PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 22 ISSUE 4 (2024), Page 1 – 13

UTILIZING GOOGLE EARTH FOR ENVIRONMENTAL PLANNING: EXTRACTION OF POINT SOURCE LOCATIONS AT THE UPSTREAM OF SUNGAI SKUDAI CATCHMENT, JOHOR MALAYSIA

Muhammad Wafiy Adli Ramli[1], Nor Eliza Alias[2], Zulfaqar Sa'adi[3], Yusrin Faiz Abdul Wahab[4], Zulkifli Yusop[5]

[1]*Geography Section, School of Humanities,*
UNIVERSITI SAINS MALAYSIA
[2,3,5]*Center of Water Sustainability and Water Security,*
UNIVERSITI TEKNOLOGI MALAYSIA
[4]*Malaysia Japanese Institute Technology,*
UNIVERSITI TEKNOLOGI MALAYSIA

Abstract

This study explores the application of geospatial technologies, specifically focusing on Google Earth (GE), to extract and mapping point source pollution in the upstream of Sungai Skudai Catchment (SRC). A thorough analysis of the locations of restaurants, launderettes, car washes, and workshops was made practical by the combination of Geographic Information Systems (GIS) tools with satellite images, which offers important data for environmental planning and water quality management. The research area, located in Johor, Malaysia, offers an example of the difficulties driven by rapid urban growth. This study provides comprehensive directions for extracting point sources, with a focus on verifying data via field surveys and Google searches. The upstream region was found to have 373 restaurants, 62 launderettes, 73 car washes, and 80 workshops. The dataset was further improved by the validation process, which determined any inconsistencies and added additional data. This study highlights the importance of field verification for improving point source pollution data accuracy. It also provides a base for comprehensive strategies for pollution management, land-use planning, and preservation efforts in rapidly changing environments, such as the Sungai Skudai Catchment.

Keywords: Point source, pollution, GIS, environmental, water, Google Earth

[1] USM Senior Lecturer Email: mwafiyadli@usm.my

INTRODUCTION

The use of advanced geospatial technology has become significant in modern environmental planning to improve the precision and effectiveness of data collection procedures. Accurate mapping, strategic decision-making, and monitoring in environmental planning depend on geospatial technologies. When contaminants are released into the environment from distinct, localized sources—often identified by precise geographic coordinates—it is referred to as point source pollution (Braden & Shortle, 2013). GIS offer a solid foundation for spatial analysis and visualization, making them important for managing and mitigating point source pollution. A comprehensive knowledge of the spatial relationships between pollution sources and their surrounding environments is made possible by the integration of many datasets, including the patterns of land use, pollution source locations, and environmental characteristics (Bateman et al., 2002; Choi et al., 2020). This is often achieved through GIS and plays an important role in effectively managing water pollution.

Google Earth (GE) was first released in 2005 by Google and currently stands as a versatile tool that provides access to high-resolution satellite imagery with an intuitive interface. It has become one of the most popular and successful virtual globe technologies that can be used to effectively analyze environmental issues (Zhao et al., 2021). GE's capability to gather and process extensive quantities of satellite imagery and geospatial data has facilitated the examination of changes in land cover and environmental management, the monitoring of ecological health, disasters, diseases, and food security, alongside the evaluation of climate change's effects on natural resources and human communities (Hoang Tu et al., 2023).

This article explores the utilization of GE in the field of environmental planning, specifically concentrating on the Sungai Skudai Catchment area. GE's capability to identify the exact locations of point sources offers a unique chance to gather accurate data that is important for making accurate choices in environmental management. Given the increasing urbanization and industrial activity in the Sungai Skudai basin, it becomes essential to identify the specific sources of pollution to ensure the sustainable development and preservation of this important ecosystem. The Sungai Skudai Catchment located in Johor, Malaysia shows the complex difficulties encountered by areas undergoing rapid urban growth. Both researchers and planners can utilize GE to collect a vast amount of spatial data for discovering and defining specific sources that contribute to environmental degradation. Additionally, this article aims to clarify the techniques used to extract point source locations from Google Earth, highlighting the importance of such data in developing effective environmental planning strategies. The combination of technology and environmental science in this particular situation offers a potential for promoting a comprehensive approach to land-use planning, pollution control, and conservation activities within the continually evolving landscape of the Sungai Skudai Catchment.

