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EXPLORING RUNOFF WATER QUALITY RESEARCH TRENDS IN MALAYSIA (2001-2023): A BIBLIOMETRIC ANALYSIS

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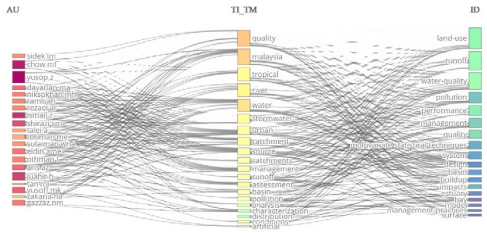
Graphical abstract



Abstract

This study presents a comprehensive bibliometric analysis of runoff water quality research conducted in Malaysia from 2001 to 2023. Significant research has been done in the area of runoff water quality as a result of growing worries about water pollution and its effects on aquatic ecosystems and public health. Through the systematic review of academic literature, this study aims to identify the key trends, influential authors, institutions, and impactful research areas within the domain of Malaysian runoff water quality. Utilizing bibliometric techniques, including co-authorship, factorial analysis, and trend topic analysis, this research provides valuable insights into the evolution of runoff water quality research over the past two decades. This study explains the progression of research interests and contributions by examining publishing patterns, collaborations, and thematic emphasis. These insights provide a roadmap for future research directions and opportunities, aiding in the development of targeted strategies for addressing water pollution challenges in the country. Through the process of synthesizing and visualizing the collective knowledge produced in this subject, the present study facilitates the making of well-informed decisions and stimulates further progress in addressing the detrimental impacts of runoff water pollution on both the natural environment and human society.

Keywords: runoff, water quality, bibliometric analysis, trends, Malaysia

Abstrak

Kajian ini membentangkan analisis bibliometrik komprehensif mengenai penyelidikan kualiti air larian yang dijalankan di Malaysia dari tahun 2001 hingga 2023. Penyelidikan penting telah dilakukan dalam bidang kualiti air larian akibat daripada kebimbangan yang semakin meningkat tentang pencemaran air dan kesannya terhadap ekosistem akuatik dan kesihatan awam . Melalui kajian sistematik literatur akademik, kajian ini bertujuan untuk mengenal pasti arah aliran utama, pengarang berpengaruh, institusi, dan bidang penyelidikan yang memberi impak dalam domain kualiti air larian Malaysia. Menggunakan teknik bibliometrik, termasuk pengarang bersama, analisis faktorial dan analisis topik trend, penyelidikan ini memberikan pandangan berharga tentang evolusi penyelidikan kualiti air larian sepanjang dua dekad yang lalu. Kajian ini menerangkan perkembangan minat dan sumbangan penyelidikan dengan meneliti corak penerbitan, kerjasama, dan penekanan tematik. Wawasan ini menyediakan peta jalan untuk hala tuju dan peluang penyelidikan masa hadapan, membantu dalam pembangunan strategi yang disasarkan untuk menangani cabaran pencemaran air di negara ini. Melalui proses mensintesis dan memvisualisasikan pengetahuan kolektif yang dihasilkan dalam subjek ini, kajian ini memudahkan membuat keputusan yang bermaklumat dan merangsang kemajuan selanjutnya dalam menangani kesan buruk pencemaran air larian terhadap kedua-dua alam sekitar semula jadi dan masyarakat.

1.0 INTRODUCTION

Runoff water quality is a critical aspect of environmental health, particularly in rapidly urbanizing regions like Malaysia. Uncontrolled urban development, industrialization, and agricultural activities have led to increased pollution of water bodies through the discharge of various contaminants via runoff. The deteriorating water quality has far-reaching implications for aquatic ecosystems, public health, and sustainable development (Camara et al., 2019; Salam et al., 2019). To develop efficient ways to deal with the problems caused by runoff water pollution, it is crucial to comprehend the research landscape and identify major trends within this area. This study does a thorough bibliometric analysis to trace the development of Malaysia's runoff water quality research from 2001 to 2023.

