journal homepage: https://journal.pktm.com.my/

International Journal of Technical Vocational and Engineering Technology

e-ISSN2710-7094, Vol 5, No. 2, 2024

Analysis of Local Fruit Production Distribution in Pahang Based on Geoinformation Technology

Noor Suhaiza Sauti[1*], Siti Hajar Ismail[1], Shadatul Shila Sharuddin[1] & Arniza Fitri[2]

[1]Department of Civil Engineering, Politeknik Sultan Haji Ahmad Shah, 25350 Kuantan, Pahang, Malaysia

[2]Department of Civil Engineering, Faculty of Engineering and Computer Science, Universitas Teknorat Indonesia, Bandar Lampung, Indonesia

*Corresponding Author email: suhaiza@polisas.edu.my

ARTICLE INFO

Article History:
Received 20 June 2024
Revised 3 October 2024
Accepted 13 October 2024

Keywords:
Fruit Production;
Geoinformation;
Map.

ABSTRACT

Fruits play a pivotal role as a staple food in society and contribute significantly to the country's economy. Consequently, information regarding fruit production holds paramount importance for human activities across various sectors, including agriculture, industry, and food resources. However, the statistical data on fruit production, provided by the Department of Statistics Malaysia, is currently presented in tabular form and has not been transformed into specific maps accessible to the public. Therefore, employing geoinformation or Geographic Information System (GIS) technology, georeferencing is executed to precisely pinpoint the coordinates of cities and regions in Pahang. The objectives are to identify both attribute and spatial data related to local fruit production in Pahang, create distribution maps using ArcMap 10.4, and analyze regional patterns. The choropleth map method is applied, utilizing corresponding colours to depict density or variation units and present aggregate summaries effectively. As a result of this process, 11 maps were generated, each depicting the production of 11 different types of local fruits across various regions in Pahang. The study's significance lies in its capacity to assist users in accessing information about the distribution of fruit production by regions in Pahang for the year 2020. The transformation of raw statistical data into visually informative maps enhances accessibility and facilitates a comprehensive understanding of the local fruit production landscape.

1.0 Introduction

Pahang, with its diverse topography and climate variations, plays a crucial role in contributing to the country's agricultural output. According to the 2020 statistics provided by the Ministry of Agriculture and Food Security of Malaysia, Pahang stands as Malaysia's second-largest fruit producer, trailing behind Johor. With a total cultivated area of 24,837 hectares, Pahang yields an impressive fruit production of 201,495 metric tons (DOA, 2023).

The use of geoinformation technology provides an innovative approach to analysing and mapping the distribution of local fruit production across various regions in Pahang. As global concerns about food security, sustainable agriculture, and environmental impact intensify, the application of geoinformation technology emerges as a powerful tool in addressing these challenges (Moral et al., 2021). The geoinformation technology used in this study aims to identify the distribution of different fruit production clusters across regions in Pahang.

Findings from this research are expected to contribute not only to academic discourse but also to practical applications in the agricultural sector. By understanding the geographical nuances of local fruit production in Pahang, policymakers, agricultural practitioners, and stakeholders can make informed decisions that promote sustainable practices, regional development, and economic resilience.

The mapping of local fruit distribution in Pahang stands as a critical yet unexplored need in the realm of agricultural research. Despite the prominence of Pahang in the national agricultural landscape, a comprehensive mapping initiative utilizing GIS or geoinformation technology tailored to the unique characteristics of local fruit cultivation is notably absent.

Current agricultural practices lack a spatially informed framework that would enable stakeholders, policymakers, and farmers to understand the intricacies of local fruit distribution across the diverse regions of Pahang. The absence of a GIS-driven mapping approach restricts our capacity to develop targeted strategies for sustainable agriculture, optimize resource allocation, and make well-informed decisions to bolster the local fruit sector (Terry et al., 2011).

This study aims to address this critical gap by implementing GIS technology to systematically map and analyze the distribution of local fruits in Pahang. The primary problem stems from the lack of a sophisticated and spatially accurate representation of local fruit distribution, hindering the development of strategic interventions and sustainable practices. The creation of these maps allows for an understanding of the variations in the types of local fruits produced in all districts of Pahang. Additionally, the production of these maps provides convenience to agencies and users in need of data on local fruits in Pahang, making it easier to visually comprehend information or statistics on the production of local fruits in the form of maps.

The significance of this problem is highlighted by its potential impact on agricultural sustainability, regional development, and economic resilience. Consequently, the research aspires to provide a valuable GIS-based mapping solution, empowering stakeholders with the knowledge necessary for fostering sustainable agricultural practices and informed decision-making within Pahang's local fruit industry.

To achieve the research aim, the objectives are to identify attribute data and spatial data related to local fruits in Pahang, generate maps of their distribution using ArcMap 10.4 software, and analyze the distribution of local fruit production by region in Pahang. The study area encompasses eleven districts in Pahang (Figure 1.1). Data on fruit production for the year 2020 was gathered from the official website of the Department of Statistics Malaysia, and spatial data depicting the locations of these districts in Pahang was acquired from the official Malaysia Geospatial Data Infrastructure (MyGDI) website. This study focuses on only eleven types of locally significant fruits in the state of Pahang.

