A SYSTEMATIC LITERATURE REVIEW OF VALUATION FOR RIVER ECOSYSTEM SERVICES IN MALAYSIA

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ABSTRACT

In Malaysia, ecosystem valuation has not been practised and has rarely been conducted. Most of what is conducted in Malaysia is using traditional methods such as the Comparison Method and Cost Method. Often this method is used as an example for logging activities for production purposes. However, to evaluate ecosystems where the focus is on production, the touch will be done on the ecosystem so that it harms the ecosystem and biodiversity particularly river ecosystem will be evaluated using the ecosystem valuation method which is a new and special valuation method. The absence of this method of ecosystem evaluation in Malaysia causes difficulties for valuation professional to determine value for ecosystem particularly ecosystem services. This study evaluates 414 research articles to evaluate the development trend of valuation of ecosystem services research and to outline the various methodologies employed in this field.

Keywords: *Ecosystem, valuation, river, systematic, literature*

1. INTRODUCTION

Evaluating the unique and uncommon aspects of river ecosystems in Malaysia presents significant challenges due to the absence of standard benchmarks for guidance. The scarcity of comprehensive data complicates the process of establishing a definitive valuation metric. This research navigates through these complexities to arrive at a conclusive valuation. Valuation, an intricate blend of science and art, is inherently dynamic and adaptable. It demands a thorough and holistic consideration of all environmental facets to achieve an informed and comprehensive valuation of these ecosystems. The valuation of river ecosystems in Malaysia is a complex and dynamic process, requiring a holistic consideration of all environmental facets (Rahman, 2020). This is particularly challenging due to the absence of standard benchmarks and comprehensive data (Pandeya, 2016). Various studies have attempted to address this challenge by employing different valuation methods. For example, Abidin (2020) used a combination of research methods to assess the landscape character of urban river corridors, while Abdullah (2022) estimated the economic value of forest ecosystems for watershed services. Mamat (2020) and Rahman (2020) both used willingness to pay (WTP) methods to estimate the economic value of protected natural environments and seagrass meadows, respectively. However, these studies also highlight the need for more locally relevant valuation approaches and data collection, as well as the importance of capturing the temporal disturbance profile and the role of institutional arrangements in determining which values are captured (Turner, 2003; Pandeya, 2016).

The importance of valuing ecosystem services and biodiversity is increasingly acknowledged as essential in decision-making processes (Atkinson, 2012). Despite this, current valuation methods often face limitations, particularly in fully capturing the diverse range of ecosystem services and accounting for temporal disturbances (Turner, 2003). In Malaysia, the practice of ecosystem valuation is still in its nascent stages, with most existing studies relying on traditional methods such as comparison and cost methods. These approaches are frequently applied in contexts like logging for production, where they may adversely impact ecosystems and biodiversity. The lack of specialised ecosystem valuation methods in Malaysia poses challenges, as adapting foreign studies to the Malaysian context can introduce discrepancies due to varying environmental and socio-economic conditions. Recognising the urgency to understand the impact of threats on ecosystems and human well-being, there is a growing trend towards the economic valuation of ecosystems (Toman, 1997). This trend has spurred the development of various monetary valuation techniques (Nijkamp, 2008). However, challenges persist in this field due to the inherent complexity of ecosystems, limitations in existing economic valuation methods, and evolving human preferences regarding ecosystem services. Despite these challenges, acknowledging and quantifying the economic value of nature and its services is imperative for guiding sustainable development initiatives (Turner, 2010).

Conducting a systematic literature review is critical for grasping the complexities of river ecosystems in Malaysia and for the development of uniform benchmarks for their economic assessment (Lee, 2022; Weng, 2020). This is particularly important given the degradation of these ecosystems due to mismanagement, pollution, and abuse (Weng, 2020). The valuation of ecosystem services, including those provided by rivers, is a key aspect of this review, with a focus on the Malaysian context (Lee, 2022; Matthew, 2019). The need for a multi-stakeholder approach, including public-private partnerships, in river management is also highlighted (Weng, 2020). The development of a multimetric index for river health assessment, incorporating biological aspects, is a valuable tool for this review (Arman, 2019; Arsad, 2012). The review should also consider the various methodologies used for ecosystem services valuation, particularly those applicable at the local scale and in data-scarce regions (do Carmo Martinelli, 2023; Pandeya, 2016).