Applying math and statistics to literature and other forms of communication media is a valuable technique known as bibliometrics (Aria and Cuccurullo, 2017). By examining the development trend of disciplines based on bibliometrics, one may systematically summarize the research status and hot themes in this field and evaluate the scientific research abilities and output of research institutes (Ahmadvand et al., 2019). This is essential to comprehend how a topic is evolving, stay current with advancements, select cutting-edge research inquiries, and increase the efficacy of scientific investigation (Xie et al., 2022).

1.1 Problem statement

The alteration of land-use configurations, in conjunction with insufficient management methodologies, has resulted in the production of runoff that transports diverse contaminants into aquatic systems, thereby deteriorating their overall quality and presenting hazards to both the natural ecosystem and human well-being. Notwithstanding the increasing acknowledgement of these difficulties, there exists an imperative necessity to thoroughly tackle the intricate interaction of elements that impact the quality of runoff water. These elements encompass a wide spectrum, including land-use patterns, sources of pollutants, and strategies for management. Moreover, in the pursuit of sustainable development and the preservation of the environment, it is crucial to ascertain areas of knowledge deficiency and research patterns within this field. This will serve to guide the formulation of impactful policies, intervention approaches, and the creation of resilient management structures.

Despite the implementation of various initiatives aimed at addressing the issue of runoff water pollution in Malaysia, there is a notable lack of comprehensive evaluation about the research conducted in this field. The absence of a comprehensive analysis of the patterns, central themes, and individuals involved in this discipline impedes the progress of specific initiatives and policies. Hence, it is imperative to undertake a bibliometric analysis to ascertain the deficiencies, progressions, and collaborative networks that exist within the realm of research on Malaysian runoff water quality.

1.2 Objectives

The primary objective of this study is to perform a comprehensive bibliometric analysis of runoff water quality research conducted in Malaysia between 2001 and 2023. The analysis aims to:

1. Identify influential authors, institutions, and collaborative networks in this field.
2. Identify the key research trends, and areas of focus within Malaysian runoff water quality research

1.3 Scope of Study

This study focuses specifically on runoff water quality research in Malaysia from 2001 to 2023. It encompasses studies related to water pollution sources, contaminants, ecological impacts, mitigation strategies, and water treatment technologies. The analysis encompasses a range of scientific sources, such as peer-reviewed journal articles, conference papers, and other publications, which collectively enhance our comprehension of runoff water quality within the Malaysian context.

2.0 METHODOLOGY

The study employs a bibliometric approach to analyze the literature related to Malaysian runoff water quality. The methodology involves the following steps:

1. Data Collection: A systematic search of academic databases will be conducted to gather relevant publications within the study period.
2. Data Preprocessing: The collected data will undergo preprocessing, including deduplication and verification of metadata.
3. Bibliometric Analysis: Co-authorship analysis, citation analysis, and keyword analysis will be conducted to identify collaborative networks, influential works, and research themes.
4. Visualization: The analysis results will be visualized using network diagrams, bibliographic coupling maps, and keyword co-occurrence matrices.
5. Interpretation: The findings will be interpreted to understand the evolution of research trends, influential authors, key institutions, and emerging themes.
6. Discussion: The implications of the findings will be discussed in relation to policy formulation, research prioritization, and sustainable water management strategies.

By employing a rigorous bibliometric analysis, this study contributes to a deeper understanding of runoff water quality research in Malaysia, facilitating evidence-based decision-making and fostering future advancements in mitigating water pollution challenges.

The selection of the Web of Science (WoS) as the primary resource for this study was based on its extensive utilization within the academic community (Yang et al., 2017). The initial and important stage in the retrieval process involves formulating a specific search query. Liu et al. (2014) argue that the inclusion or exclusion of non-alphabetic characters in a search filter can lead to inaccurate outcomes and result in erroneous interpretations (Liu et al., 2014). A literature search was conducted using the selected keywords "runoff", "water quality", and "Malaysia" to retrieve papers published between

2001 and 2023. The author, title, abstract, and keywords plus were all included in the keyword retrieval object. The data was downloaded in "bibtex" format and included "full records and cited references"; it was then put into R studio version 4.3.0 software for analysis. R Studio is a valuable resource for conducting thorough literature reviews and extracting significant insights from academic research, owing to its user-friendly interface and extensive array of capabilities (Bhat et al., 2023).