The following sections of the paper provide with details explanation of the step-by-step techniques used in point source extraction. Additionally, the significance of data validation being discussed, and examples presented to shows the effective use of this methodology in environmental planning activities. The point source pollution extracted includes pollutants from restaurants, laundrettes, car wash service centres, and workshops. Wastewater from restaurants, which comes from activities such as cooking, dishwashing, and housekeeping, usually consists oil and grease (O&G), suspended solids (SS), and detergents (Yau et al., 2021). The presence of detergent-derived chemicals and various contaminants in laundry wastewater presents difficulties in wastewater treatment, which might potentially reduce plant efficiency and microbiological activity, ultimately leading to water pollution. The presence of detergent-derived surfactants and various contaminants in laundry wastewater creates difficulties in treating the wastewater. This might potentially reduce the effectiveness of wastewater treatment plants and prevent microbial activity, ultimately leading to water pollution (Kah et al., 2021). Also, the waste from the car wash produced petroleum hydrocarbons, heavy metals, phosphorus, nitrogen, ammonia, total suspended solids (TSS), and surfactants from car wash soap may cause water pollution issues (Hu et al., 2022).

Furthermore, the exploration of challenges and proposed solutions, alongside the integration of extracted data into Geographic Information Systems (GIS) database, will underscore the comprehensive nature of utilizing Google Earth for point source location extraction. GIS databases store spatial data, including the location of affected areas. This may also optimize the use of spatial data in a specific area, enabling research to inform decision-making and facilitate more precise actions (Ariffin et al., 2023). This studies investigation aims to contribute to the discourse surrounding innovative methodologies in environmental planning and pave the way for informed and effective strategies in mitigating the impact of anthropogenic activities within the Sungai Skudai catchment and beyond. These studies focusing on the capability of GE as tools to locate the point source pollution (restaurant, launderette mart, car wash, and workshop) and how accurate it provides the information.

STUDY AREA

SUNGAI SKUDAI CATCHMENT (UPSTREAM)

This study used ArcGIS 10.8 for analysis, geodatabase, data conversion, and point source pollution mapping. In the first step, the catchment of Sungai Skudai's upstream was generated from the Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM). Such step was important to identify the boundary of this study. SRTM DEM, obtained through radar-based remote sensing with a resolution of 90 m, is a freely accessible topographic dataset and is widely utilized across diverse fields, such as geology, water resources, glaciology, natural hazards assessment, and vegetation survey (Bello & Haniffah Mohd, 2021).

SRC covers an area of approximately 293.3 km2 with the main river stretching for 46 km in length. However, this study concerns the quality of water at the Sultan Ismail Water Treatment Plant (SIWTP). Conversely, the study area was confined to the area upstream of SIWTP, which was approximately 136 km2 or 46% of the whole SRC. The river flows south-east across several urban areas, including Kulai, Saleng, Skudai, and Tampoi, and ends in the Straits of Johor. The basin is generally undulating with the steepest slope between 25 to 40 degrees covering only a small part in the west of the Sungai Senai sub-basin. Figure 1 shows a map of SRC's upstream and SIWTP's location. It is projected that urban areas will occupy 80% of the catchment area in the future, encompassing approximately 62% of residential areas, 27% of commercial areas, 2.6% of industrial areas, and 8.4% of roads and utilities (IRDA, 2011). River pollution in Peninsular Malaysia is exacerbated by the uncontrolled release of waste into rivers, especially in developing and industrial areas (Mohd Zin et al., 2024).

