time, as reported previously by several researchers (Duenas et al., 2004; Ghazali et al., 2010). However, the magnitudes of the variations differ. The peak values of O_3 concentrations are triggered by incoming solar radiation and O_3 precursors, which promote photochemical reactions that produce O_3. The highest O_3 peak was observed at SSH. Higher O_3 precursor concentrations were expected near this school than STR because SSH is located in urban area, where a high level of anthropogenic activity is expected mainly from high traffic volume. Many traffic-related studies found that high traffic volume leads to more traffic emissions than low traffic volume (Mayer et al., 1999; Unal et al., 2003; Nesamani et al., 2007; Pandian et al., 2009; Gokhale, 2011; Kimbrough et al., 2011). During afternoon, O_3 precursors should start to decrease due to photochemical reactions. However, different from other area, schools recorded higher O_3 precursors' concentrations especially NO_2 during afternoon. This was due to high volume of traffic nearby schools area where most of them were caused by parents or

guardians who sent and picked up their children to or from schools. Other pollutants that are also emitted from vehicles which are PM_{10} also increased during these hours.

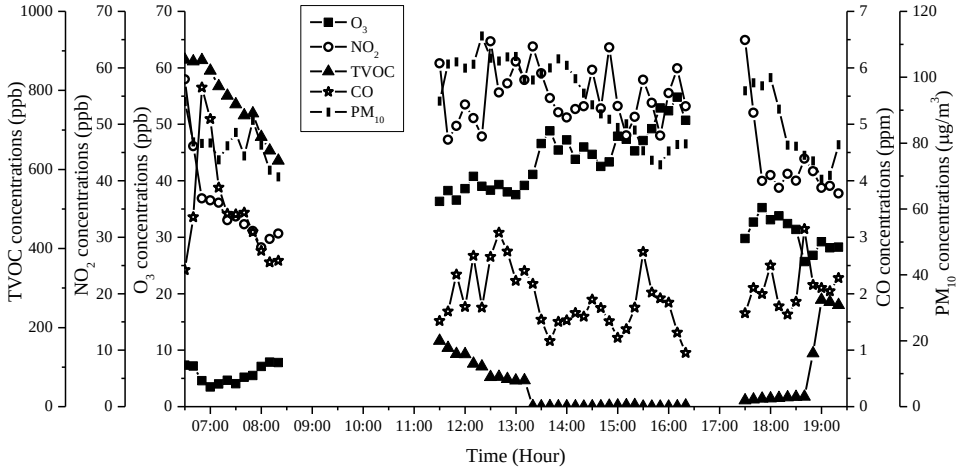


Fig. 3. Daily trend of pollutants and meteorological parameters for 10-minutes average at SSH

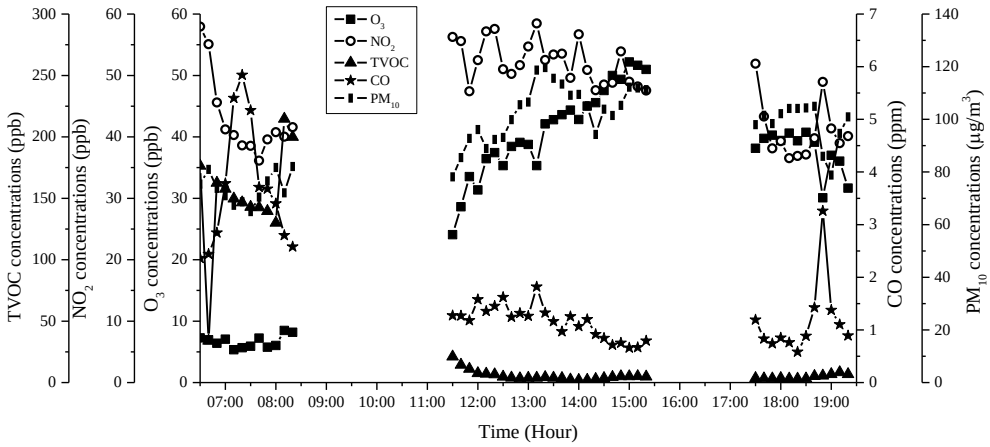


Fig. 4. Daily trends of pollutants and meteorological parameters for 10-minutes average at STR