3.0 RESULTS AND DISCUSSIONS

3.1 Publications

From January 2001 to August 2023, a total of 50 papers were published (38 journal articles, 11 proceedings and 1 review paper). The years 2012, 2013, 2017, and 2018 show relatively higher publication counts, indicating periods of concentrated research activity. These could be the years when significant developments, breakthroughs, or collaborations occurred within the field. The publication output continues to increase, with a notable spike in 2021. This surge could be due to various factors, such as heightened environmental concerns, policy initiatives, or advancements in research methodologies especially in the past 5 years. In summary, the data reveals a growing trend in scientific production related to runoff water quality research in Malaysia, particularly in the latter years of the analyzed period. This trend could be indicative of increasing environmental concerns, regulatory efforts, and research advancements aimed at addressing the challenges posed by runoff water pollution. The fluctuations in publication output during certain years may reflect varying levels of attention and funding within this research domain. Those 14 articles contained a total of 170 authors, and only two of those pieces had just one author. The average number of authors per piece was 3.98.

The variable "Average citations per year" in Figure 1b denotes the number of citations received per year for the papers published within a specific year. These year 2019-2021 exhibit relatively higher average citations per year, suggesting increased attention to the published works and possibly higher quality research. In summary, the data indicates varying patterns in average citations per year across different years. The impact of a publication can be influenced by factors such as the number of publications, the quality of research, the significance of findings, and the duration over which the citations accumulate. The overall trends suggest a mix of impactful years with high average citations per year and years with lower average citations, often corresponding to variations in the number of publications and the duration for which citations are counted.

Figure 2a comprises authors that have published scholarly publications on the investigation of runoff water quality pollution in Malaysia. The provided data lists the most relevant authors along with the frequency of their appearance as authors in the dataset. The number beside each author's name indicates the count of their appearances as authors. It appears that there are several authors who have contributed significantly to the runoff water quality research in Malaysia like YUSOP Z (5), CHOW MF (4) ISMAIL Z, JUAHIR H, SHIRAZI SM, and YUSOFF MK (3 each). It is important to note that the relevance and significance of an author's contributions cannot be solely determined based on their appearance frequency in the dataset. Further analysis of their individual contributions, publication quality, citations received, and their role in shaping the field of runoff water quality research would provide a more comprehensive understanding of their impact. The compilation in Figure 2b denotes a collection of references that have been cited globally. The paper by JUAHIR H in 2011 from the journal "Environmental Monitoring and Assessment" with a DOI of 10.1007/s10661-010-1411-x has the highest total citations of 221. This paper has an impressive average citation per year (17) and a normalized total citation score of 1, indicating that it has consistently garnered attention over time. Several authors have multiple papers in the list, indicating their consistent contribution to the field. Notably, GAZZAZ NM has two papers with substantial citations. Some papers from recent years, such as 2021 and 2023, have already gathered a significant number of citations, indicating their rapid influence and relevance.