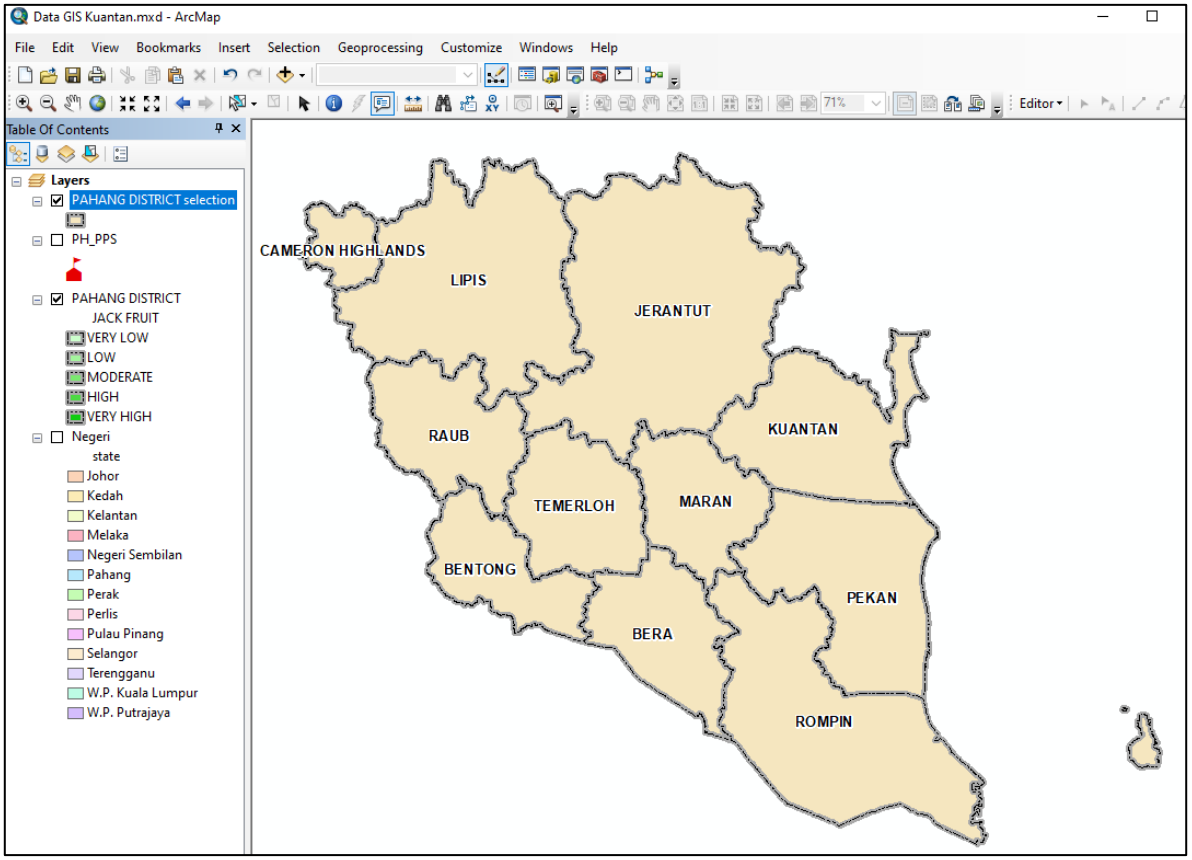


Figure 1.1: Study area

ArcMap 10.4 software was employed to combine attribute and spatial data. Moreover, Google Earth Pro was used to map coordinates in the urban canters of districts involved in local fruit production.

2.0 Literature review

Fruits play a crucial role in maintaining a balanced diet and hold significant economic importance in many countries, including Malaysia. The impact of fruit production extends beyond agriculture, affecting sectors such as food processing, trade, and export industries. As a staple food, fruits contribute to national food security and provide livelihoods for many people involved in agricultural activities (Sithole et al., 2023).

The use of Geographic Information System (GIS) technology in agriculture has become increasingly important due to its ability to analyze spatial data and present information in an accessible format (Jin et al., 2024). GIS enables the mapping of agricultural activities, including crop distribution, soil fertility, and climate conditions, which can greatly enhance decision-making processes (Raihan, 2024). Applying GIS to map fruit production provides a visual representation of data traditionally presented in tables, making it easier to interpret and use for planning and management purposes (Ahmad et al., 2020; Eberhard, 2023)

Georeferencing is a crucial procedure in GIS that entails matching spatial data with geographic coordinates, enabling precise location identification on maps. This step is vital for producing choropleth maps, which utilize various colors to depict data density or magnitude, facilitating the observation of patterns and trends across different areas (Cybulski, 2022). Choropleth mapping is widely used to present agricultural data as it effectively communicates variations in production levels, helping stakeholders identify areas of high and low productivity (Madhu et al., 2023).