In addition, the scarcity of comprehensive data makes it imperative to develop tailored standards and methods that are specific to the Malaysian context. Valuation is a dynamic and multifaceted process, requiring an integrated approach that encompasses all environmental aspects to create a robust valuation framework. This review is essential for synthesising various methodologies to offer a cohesive and context-specific understanding of ecosystem valuation. Moreover, there is a clear need for valuation approaches that are relevant to the local environment, reflecting the temporal disturbances and the influence of institutional arrangements. The review can bring together disparate studies, highlighting the necessity for locally adapted valuation methods. It can also elucidate the gaps in current valuation methods that do not fully capture the diverse range of ecosystem services, thereby influencing decision-making processes. These insights are crucial for developing comprehensive valuation techniques that inform sustainable management and policy-making.

The adaptation of valuation methods to Malaysian conditions is critical, especially in practices like logging, which have the potential to adversely impact ecosystems and biodiversity. A systematic review can examine how traditional methods can be adapted or improved, ensuring they are culturally and environmentally appropriate. It underscores the importance of economic valuation of ecosystems in guiding sustainable development initiatives, consolidating various monetary valuation techniques, and addressing the challenges of ecosystem complexity and evolving human preferences. Such a review is necessary for recognising the economic value of nature and its services, which is imperative for the advancement of sustainable development in Malaysia.

2. METHODOLOGY

2.1 Bibliometric Analysis

A range of studies have explored the use of bibliometric analysis in various fields. De Oliveira (2019) and Moresi (2021) both present methods for mapping the state of the art and identifying research gaps and trends, with Moresi's approach integrating qualitative analysis. Zupic (2014) and Ellegaard (2015) discuss the use of bibliometric methods in management and organisation, with Zupic introducing specific methods and a workflow. Thanuskodi (2010) and Kanna & Thanuskodi (2019) apply bibliometric analysis to specific journals, Library Philosophy and Practice, and The Electronic Library, respectively, to identify patterns in publication and authorship. Hussain et al., (2012) uses bibliometric analysis to measure the impact of individual online journals. These studies collectively demonstrate the value of bibliometric analysis in understanding the scholarly landscape and identifying research trends and gaps.

A range of studies have employed bibliometric analysis to explore the valuation of ecosystem services. Velasco-Muñoz (2022) and Liu (2019) both highlight the importance of this approach in understanding the economic value of these services, with Velasco-Muñoz emphasising the need for further research on temporal and spatial scales. Gölgeci (2021) and Binoy (2021) provide broader perspectives on the use of bibliometric analysis in the fields of service ecosystems and property valuation, respectively. These studies underscore the potential for this method to reveal trends and gaps in research. However, the specific application of bibliometric analysis to the valuation of ecosystem services is not extensively discussed in these studies. Further research is needed to explore the potential of this approach in this specific context.

Bibliometric analysis serves as a crucial tool in ecosystem service valuation for Johor River, allowing for a comprehensive examination of the literature encompassing economic analyses, ecological evaluations, and policy-making implications. By employing specific search phrases, the analysis can effectively map scholarly work, revealing the depth of research in areas such as the economic efficiency of conservation efforts, interdisciplinary valuation of ecological systems, and quantification of the monetary benefits of ecosystem services.

The methodology for this study involves a systematic literature review with a focus on journal articles sourced from two major databases: Scopus and Web of Science. The rationale for selecting these databases is their comprehensive coverage of peer-reviewed literature across various disciplines, which is crucial for interdisciplinary topics such as ecosystem services valuation. The process begins with the development of search phrases that are directly related to the valuation of ecosystem services within the context of Sungai Johor. These phrases are carefully chosen to cover a broad spectrum of economic and ecological valuation methods and their applications in river ecosystems. Each phrase is justified based on its relevance to the research objectives.