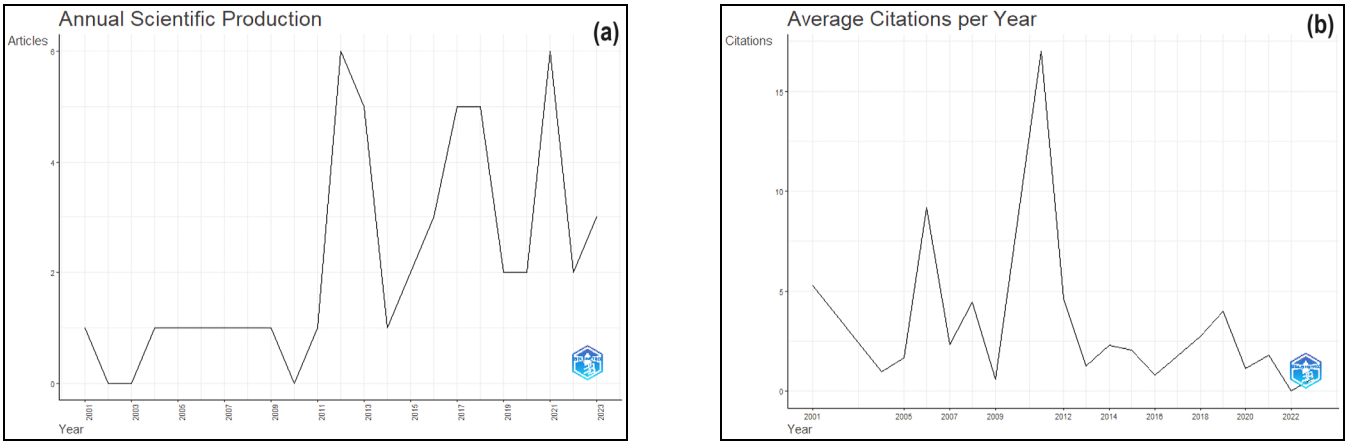


Figure 1: Publication details in Malaysia from 2001 to 2023 (a) Annual Scientific production and (b) Average citations per year

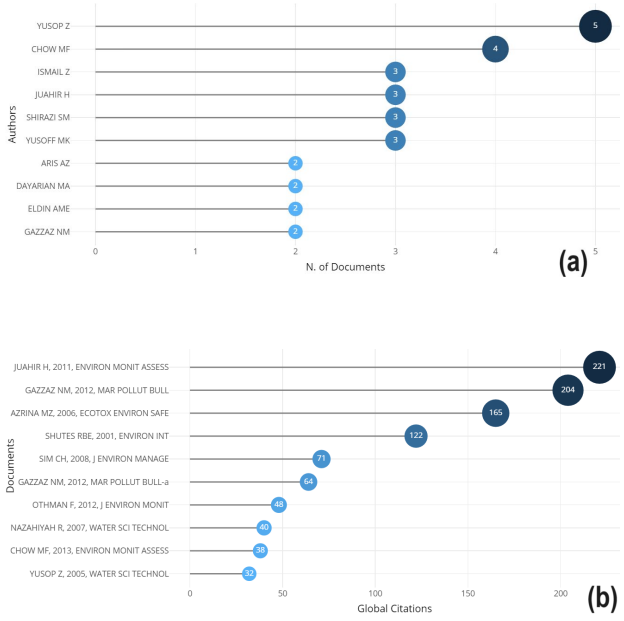


Figure 2: (a) Most relevant authors and (b) Most global cited documents

3.2 Factorial analysis

Factorial analysis, commonly referred to as factor analysis, is a statistical method for pattern recognition and data reduction that is frequently used in the social sciences, psychology, and data mining. It is used to deconstruct complex data into more digestible parts and to reveal hidden connections between a large number of variables (Watkins, 2021). From the data provided in Figure 3, Factorial Analysis was performed on a set of terms (words) and their corresponding values in two dimensions (Dim.1 and Dim.2), resulting in a clustering of terms. The term “Water quality” is positioned with a positive value on Dim.1 and a negative value on Dim.2. It's relatively closer to the origin, indicating a moderate presence in the dataset and a balance between the two derived dimensions. Likewise, the term ‘Runoff’ has positive values on both Dim.1 and Dim.2, suggesting a positive presence along both dimensions. It's positioned further from the origin than "water quality," indicating a potentially higher importance in the analysis. Overall, it appears that the words have been projected onto two dimensions in a way that emphasizes their relative positions and relationships within the dataset. The cluster assignment (Cluster 1) suggests a commonality or grouping among these terms in this new space, potentially indicating semantic or contextual similarities among them. However, the specific meaning and interpretation of these dimensions and the clustering would depend on the broader context of the analysis, the nature of the original dataset, and the purpose of the analysis.