In Malaysia, where fruit production data is mainly available in tabular form, converting this data into maps can offer significant advantages. The Department of Statistics Malaysia publishes

extensive data on fruit production, but the lack of geospatial representation limits its usefulness for regional analysis and decision-making (Barbara Sowińska-Świerkosz & Soszyński, 2022). By using GIS technology to create maps showing fruit production across different regions, stakeholders can better understand the spatial distribution of agricultural activities, which is crucial for resource allocation, policy development, and market planning (Drăguleasa et al., 2023).

Creating choropleth maps for fruit production in Pahang, as outlined in this study, is an innovative way to improve data accessibility and usability. These maps not only provide a comprehensive understanding of regional fruit production but also support agricultural planning, food security, and economic development efforts. The study's findings highlight the potential of GIS technology to transform raw statistical data into valuable insights that can inform various sectors and contribute to the overall growth of the agricultural industry (Tian et al., 2022).

3.0 Methodology

The methodology section of this research details the systematic approach used to gather and analyze data, ensuring the research objectives are achieved. It consists of four main phases, each providing a thorough explanation of the research design, data collection methods, sampling techniques, and analytical tools utilized, enabling the replication and validation of the study's findings (Figure 3.1).

3.1 Phase 1 Literature Review

The research starts with comprehensive understanding of the objective to map the distribution of local fruits in Pahang using GIS technology. A comprehensive literature review was conducted to identify GIS technology applications, methodologies and best practices for agricultural distribution mapping.

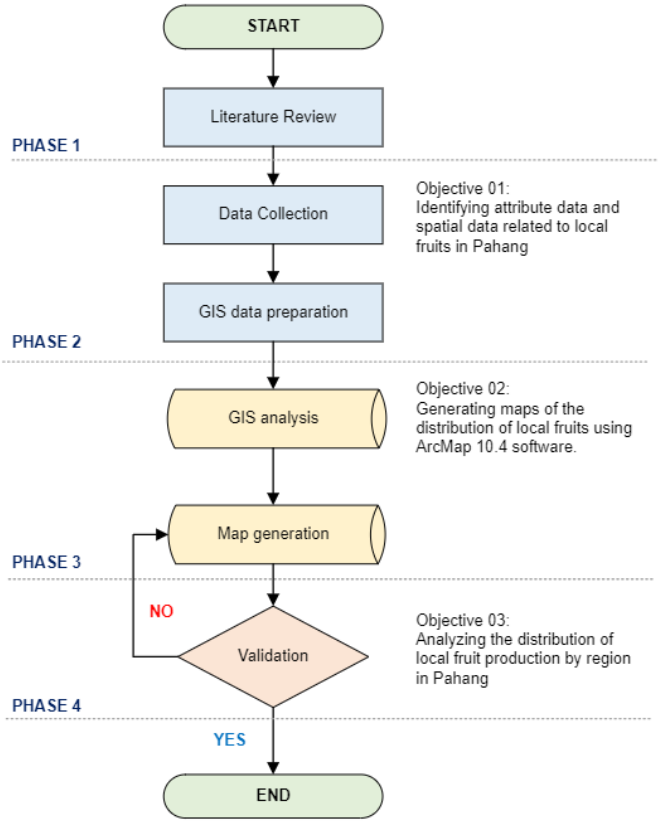


Figure 3.1: Research methodology

3.2 Phase 2 Data Collection and Data Preparation

Next, local fruit production data that has been identified was obtained from the Department of Statistics Malaysia and the Department of Agriculture, Pahang. Additionally, geospatial data, including topographic maps and satellite imagery was gathered. GIS data preparation involved with cleaning and pre-processing of acquired data to ensure accuracy and consistency. Followed by the integration of geospatial data with fruit production attribute data.

3.3 Phase 3 GIS Analysis and Map Generation

During this stage, geoinformation technology is employed using the choropleth map method to visually illustrate the distribution of fruits. Distinct maps showcasing the distribution of local fruits in various regions of Pahang are then produced.

3.4 Phase 4 Validation

Finally, field visits for ground truth validation of mapped fruit distribution patterns was conducted. It concludes with a conclusion of the study, a summary of key findings, and consideration of implications for future research or applications.

4.0 Discussion of analysis and findings

The application of GIS technology to map the distribution of local fruits in Pahang has yielded insightful findings. The choropleth maps generated through geoinformation technology provide a clear visual representation of the spatial patterns of fruit distribution across different regions within the state. A grand total of 11 local fruit types have been mapped, specifically including chempedak, rambutan, mango, watermelon, durian, banana, mangosteen, papaya, pineapple, salak fruit, and guava. An example of the distribution map of chempedak production in Pahang district is as in Figure 3.2. Deeper hues indicate increased quantities of local fruit production, while lighter colors signify lower quantities.