For instance, "Cost Benefits Analysis of Ecosystem Services" seeks studies that conduct an economic analysis comparing the costs and benefits of actions affecting ecosystem services. This is essential for understanding the economic efficiency of conservation efforts specific to river ecosystems. Similarly, "Ecological Economics Valuation" focuses on interdisciplinary studies that combine economics and ecological systems, providing insights into the economic value of the ecological services offered by Sungai Johor.

"Environmental Valuation" looks for methods to value the environment and its services, which is applicable to the multifaceted aspects of Sungai Johor's ecosystem. Phrases like "Nature Capital Valuation" are included to capture studies valuing natural capital, including natural resource stocks and living organisms, which is crucial for grasping the value of Sungai Johor's natural resources. Once the search phrases are established, they are used to query the databases. The search yields a set of journal articles that are then screened based on specific inclusion criteria, such as relevance to the research questions, methodological rigor, and the context of Sungai Johor. Articles may be excluded based on factors such as being outside the scope of the ecosystem services valuation, lack of focus on river ecosystems, or insufficient methodological details. The selected articles undergo a thorough review, where data on various valuation methodologies, applied case studies, and the implications of the findings for policy and decision-making are extracted and analysed. The sampling of journal articles ensures a diverse and comprehensive set of perspectives and methodologies, which contributes to a robust synthesis of current knowledge on ecosystem service valuation in the context of Johor River.

Table 1 summarises the number of articles related to various aspects of ecosystem services and their economic and environmental valuation. The majority of the categories, including "Cost Benefit Analysis of Ecosystem Services," "Economic Valuation of Ecosystem Services," "Ecosystem Services Assessment," "Ecosystem Services Pricing," "Ecosystem Services Valuation," "Environmental Economics of Ecosystem Services," "Environmental Valuation," and "River Ecosystem Services," have a significant number of articles, each containing 51 articles. However, "Ecological Economics Valuation" and "Valuation of Ecosystem Services" have a notably lower count, with seven articles each. "Nature Capital Valuation" has the least, with only four articles. This summary indicates a strong research interest and literature

availability in most areas related to the economic and environmental aspects of ecosystem services, with a particular emphasis on valuation and pricing methodologies.

Table 1. Number of papers based on the phrases

Phrases	Number of Articles
Cost Benefit Analysis of Ecosystem Services	51
Ecological Economics Valuation	7
Economic Valuation of Ecosystem Services	51
Ecosystem Services Assessment	51
Ecosystem Services Pricing	51
Ecosystem Services Valuation	51
Environmental Economics of Ecosystem Services	51
Environmental Valuation	51
Nature Capital Valuation	4
River Ecosystem Services	51
Valuation of Ecosystem Services	7

Table 2 illustrates list of phrases for the purpose of systematic literature review in this study. The phrases like "Cost-Benefit Analysis of Ecosystem Services" target studies that weigh the economic trade-offs in ecosystem conservation, which is pivotal for optimising resource allocation in river ecosystems. "Ecological Economics Valuation" captures the intersection between ecology and economics, shedding light on Johor River's ecological worth. "Economic Valuation of Ecosystem Services" directs the search toward literature that places monetary value on these services, thereby informing decision-making processes.

Further, terms such as "Ecosystem Services Assessment" identify qualitative appraisals of ecosystem services, outlining the range of services provided by Johor River. "Ecosystem Services Pricing" and "Ecosystem Services Valuation" encompass methodologies for assigning monetary values and estimating the value of these services, respectively. These are fundamental for policy and economic decisions impacting the river ecosystem.

Additionally, "Environmental Economics of Ecosystem Services" reveals the economic impact of environmental changes on the services, relevant for Sungai Johor's policy-making and environmental management. "Environmental Valuation" and "Nature Capital Valuation" delve into methods for valuing the environment and its natural capital, crucial for understanding Sungai Johor's natural resource value.

Specifically, "River Ecosystem Services" zeroes in on the unique contributions of river ecosystems, while "Valuation of Ecosystem Services" ensures a broad inclusion of valuation methods. Utilising these terms, bibliometric analysis provides a structured overview of research, highlighting publication trends, key themes, research gaps, and the network of scholarly communication. This methodical approach can influence future research directions, shape local environmental policies, and promote the sustainable management of Sungai Johor's natural resources.