3.3 Collaboration Network

A collaboration network, also known as a co-authorship network, is a graphical representation that illustrates the relationships and collaborations among individuals, organizations, or entities based on their joint contributions to a specific field, project, or body of work (Lei et al., 2021). In the context of academia and research, collaboration networks often depict how researchers, authors, or institutions work together on publications, papers, or projects. Analyzing these networks helps researchers understand the collaborative dynamics, knowledge flow, and influence within a specific research landscape. It also provides a visual representation of how individuals and organizations work together to advance knowledge and innovation in a particular field. From Figure 4, Nodes refer to the specific researchers or individuals who are actively involved in the collaboration network. Cluster refers to the membership of each node in a cluster. In the present scenario, the researchers are assigned to the same cluster (Cluster 1) based on their collaborative patterns. Betweenness centrality is a metric used to quantify the degree to which a node is positioned on the shortest paths connecting other nodes within a network. Nodes exhibiting high betweenness centrality frequently serve as connectors between distinct components within a network. The effectiveness of a node in connecting to every other node inside a network is measured by the closeness centrality statistic. Nodes that possess a high degree of proximity centrality have strong connectivity and are capable of efficiently spreading information. From the figure, Nodes with higher betweenness values (e.g., "Chow mf 2011," "Goonetilleke a 2005") may play a crucial role in connecting different parts of the co-citation network. They act as bridge nodes through which information flows between various documents. Nodes with higher closeness values (e.g., "Mcleod sm 2006," "Ballo s 2009") are more central and well-connected within the network. These nodes have shorter average distances to other nodes, indicating their potential influence in the network.