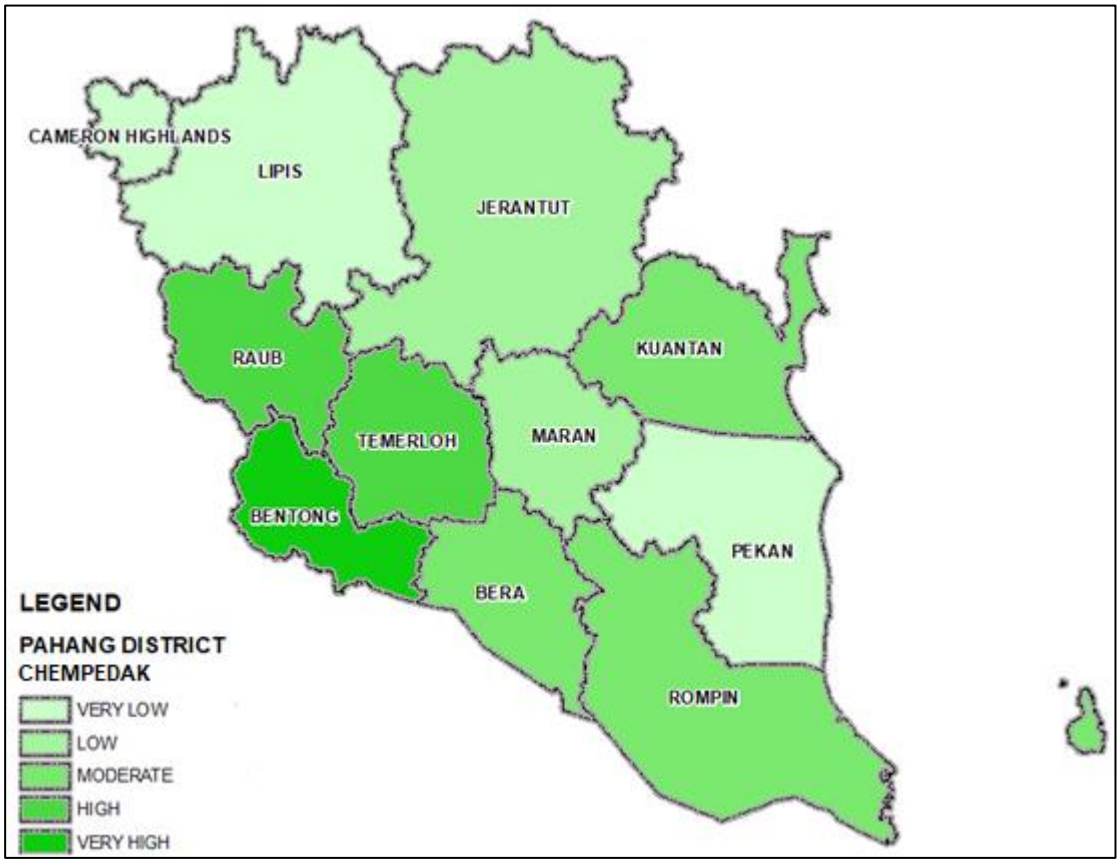


Figure 3.2: Chempedak production distribution map in Pahang district (year 2020)

The results highlight variations in fruit cultivation density, offering a valuable overview for stakeholders, policymakers, and agricultural practitioners. The maps effectively distinguish areas with high and low concentrations of fruit production, aiding in the identification of potential clusters and trends (Shah et al., 2022) (Figure 3.3). The distribution maps produced in this study hold great potential for optimizing resource allocation and promoting sustainable agricultural practices. By visually illustrating the spatial patterns of local fruit production in Pahang, these maps offer a clear and detailed view of where various fruits are predominantly cultivated.

Policymakers can use these maps to allocate resources more efficiently, ensuring that regions with higher fruit production receive the necessary support and infrastructure. This targeted resource distribution can aid in planning development initiatives that foster balanced regional growth. Additionally, the maps can serve as a basis for crafting policies that encourage sustainable agriculture, such as offering incentives for organic farming in high-yield areas.

Agricultural practitioners can also benefit from these maps by using them to guide interventions in regions with lower production. Identifying these areas allows for the implementation of specific measures, such as adopting advanced farming techniques or improving pest control, to boost yields. Moreover, the maps help optimize supply chains by highlighting production distribution, reducing transportation costs, and enhancing market access.

Figure 3.4 display the local fruit distribution statistics by district in Pahang in the form of a graph that is easy to interpret. The spatial analysis reveals nuances in the distribution, allowing for a more nuanced understanding of the factors influencing fruit cultivation in Pahang.