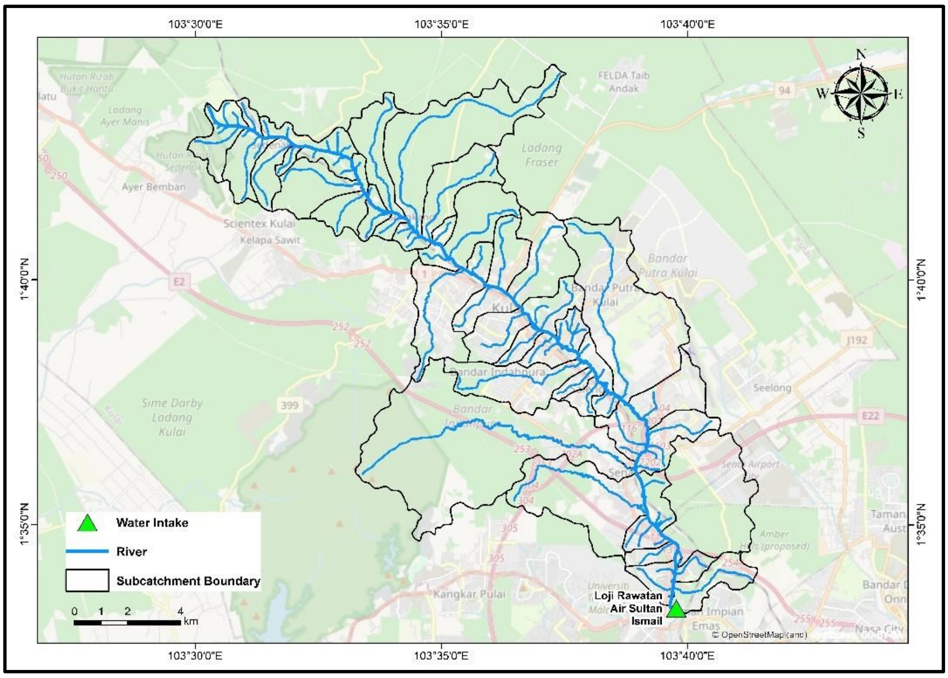

Figure 1: Map for Sungai Skudai Upstream Catchment

RESEARCH METHODOLOGY

This study used ArcGIS 10.8 for analysis, geodatabase, data conversion, and point source pollution mapping. In the first step, the catchment of Sungai Skudai's upstream was generated from the Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM). Such step was important to identify the boundary of this study. SRTM DEM, obtained through radar-based remote sensing with a resolution of 90 m, is a freely accessible topographic dataset and is widely utilized across diverse fields, such as geology, water resources, glaciology, natural hazards assessment, and vegetation survey (Zhang et al., 2015). Since this study focused only on the upstream of SRC, the outlet was determined as the location of water intake at SIWTP. Meanwhile, the Watershed tools in ArcGIS 10.8 was used to create the catchment boundary for Sungai Skudai's upstream for catchment delineation purposes. Figure 2 shows the process flow to extract the point source pollution.