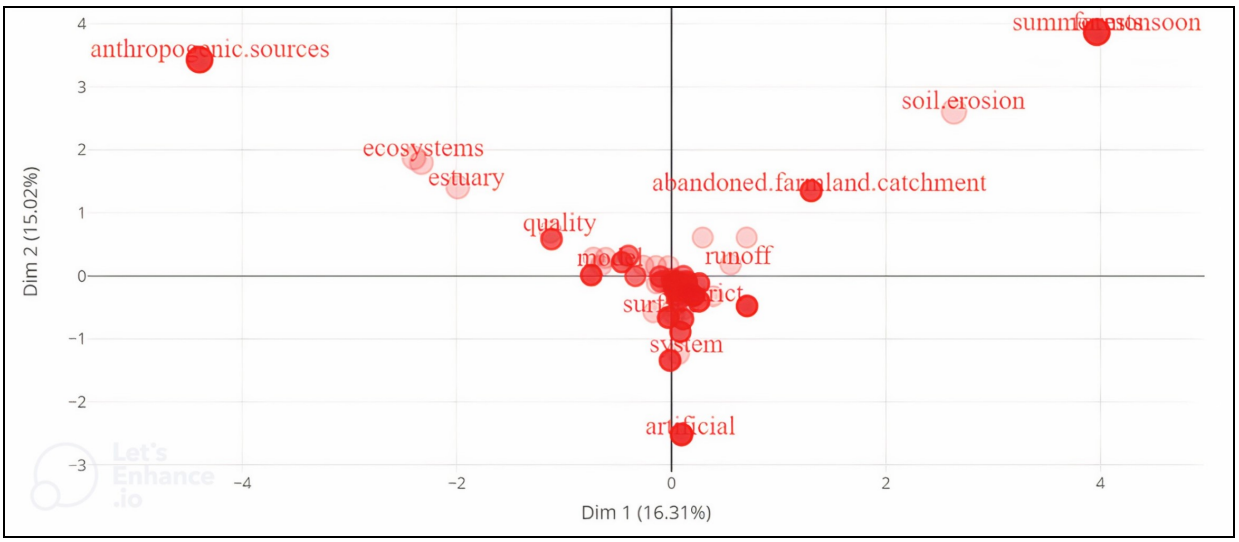


Figure 3 Factorial analysis

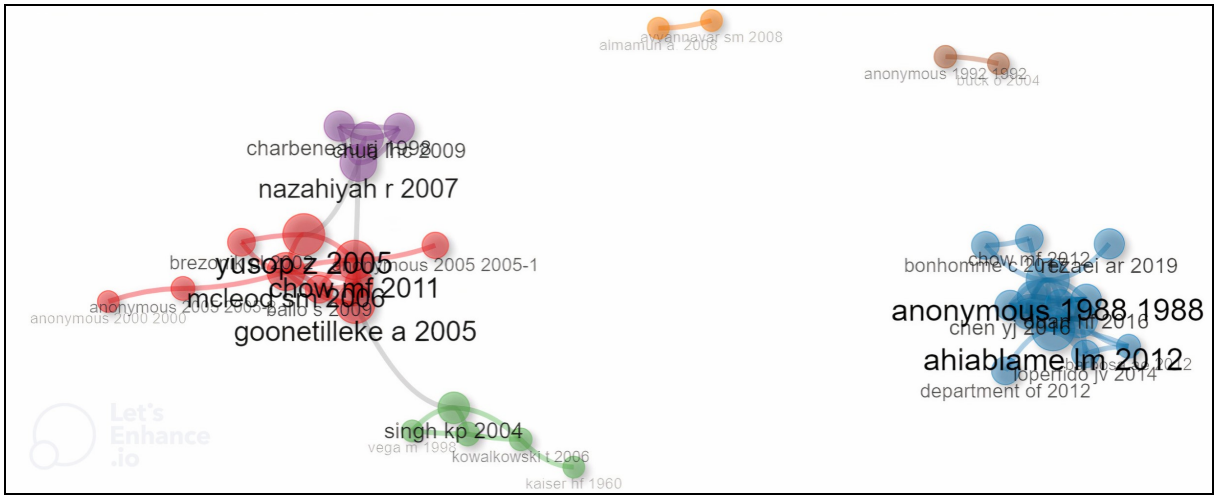


Figure 4 Collaboration Network

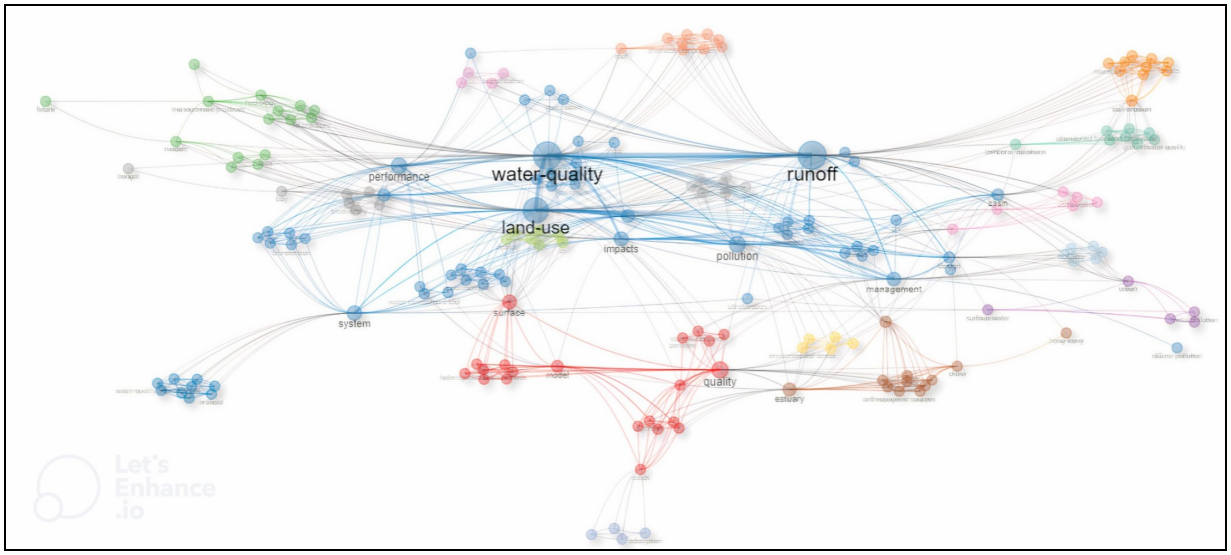


Figure 5 Thematic map

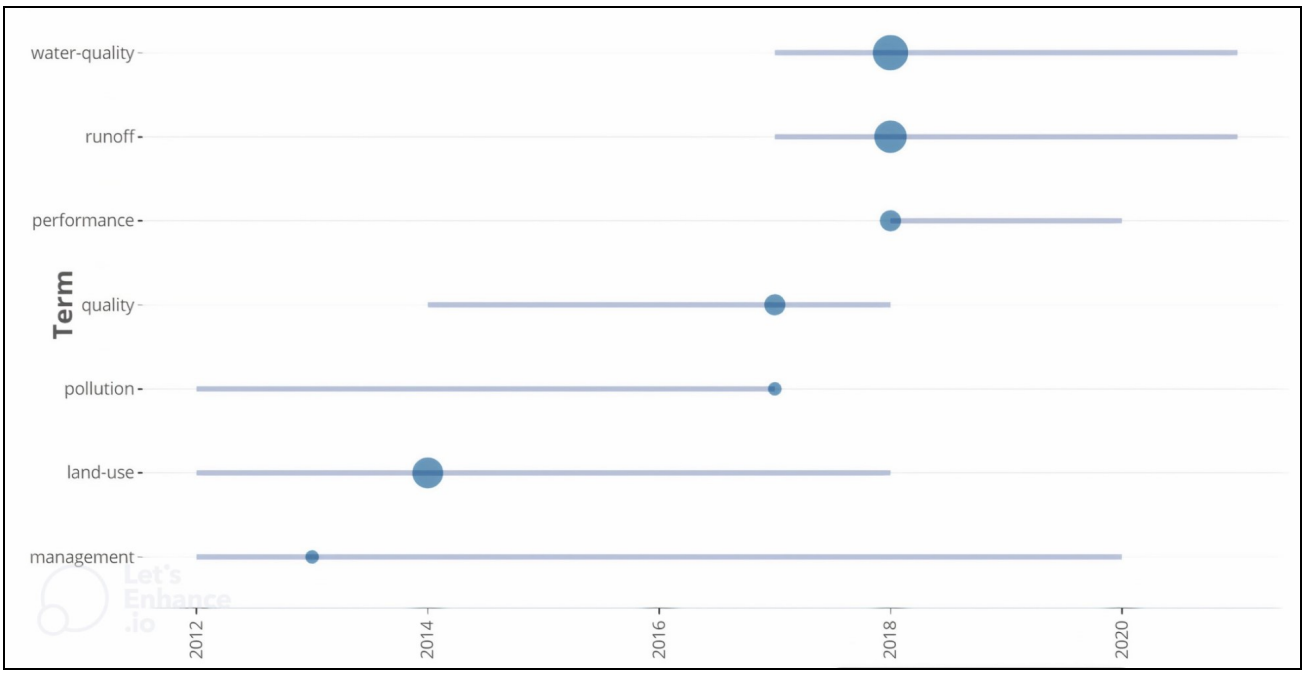


Figure 6 Trend topics

3.5 Thematic Map

Thematic maps are a type of map that displays spatial patterns or relationships between different geographic areas based on a specific theme or topic. The key feature of thematic maps is that they use colours, symbols, or other visual elements to represent the data being displayed, making it easy for viewers to quickly grasp the information being presented. By using thematic maps, researchers can gain insights into patterns and trends that might not be immediately apparent from raw data alone. This can help them make better decisions, communicate more effectively, and ultimately achieve their goals more efficiently (Watkins, 2021). In summary, the thematic map in Figure 5 showcases clusters of words and their centrality measures. For Cluster 1 (Theme: Quality), words like "quality," "model," "surface," "solids," and "water" are part of this cluster. "Quality" has the highest betweenness centrality, indicating its importance in connecting different parts of the network. For Cluster 2 (Theme: Water Quality), words like "water-quality," "runoff," "land-use," "performance," and "management" belong to this cluster. "Runoff" has the highest betweenness centrality, suggesting its significance in connecting different elements in the network while "Water-quality" has the highest occurrences and also has high centrality measures across the board, indicating its central role in this thematic cluster..