Therefore, findings from this study identified the significant effects of O_3 precursors on O_3 levels that schoolchildren are repeatedly exposed to, with the role of meteorological condition. Non-motorized mode i.e. walking can help in reducing O_3 and its precursors, thus reducing the exposure of schoolchildren to these harmful pollutants. Interest should be given around the schools area in terms of providing pedestrian facilities by the local authorities to attract schoolchildren to change transportation mode from motorized vehicles to walking. The pedestrians can walk freely to assist reduction on air pollution from motorized vehicles. It is believed that if walkability index is higher, the probability in reducing O_3 concentrations will increase. Inversely to the lower walkability index, formation of O_3 will rise.

4. CONCLUSION

This study monitored and analysed the concentrations of O_3 and its precursors at different walkability index schools because of the concern over the exposure of schoolchildren to these harmful pollutants. Higher O_3 levels were expected at SSH and STR during afternoon (maximum of 54.80 ppb and 52.20 ppb, respectively) due to high intensity of solar radiation and O_3 precursors should start to decrease due to photochemical reactions. However, different from other area, schools recorded higher O_3 precursors' concentrations especially NO_2 during afternoon which happened due to high traffic volume caused by parents or guardians who sent and picked up their children to or from schools. Attention should be given in terms of providing properly designed and built of pedestrian facilities as it has been proven can assist to reduce emission from motor vehicles, hence declining the production of O_3.

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MINING WASTE RECOVERY THROUGH MINERAL CARBONATION PROCESS FOR CARBON CAPTURE AND STORAGE (CCS)

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ABSTRACT

Anthropogenic carbon dioxide emission mainly from metallic mining industry is among the major gases that contribute to the increase of greenhouse gases in the atmosphere that can cause climate change. Mining wastes that are discarded from mining operation might have potential as a solid buffer in storing atmospheric carbon dioxide for long term by mineral carbonation processes. This study investigated the major minerals in the waste materials of a gold mine (sedimentary waste rocks) and evaluated the potential of carbonate and silicate minerals for mineral carbonation process. Samples of waste rocks, soil, sediment and sludge were obtained and were analyzed using x-ray diffraction and energy dispersive x-ray analysis for mineralogical and chemical composition identification, respectively. Findings indicated that quartz, mica, dolomite, and calcite are the major minerals found in the waste rocks. Results also demonstrated that carbonate-rich minerals such as dolomite, calcite, and siderite are in stable carbonates form that are considered a reservoir for carbon storage due to its high availability in gold mining wastes for mineral carbonation. Silicate minerals such as chlorite, pyroxene, mica, amphiboles that are present in the mining waste contain magnesium and calcium silicate ions, which can facilitate the formation of carbonate minerals. Therefore, the presence of potential minerals in gold mining wastes provides a great potential for carbon sequestration that can encourage evaluation of carbon footprint in mining industry.

Keywords: mining waste, mineral carbonation, carbon sequestration, mineralogy, sedimentary rocks

1. INTRODUCTION

The removal of soil and rocks through extraction and processing of materials from mining industry to gain access to buried ore, includes the leftover materials such as solids, water, and gases that are called waste materials or residues. This process releases carbon dioxide (CO2) which contributes to high accumulation of anthropogenic greenhouse gases (GHGs) in the atmosphere (Assima et al., 2014;