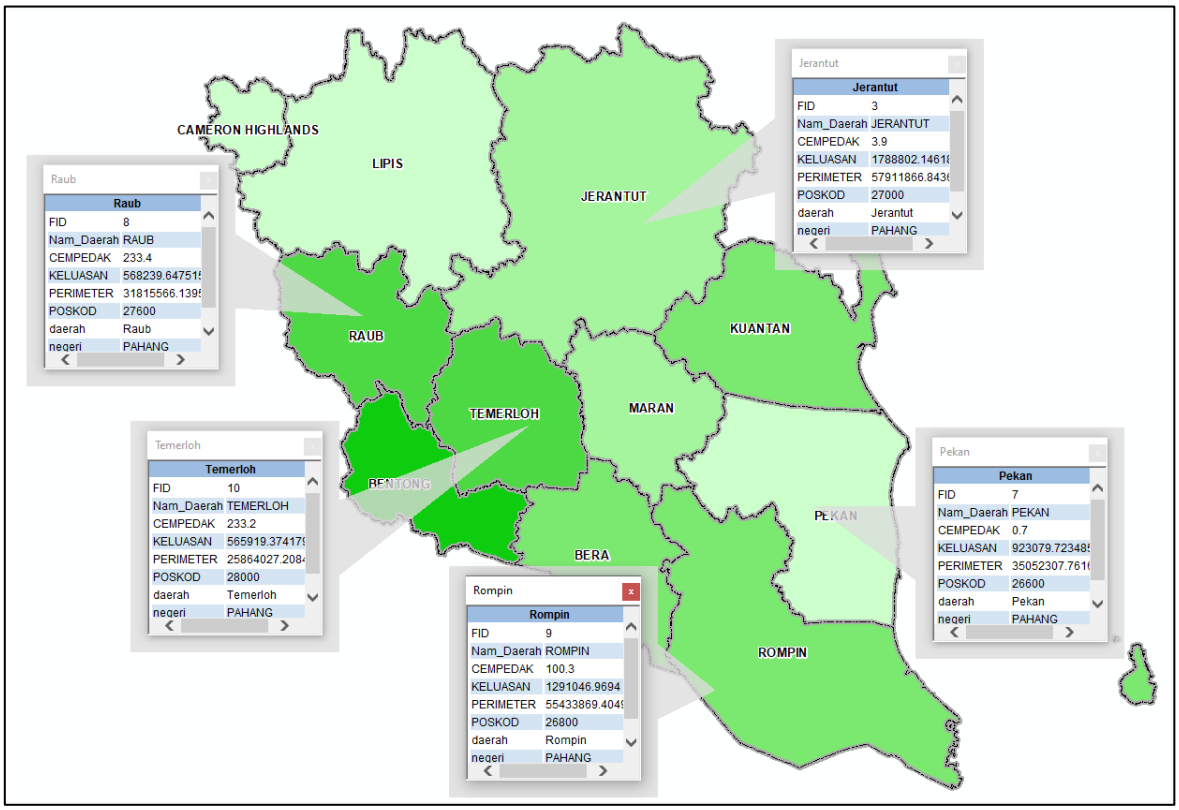
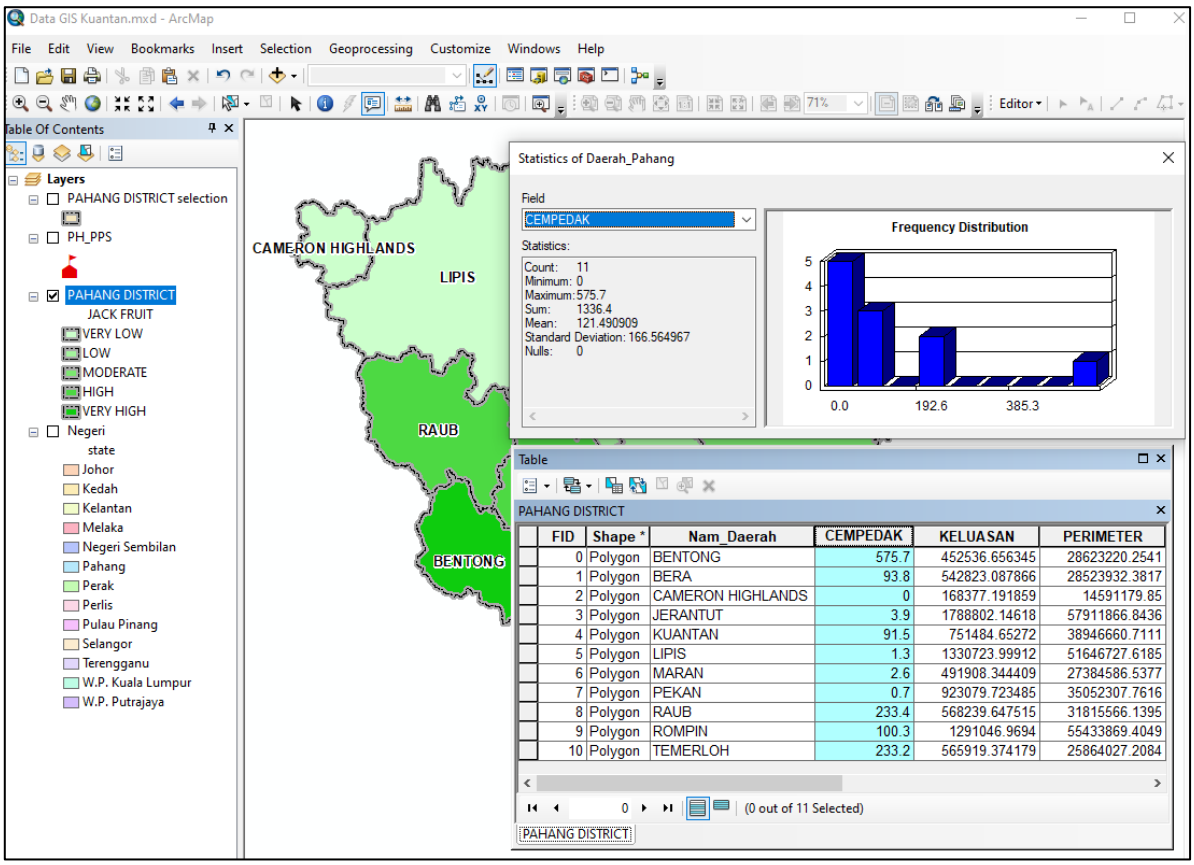