3.5 Trend Topic

Figure 6 is a visual representation of the trend topic analysis provides insights into the temporal distribution of specific terms within the field of runoff water quality research. The terms considered in the analysis include "management," "land-use," "quality," "pollution," "water-quality," "runoff," and "performance." The analysis is based on the frequency of these terms across different years, including the first quartile (year_q1), median (year_med), and third quartile (year_q3) years. The term "management" appears five times in the dataset. The analysis shows that research on management as it relates to runoff water quality started gaining significant attention around 2012, with the median year of 2013. This attention continued through the years, with the third quartile year being 2020. This suggests that the study and implementation of management strategies for addressing runoff water quality have been a consistent and evolving focus over the years. The terms "water-quality" and "runoff" are the most frequent, with 13 and 11 occurrences, respectively. The analysis indicates that research on water quality and runoff gained significant momentum around 2017, with the median year being 2018. The focus on these topics continued to grow, with the third quartile year being 2021. This suggests that understanding, managing, and mitigating the impact of runoff on water quality has been a central and evolving theme in recent years. Overall, the trend topic analysis highlights a consistent and evolving interest in researching and addressing various aspects of runoff water quality. The analysis underscores the importance of managing land-use practices, mitigating pollution, and ensuring water quality in runoff scenarios. The increasing focus on the performance of strategies and systems indicates a move towards practical and effective solutions. Furthermore, the prominence of "water-quality" and "runoff" signifies the continuous efforts to understand and manage the impact of runoff on water quality.

4.0 CONCLUSIONS

Based on the comprehensive study conducted on runoff water quality through bibliometric analysis in Malaysia from 2001 to 2023, several significant conclusions can be drawn:

- Evolution of Research Trends: The analysis of annual scientific production indicates a noticeable increase in research output related to runoff water quality in Malaysia over the past two decades. This suggests a growing interest and recognition of the importance of addressing this issue.

- Focus on Water Quality and Runoff: The study's most relevant authors and frequently cited documents highlight the emphasis on water quality, runoff management, and their interconnections. This signifies the importance of understanding and managing runoff water quality to ensure the sustainability of water resources.

- Multidisciplinary Approach: The thematic analysis of frequent words underscores the multidisciplinary nature of runoff water quality research. Terms such as "water-quality," "runoff," "land-use," and "performance" indicate that research in this field integrates various domains, including hydrology, environmental engineering, and management.

- Challenges and Solutions: The research likely addresses challenges related to water pollution, land-use changes, and the impacts of human activities on water quality. By focusing on these aspects, the study aids in identifying potential solutions and strategies for sustainable runoff water quality management.

- Collaborative Research: The co-citation network analysis reveals collaboration among researchers, as evidenced by shared citations and research contributions. Collaborative efforts contribute to the exchange of knowledge and the advancement of runoff water quality studies.

- Research Gaps and Future Directions: The study indicates potential research gaps or areas that warrant further investigation. Addressing these gaps could lead to a deeper understanding of specific aspects, such as pollutant sources, impact assessment, and innovative mitigation strategies.

In conclusion, the study on runoff water quality through bibliometric analysis offers valuable insights into the evolution, trends, and focus areas of research in Malaysia. The multidisciplinary nature of this research, coupled with collaborative efforts, provides a foundation for addressing the challenges posed by runoff water quality. As researchers continue to explore innovative solutions and bridge existing gaps, the field is poised to contribute to sustainable water resource management and environmental protection in the country.

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