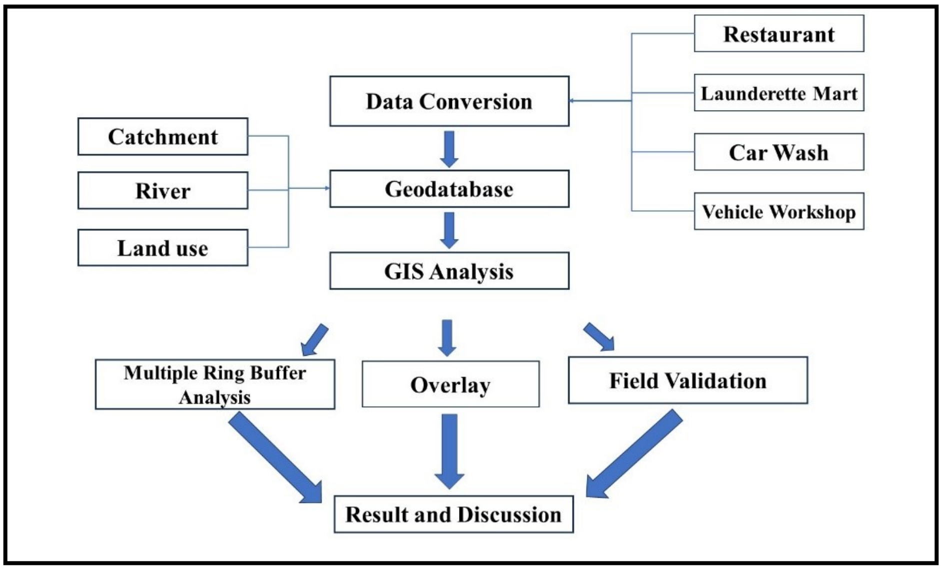

Figure 2: Flow chart for methodology of the study

The next step was to extract the point source pollution (restaurants, launderettes, car washes, and workshops). It began by searching for pollution sources using keywords like 'Restaurant near Skudai and Pulai' in the GE search engines. The results provided the location of all restaurants located near or inside the study area. The next step was to export and save these locations in the Key Markup Language (KML) format. The data was later converted into the shapefile format and overlayed with the Sungai Skudai catchment data. Overlay tools were then used to select restaurant locations that were located inside the study area. The attribute table for each data was also checked to update the coordinates and names of the restaurants. Similar step was repeated for other types of pollution sources, namely car washes, workshops, and launderettes. All data was checked and updated to eliminate any redundancy.

Finally, the data was checked and validated through two different processes. The first process involved utilizing the Google search engine to obtain information regarding the restaurants, launderettes, car washes, and workshops. Such process was crucial to determine whether these establishments existed, remained in business, and were still situated at the exact locations based on the Google images, reviews, and input from users. This process was also useful to determine other point sources of pollution that could have been overlooked during the previous step. Meanwhile, the second process involved validating 30 samples on the ground, consisting of 15 restaurants, five car washes, five launderettes, and five workshops.

RESULT AND DISCUSSION

This section discusses the results extract from the four types of point source pollution, namely restaurants, launderettes, car washes, and workshops. A total of 776 restaurants were identified by GE along the upstream of SRC, encompassing of food courts, fast food restaurants, and restaurants located inside hypermarkets and petrol stations. A database checking was done to remove any duplications and overlays within the SRC boundary, resulting in 373 restaurants after further validation from the field survey and Google search. Figure 3 shows the presence of restaurants within the study area, particularly focusing on locations where these establishments could potentially impact water quality. The data highlighted the number of restaurants in each designated area, shedding light on areas of concern and the need for environmental management strategies. Most of the restaurants are located in the middle of the upstream catchment location where there is a residential and commercial area. Given its relatively high restaurant density, it is crucial to ensure that proper wastewater management practices are in place to prevent any adverse effects on local water sources. The discharge of highly concentrated restaurant oily wastewater from restaurants and food processing enterprises into the aquatic environment typically leads to environmental contamination and hampers the activity of microorganisms in biological wastewater treatment systems (Gao et al., 2019).