Harrison et al., 2013), and yields large amount of waste that has little or no economic value. However, mining wastes in a positive approach can help to mitigate environmental pollution due to its potential for CO2 storage in reducing anthropogenic GHG emission to the atmosphere. Therefore, the process of passive CO2 sequestration or carbon capture and storage (CCS) is required to stabilize CO2 in the atmosphere which involves trapping CO2 from the gas streams into geological formations such as soil and rocks in carbonate form by natural carbonation reaction (Assima et al., 2013; Wilson et al., 2009; Assima et al., 2014). Carbonate minerals that form in the soil include formation of stable carbonate or bicarbonate to capture carbon through weathering of primary minerals that release ions such as hydrogen (H+), magnesium (Mg2+), and calcium (Ca2+), reacting with CO2 (Assima et al., 2014; Wilson et al., 2009; Assima et al., 2014; Lechat et al., 2016; Power et al., 2013; Renforth, 2011). This natural process of carbonation provides a great potential for carbon storage of mining residue in reducing GHG emission. Furthermore, mining waste from different types of mining production might have potential for CO2 sequestration and also provide economic benefits that involve minimal cost technology (Assima et al., 2013; Assima et al., 2014).

2. MATERIALS AND METHODS

2.1. Study Site Description

Field sampling was undertaken at an active gold mining area in Selinsing, Pahang with coordinate of N 4°15'0", E 101°47'10", which itself is in a prominent gold mining region in Peninsular Malaysia (Makoundi et al., 2014). Waste rock samples have been collected at seven sampling points which consist of stockpiles of high grade (HG), lower grade (LG), super lower grade (SLG), waste dump, borrow pit, and the main pit which consist of open pit 1 and open pit 2. The host rock at the Selinsing gold mine consists of sedimentary rocks, including siltstone, argillite, phyllite, carbonaceous shale, grey-black limestone, sandstone, and tuffaceous conglomerate (Makoundi et al., 2014; Pour and Hashim, 2015). Minerals such as quartz (SiO_2), dolomite [$CaMg(CO_3)_2$], and pyrite (FeS_2) are all widely distributed in gold mines (Makoundi et al., 2014).

2.2. Mineralogical Analysis

Samples of rocks were obtained from a gold mine for field trial assessment. The rock samples were crushed and were grounded into fine particles using agate mortar and pestle. The fine samples were sieved to 1mm size fraction using particle sieves because grain size of samples is a critical consideration that can affect results of x-ray diffraction (XRD) analysis (Saat et al., 2009). Then, sieved samples were grounded in a very finely powder form using a special mortar and about 1 ± 0.5 g of fine powder samples

were placed on special sample holder before being attached on x-ray machine (Arce et al., 2017). Powder samples were analyzed using Philips PW3440/60 X'Pert Pro model of XRD instrument (Cu-Kα radiation) at 1°/min rate (0.02° step size) over the 2–65° scattering angle range (Harrison et al., 2013; Assima et al., 2014), where the range of detection limit are between 1 to 2% (Kandji et al., 2017). This analysis was used to classify mineral characterization at the waste dump and stockpile within the gold mine (Harrison et al., 2013; Arce et al., 2017).

3. RESULTS AND DISCUSSION

3.1. Mineralogy and Chemical Composition of Mining Waste Rocks

Example from the case study of a gold mining is presented here. Potential feedstocks for mineral carbonation found for this case study were the carbonate and silicate minerals as shown in Table 1. There were 15 types of minerals that were identified from XRD analysis of the waste rock samples at the waste dump and stockpile of the gold mine. There were four major minerals found in both the waste dump and stockpile samples which are quartz, mica, dolomite, and calcite, followed by other minerals such as kaolinite, pyroxene, goethite, anatase, chlorite, illite, larosite, rutile, siderite, amphiboles, and opal. Major minerals were discovered widespread at both mining wastes due to parent rocks from the waste rock samples were originated from volcanic, sedimentary (e.g. limestone, carbonaceous shale, conglomerate), and metamorphic rocks (e.g. phylite) (Makoundi et al., 2013). Figure 2 and 3 indicate that the highest peak of quartz and mica were present in both types of mining wastes because these minerals were resistant to weathering (Shamshuddin, 2011). Thus, quartz and mica minerals were considered as the common minerals found in all types of rocks.