Figure 3.3: Information on chempedak production by district in Pahang

The obtained results underscore the significance of employing GIS technology for mapping local fruit distribution in Pahang. The visual representations offer a comprehensive overview of the spatial dynamics, enabling stakeholders to make informed decisions regarding resource allocation, agricultural planning, and sustainable practices (Pal et al., 2022).

The variations observed in fruit distribution patterns may be attributed to factors such as topography, climate, and soil composition (Chen et al., 2017). Further analysis and collaboration with local agricultural experts are essential to delve deeper into the specific determinants influencing these spatial patterns.



FID	Shape *	Nam_Daerah	CEMPEDAK	KELUASAN	PERIMETER
0	Polygon	BENTONG	575.7	452536.656345	28623220.2541
1	Polygon	BERA	93.8	542823.087866	28523932.3817
2	Polygon	CAMERON HIGHLANDS	0	168377.191859	14591179.85
3	Polygon	JERANTUT	3.9	1788802.14618	57911866.8436
4	Polygon	KUANTAN	91.5	751484.65272	38946660.7111
5	Polygon	LIPIS	1.3	1330723.99912	51646727.6185
6	Polygon	MARAN	2.6	491908.344409	27384586.5377
7	Polygon	PEKAN	0.7	923079.723485	35052307.7616
8	Polygon	RAUB	233.4	568239.647515	31815566.1395
9	Polygon	ROMPIN	100.3	1291046.9694	55433869.4049
10	Polygon	TEMERLOH	233.2	565919.374179	25864027.2084

Figure 3.4: The graph shows the frequency of local fruit distribution

The study's outcomes have practical implications for the agricultural sector in Pahang. By understanding the distribution of local fruits, policymakers can tailor interventions to specific regions, optimizing agricultural practices for improved sustainability and productivity. The choropleth maps serve as valuable tools for communication, providing accessible and visual information that can guide future agricultural development strategies.

Table 1.1 displays the distribution of the highest local fruit production by district in Pahang. Rompin tops the charts as the leading producer of watermelon (69%) and pineapple (54.3%), while Raub takes the lead in durian (81.5%), papaya (32.7%) and banana (54.9%) production. Over the course of 17 years, Raub observed a substantial and statistically significant increase in durian production, reaching a 95% level of significance (Ahmad et al., 2020). Temerloh claim the spotlight as major producers of mangosteen (38.6%), rambutan (35.3%), and salak (30.4%). The pinnacle of chempedak (43.1) production is reached in Bentong, while Bera district boasts the highest market share for mangoes (43.4%). Kuantan secures the title for the largest producer of guava (34.3%) and salak fruit. A GIS application is utilized to produce choropleth maps depicting the distribution of fruit production across districts in Pahang (Figure 3.5).

Table 1.1: Highest local fruit production by district in Pahang

District	Fruit	Total production (%)
Raub	Papaya	32.7
	Banana	54.9
	Durian	81.5
Temerloh	Mangosteen	38.6
	Rambutan	35.3
	Salak	30.4
Rompin	Pineapple	54.3
	Watermelon	69.0
Bera	Mango	43.4
Bentong	Chempedak	43.1
Kuantan	Guava	34.3

In conclusion, the integration of GIS technology into mapping the distribution of local fruits in Pahang has proven to be a valuable approach. The results and discussions pave the way for more targeted initiatives, fostering sustainable practices and contributing to the overall development of the local fruit industry in the region.