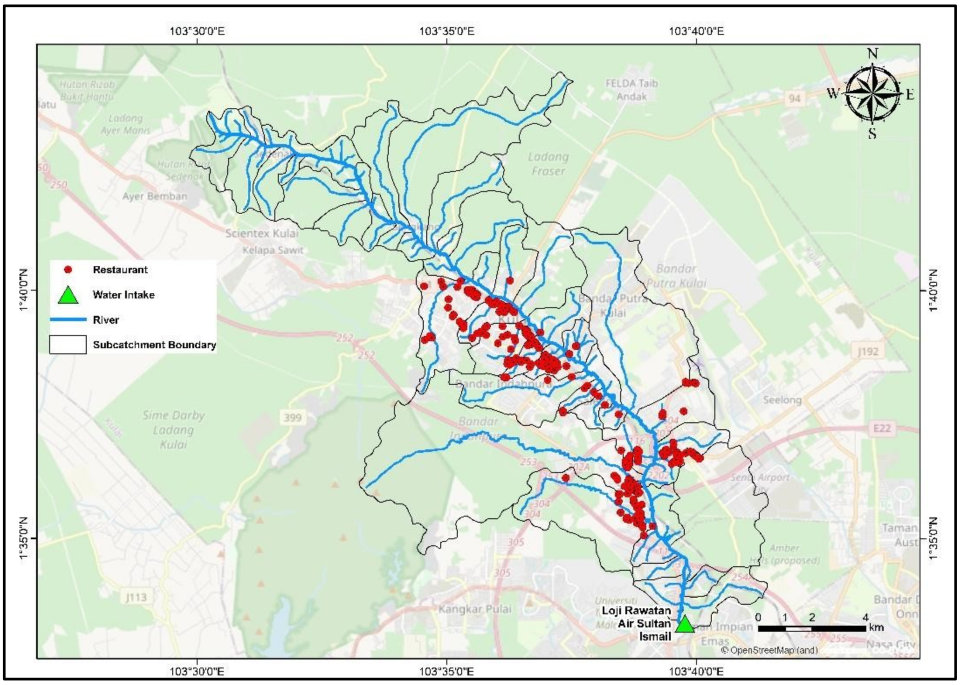

Figure 3: Restaurant location map

Meanwhile, 112 launderettes were found along the upstream of SRC; however, only 62 launderettes existed within the study area. Figure 4 shows the presence of launderettes across various locations in the study area and their potential impact on water quality. Given the high number of launderettes in this area, it is crucial to monitor and regulate their effluent disposal practices to prevent potential pollution. While these businesses play an important role in providing laundry services to the community, their effluent management practices must be closely monitored to prevent negative effects on water quality. The substantial discharge of laundry wastewater has significantly overwhelmed the city's sewage treatment system and caused severe contamination of the surface water (Liu et al., 2014).

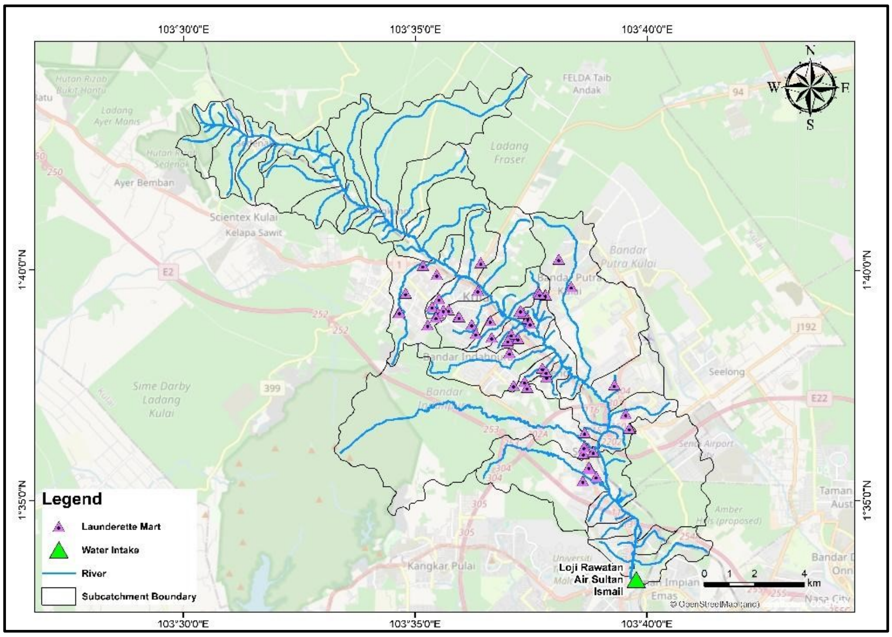

Figure 4: Launderette mart location inside upstream of Sungai Skudai Catchment

The GE imagery also denoted a total of 155 car washes along the upstream of SRC. Subsequent field validation and careful scrutiny revealed 73 car washes within the study area after the removal of duplications. This meticulous process of data verification and elimination of redundancies ensures a more precise understanding of the spatial distribution and density of car wash facilities in the upstream region. The refined dataset serves as a valuable foundation for further analyses related to environmental impact assessments, land-use planning, and water quality management initiatives within the Sungai Skudai Catchment. While the car wash industry is vital for post-sales service in the automobile sector, it consumes substantial water and transforms it into heavily polluted runoff that is often untreatably discharged into drain or river (Monney et al., 2019). Figure 5 depicts the presence of car washes at various locations within the study area and the potential impact of these facilities on water quality.