From the XRD results, majority of minerals were present in the waste dump and stockpile except for minerals such as siderite, amphiboles, and rutile that were found at stockpile only, whereas opal mineral was only present at the waste dump (Table 1). Data in the table shows that silicate minerals such as chlorite, pyroxene, mica, and amphiboles that were present at the waste dump and stockpile are the potential feedstocks for mineral carbonation. These silicate minerals contain magnesium and/or calcium silicates ions, which can react with CO_2 to form stable carbonate mineral (Power et al., 2013; Hitch et al., 2010; Manning and Renforth, 2012).

Table 1. Composition of minerals in waste rocks of a gold mine

Minerals	Chemical formula	Waste dump	Stockpile
Primary minerals			
1. Quartz [a]	SiO_2	√	√
2. Mica [a]	$K(Mg,Fe)_3(AlSi_3O_{10})(OH)_2$	√	√
3. Pyroxene [a]	$(Ca,Na)(Mg,Fe,Al)(Al,Si)_2O_6$	√	√
4. Amphiboles [a]	$NaCa_2(Mg,Fe,Al)_5(Al,Si)_8O_{22}(OH)_2$		√
Secondary minerals			
5. Dolomite [b,c]	$CaMg(CO_3)_2$	√	√
6. Calcite [b,c]	$CaCO_3$	√	√
7. Siderite [b,c]	$FeCO_3$		√
8. Kaolinite [a]	$Al_2Si_2O_5(OH)_4$	√	√
9. Chlorite [a]	$Mg_6Si_4O_{10}(OH)_8$	√	√
10. Goethite [c]	$HFeO_2$	√	√
11. Illite	$(K,H_3O)(Al,Mg,Fe)_2(Si,Al)_4O_{10}[(OH)_2,(H_2O)$	√	√
12. Anatase	TiO_2	√	√
13. Larosite	$(Cu,Ag)_{21}(Pb,Bi)_2S_{13}$	√	√
14. Rutile	TiO_2		√
15. Opal	$SiO_2.nH_2O$	√	

[a] Silicates minerals
[b] Carbonate minerals
[c] Non-silicates minerals

4. CONCLUSION

Metallic mineral from mining industry is highlighted in this study due to their potential to mitigate the release of CO_2 to the atmosphere through mineral carbonation processes. Extraction of gold for instance, are mined from mafic and ultramafic rocks for economic purposes, however natural weathering of the waste rocks results in the formation of carbonates that encourage carbon sequestration processes. Gold mining wastes have a great potential for carbon sequestration in reducing CO_2 in the atmosphere. The major minerals that were discovered at the waste dump and stockpile of the gold mine include the quartz, mica, dolomite, and calcite. Dolomite and calcite-rich minerals are considered a reservoir for carbon capture and storage because both minerals were in stable carbonate forms. The presence of silicate minerals such as chlorite, pyroxene, mica, and amphiboles at the waste dump and stockpile are the potential feedstocks for carbon sequestration because these minerals are rich in calcium and magnesium that are essential for mineral carbonation processes.

5. ACKNOWLEDGEMENT

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RELICT LANDSLIDES MAPPING IN KUNDASANG, SABAH, MALAYSIA

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ABSTRACT

Background: Telltale signs of the presence of land instability such as structural defect to the building and drainage, land subsidence, cracks and bulges on the road surface, leaning telephone poles, retaining walls and electric cables are widespread in Kundasang, Sabah. Kundasang generally is an area littered with relict landslides. **Objective**: The main objective of this study is to map these relict landslides. **Methods**: High resolution satellite imagery of Quickbird with up to 0.65m panchromatic and 2.65m multispectral had been evaluated Result: Preliminary results showed that the features are not well-defined in the Quickbird imagery probably due to the thick vegetation coverage of the study area. Conclusion: The limitation in Quickbird imagery can probably be overcome by the utilisation of LiDAR data images. Point clouds from vegetation and buildings can be eliminated to show the ground surface.

Keywords: Kundasang, Quickbird, Relict landslides