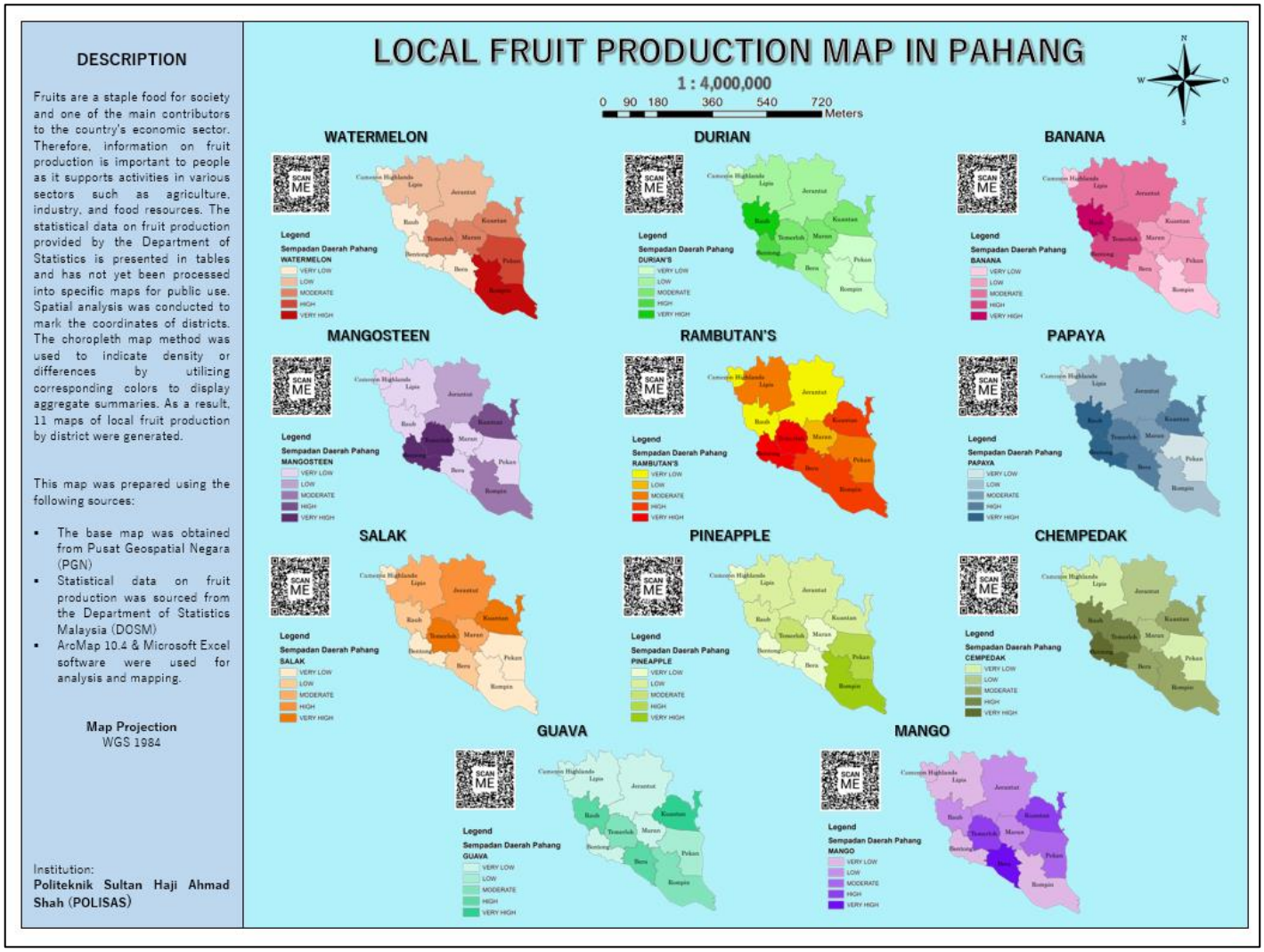


Figure 3.5: Pahang district's local fruit distribution map

5.0 Conclusion and Future Research

The utilization of geoinformation technology to map the distribution of local fruits in Pahang has proven instrumental in providing a nuanced understanding of the spatial dynamics within the state's agricultural landscape. The Choropleth Maps generated through geoinformation technology offer a visually compelling representation of the variations in fruit production across different regions.

The study's outcomes have not only identified clusters and patterns in local fruit distribution but have also underscored the importance of leveraging technology for informed decision-making in the agricultural sector. The visual insights gained from these maps serve as a valuable resource for policymakers, agricultural practitioners, and stakeholders, facilitating targeted interventions and sustainable agricultural planning.

In essence, the integration of GIS technology has not only addressed the immediate need for mapping local fruit distribution but has opened avenues for more targeted, data-driven approaches to sustainable agriculture. This study will continue to guide strategic decision-making, contributing to the holistic development of Pahang's agricultural sector.

Future research could expand the scope of this study to include other regions in Malaysia or even cross-border comparisons to gain a broader understanding of fruit production patterns. Additionally, incorporating real-time data on fruit production or environmental factors, such as soil quality and climate conditions, could provide even more comprehensive insights into agricultural productivity. The integration of such dynamic data would allow for the development of more adaptive and responsive strategies, ultimately promoting resilience in the agricultural sector.

Acknowledgements

Thank you to all the researchers who contributed energy and ideas to this study. We greatly appreciate your contributions.