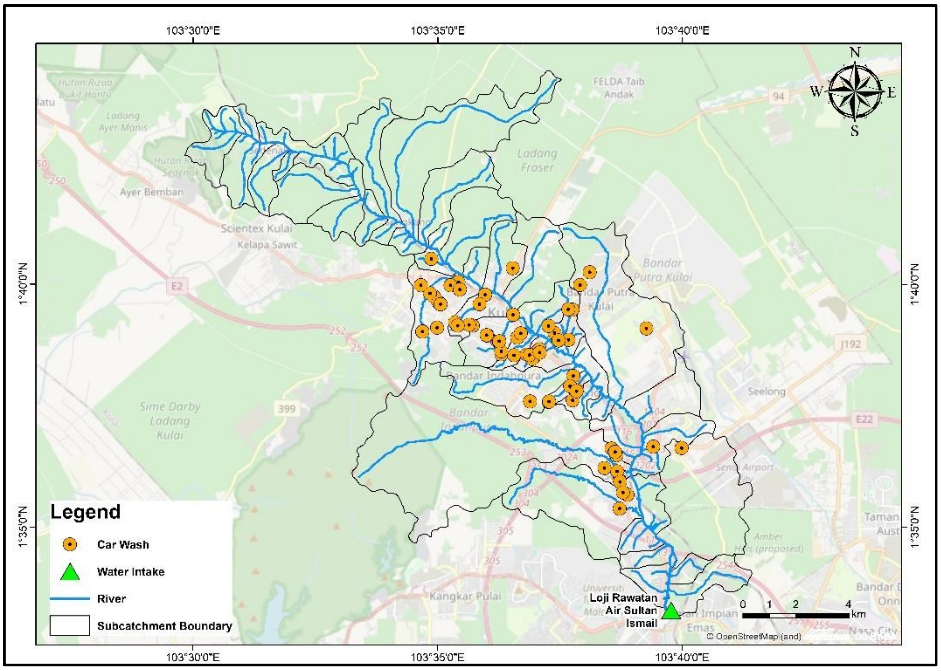

Figure 5: Car wash location map

A comprehensive survey of vehicle workshops was also undertaken via GE imagery and found 167 of such establishments along the upstream of SRC. Rigorous validation procedures, encompassing both remote verification and on-site field inspections, were implemented to ensure data accuracy and the removal of duplicate entries. A final count of 80 vehicle workshops were identified within the study area. This meticulous approach to data refinement provides a reliable foundation for subsequent analyses, including environmental assessments, land-use planning, and considerations of potential impacts on water quality and the broader ecosystem within the Sungai Skudai Catchment. Workshops can have a significant impact on water quality in nearby rivers and water bodies if their waste and pollutants are not properly managed. Past studies reported that improper management of workshop wastes like engine oil and lubricants can cause water pollution in nearby rivers as these substances are difficult to decompose, significantly reducing water quality and hindering self-purification processes (Fikri et al., 2020). Figure 6 displays the various locations of workshops in the study area and their potential impact on water quality.