Author Contributions

Noor Suhaiza S.: Conceptualization, Methodology, Software, Writing- Original Draft Preparation; **Siti Hajar I.**: Data Curation, Validation, Supervision; **Shadatul Shila S.**: Software, Validation, **Arniza F.:** Writing-Reviewing and Editing.

Conflicts of Interest

The manuscript has not been published elsewhere and is not being considered by other journals. All authors have approved the review, agree with its Submission and declare no conflict of interest in the manuscript.

6.0 References

Ahmad, A. A., Yusof, F., Mispan, M. R., Rasid, M. Z. A., & Nizar, M. M. M. (2020). Durian yield trends and distribution patterns in peninsular Malaysia. *Pertanika Journal of Tropical Agricultural Science*, *43*(1), 47–64. https://core.ac.uk/download/pdf/322382521.pdf#page=59

Barbara Sowińska-Świerkosz, & Soszyński, D. (2022). Spatial indicators as a tool to support the decision-making process in relation to different goals of rural planning. *Land Use Policy*, *119*(106180). https://doi.org/https://doi.org/10.1016/j.landusepol.2022.106180.

Chen, S. C., Cornwell, W. K., Zhang, H. X., & Moles, A. T. (2017). Plants show more flesh in the tropics: variation in fruit type along latitudinal and climatic gradients. *Ecography*, *40*(4), 531–538. https://doi.org/10.1111/ecog.02010

Cybulski, P. (2022). An Empirical Study on the Effects of Temporal Trends in Spatial Patterns on Animated Choropleth Maps. *ISPRS International Journal of Geo-Information*, *11*(5). https://doi.org/10.3390/ijgi11050273

DOA. (2023). *Booklet Statistik Tanaman 2023*.

Drăguleasa, I. A., Niță, A., Mazilu, M., & Curcan, G. (2023). Spatio-Temporal Distribution and Trends of Major Agricultural Crops in Romania Using Interactive Geographic Information System Mapping. *Sustainability (Switzerland)*, *15*(20). https://doi.org/10.3390/su152014793

Eberhard, K. (2023). The effects of visualization on judgment and decision-making: a systematic literature review. In *Management Review Quarterly* (Vol. 73, Issue 1). Springer International Publishing. https://doi.org/10.1007/s11301-021-00235-8

Jin, L., Badarulzaman, N., Omar, S. I., & Pan, M. (2024). Dynamics of Tourism Flows in Jiangxi , China : A Spatial-Temporal Analysis of Quantity and Quality Since 2000. *International Journal of Technical Vocational and Engineering Technology*, *5*(1), 59–72.

Madhu, Banavath, S. N., Shevakula, M., Nigam, S., & Singh, A. (2023). Geographic Information Systems (GIS) and its Applications. In *Research Trends in Multidisciplinary Research (Volume - 49)* (Issue 49, pp. 125–150). AkiNik Publication.

Moral, F. J., García-Martín, A., Rebollo, F. J., Rozas, M. A., & Paniagua, L. L. (2021). GIS-based analysis and mapping of the winter chilling hours in mainland spain. Application to some sweet cherry cultivars. *Agronomy*, *11*(2), 1–14. https://doi.org/10.3390/agronomy11020330

Pal, S., Pandey, S., & Sharma, S. (2022). *Applications of remote sensing and GIS in fruit crops: A review*. *11*(2), 186–191. http://www.thepharmajournal.com

Raihan, A. (2024). A Systematic Review of Geographic Information Systems (GIS) in Agriculture for Evidence-Based Decision Making and Sustainability. *Global Sustainability Research*, *3*(1), 1–24. https://doi.org/10.56556/gssr.v3i1.636

Shah, Z. A., Dar, M. A., Dar, E. A., Obianefo, C. A., Bhat, A. H., Ali, M. T., El-Sharnouby, M., Shukry, M., Kesba, H., & Sayed, S. (2022). Sustainable Fruit Growing: An Analysis of Differences in Apple Productivity in the Indian State of Jammu and Kashmir. *Sustainability (Switzerland)*, *14*(21). https://doi.org/10.3390/su142114544

Sithole, Z., Siwela, M., Ojo, T. O., Hlatshwayo, S. I., Kajombo, R. J., & Ngidi, M. S. C. (2023). Contribution of Fruits and Vegetables to the Household Food Security Situation of Rural Households in Limpopo. *Nutrients*, *15*(11), 1–14. https://doi.org/10.3390/nu15112539

Terry, L. A., Mena, C., Williams, A., Jenney, N., & Whitehead, P. (2011). Fruit and vegetable resource maps: Mapping fruit and vegetable waste through the retail and wholesale supply chain. *Waste & Resources Action Programme (WRAP)*, 95. https://pdxscholar.library.pdx.edu/busadmin_fac/109/

Tian, T., Zhang, Y., & Mei, Y. (2022). Intelligent analysis of precision marketing of green agricultural products based on big data and GIS. *Earth Sci Inform*, *15*, 1395–1406. https://doi.org/https://doi.org/10.1007/s12145-022-00789-5