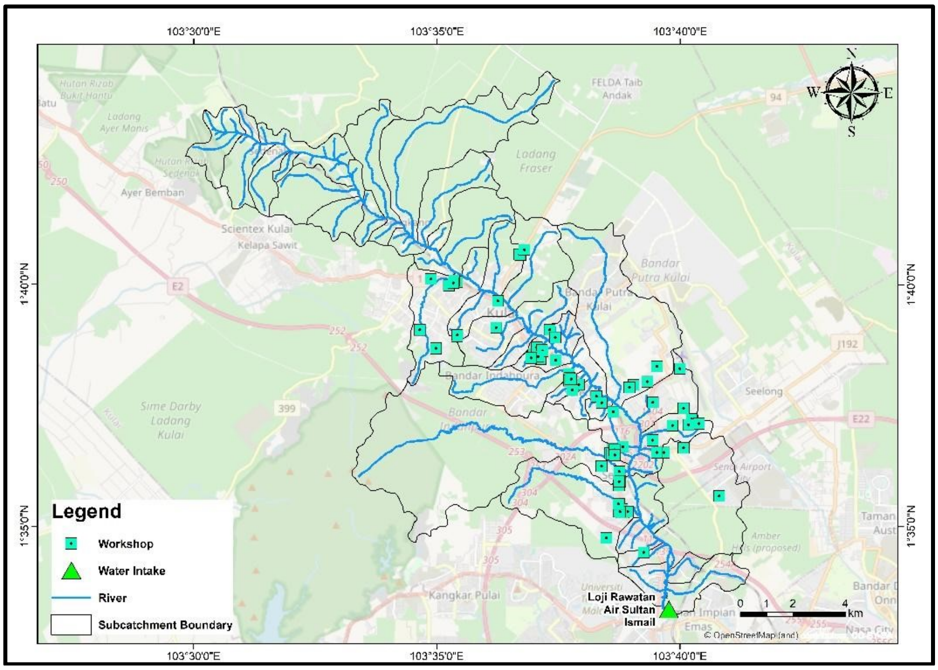

Figure 6: Vehicle location map

During the validation phase of the field survey, 30 selected points (15 restaurants, five launderette marts, five car washes, and 5 workshops) within the study area in SRC underwent rigorous assessment. Several discrepancies between GE data and field-validated information were identified, yielding a total of 6 errors. Specifically, three errors were associated with restaurants, one error with car wash, and two errors with workshops. Notably, field validation revealed new data, including two additional restaurants and one launderette, thereby enriching the dataset. These findings underscore the importance of on-the-ground verification in enhancing the accuracy and reliability of point source pollution data, ultimately contributing to a more comprehensive understanding of the environmental landscape in the upstream of the Sungai Skudai Catchment. Table 1 shows the results from the validation process via Google search and field survey.

Table 1: Validation result

Type of point source pollution	Error		New added from field survey
	Google search	**Field validation**	
Restaurant	3	0	2
Launderette mart	0	1	1
Car wash	1	1	0
Workshop	2	0	0
Total	6	2	3

CONCLUSION

In conclusion, this study demonstrates the crucial role of advanced geospatial technologies, particularly GE, in extracting and analyzing point source pollution in the upstream of Sungai Skudai Catchment. The integration of GIS tools and satellite imagery allows for a detailed examination of restaurant, launderette, car wash, and workshop locations, thus providing valuable insights for environmental planning and water quality management. The field survey validation process proved to be pivotal in enhancing the accuracy of the extracted data, revealing discrepancies and introducing new information. The spatial distribution maps of point source pollution highlight areas of concern, emphasizing the need for targeted environmental management strategies. With its diverse land uses and increasing urbanization, the Sungai Skudai Catchment, faces environmental challenges that demand for informed decision-making. Moreover, the utilization of GE to extract pollution sources can reduce the cost of collecting data on the ground while serving as a time-effective tool for collecting the pollution source location. Google Earth breaks from traditional GIS by freely sharing vast geospatial data, fostering the "democratization of GIS", and acting as a crowd-sourcing platform for volunteered geographic information from citizens (Liang et al., 2018).

This study contributes to the discourse surrounding innovative methodologies in environmental planning and underscores the importance of accurate, validated data in devising effective strategies for mitigating the impact of anthropogenic activities. By bridging technology and on-the-ground validation, this research sets a foundation for holistic approaches to land-use planning, pollution control, and conservation efforts in dynamic landscapes, such as the Sungai Skudai Catchment. Future research can further explore the collection of additional sources of pollution, including industrial zones or illicit factories, via GE.

ACKNOWLEDGEMENT

This work was supported by the Uni – Technologies, Study of Total Maximum Daily Load (TMDL) in Skudai River (Phase 2) (Vote 2181) project by BAKAJ.

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Received: 2nd January 2024. Accepted: 23rd May 2024