Table 2. Search Phrases and Justifications

Phrases	Justifications
Cost Benefits Analysis of Ecosystem Services	Seeks information on the economic analysis that compares the costs and benefits of actions affecting ecosystem services, essential for understanding the economic efficiency of conservation efforts in river ecosystems.
Ecological Economics Valuation	Focuses on the interdisciplinary study of economics and ecological systems, relevant for understanding the economic value of ecological services provided by Sungai Johor.
Economic Valuation of Ecosystem Services	Explores the monetary value of ecosystem services, crucial for quantifying the economic benefits provided by the Sungai Johor ecosystem for informed decision-making.
Ecosystem Services Assessment	About assessing the services provided by ecosystems, important for understanding the range of services provided by Sungai Johor.
Ecosystem Services Pricing	Looks for information on assigning monetary values to ecosystem services, crucial for policy and economic decisions affecting Sungai Johor.
Ecosystem Services Valuation	Encompasses various methods and approaches to estimate the value of ecosystem services, fundamental for a comprehensive valuation of Sungai Johor's ecosystem services.
Environmental Economics of Ecosystem Services	Aims to understand the economic impacts of environmental changes on ecosystem services, relevant for economic policy-making and environmental management in the context of Sungai Johor.
Environmental Valuation	Seeks methods and approaches to value the environment and its services, applicable to various aspects of Sungai Johor's ecosystem.
Nature Capital Valuation	Focuses on valuing natural capital, including natural resource stocks and living organisms, essential for understanding the value of Sungai Johor's natural resources.
River Ecosystem Services	Specific to river ecosystems like Sungai Johor, seeks information on the unique services rivers provide.
Valuation of Ecosystem Services	A broad term for any methods and approaches to estimate the value of ecosystem services, highly relevant for a comprehensive understanding of the value provided by Sungai Johor's ecosystem.

3. FINDINGS

3.1 Cost Benefit Analysis from Ecosystem Services

From the previous findings from the theme of cost benefit analysis from ecosystem services delves into a multifaceted research spectrum, centering on the appraisal and application of economic and ecological models within environmental policy and conservation. It underscores the necessity of meticulous cost-benefit analyses in environmental policies, considering both immediate and enduring impacts like global warming and biodiversity diminution. The pivotal role of strategic investments, guided by such analyses for optimal conservation funding allocation, is exemplified by a Paraguayan Atlantic Forest case study. The study emphasises the paramount economic value of global ecosystem services, surpassing global gross national product, thereby highlighting their essential contribution to human welfare. The introduction of Social Multi-Criteria Evaluation (SMCE) to navigate complex policy dilemmas is discussed, incorporating political and social elements into economic frameworks. The compilation addresses the integration challenges of ecosystem service assessments in environmental governance and explores the role of institutions in environmental policy formulation. It also touches upon the complexity inherent in public preferences for biodiversity conservation, noting a general lack of public awareness and reluctance to prioritise biodiversity over other benefits. Furthermore, the anthology critiques contingent valuation methods in environmental economics, probing into ethical aspects and the comparability of environmental values.

The evolution of cost-benefit analysis in British environmental policy and its current challenges, including the validity of benefits transfer, are reviewed. The inherent weak comparability of values in ecological economics is highlighted, proposing multicriteria evaluation to manage value incommensurability. The paper also discusses Amartya Sen's perspectives on development and freedom, linking individual liberty, institutional roles, and development. The notion of economic sustainability and the long-term maintenance of natural resources are explored, considering individual time preferences for consumption and resource amenities. It advocates for defined units of account in environmental valuation to accurately quantify nature's contributions to human welfare, aiding policy decisions. The integration of economic principles into ecosystem service research is suggested to augment policy relevance via cost-benefit evaluations.

The paper challenges the monetary depiction of ecosystems, advocating for value pluralism and participatory decision-making processes. It underlines the strategic significance of recognising nature's value in conservation endeavours and proposes a framework for incorporating ecosystem services into decision-making. The Millennium Ecosystem Assessment's approach is scrutinised, stressing the necessity for research that encompasses the entire gamut of social-ecological system processes and feedback. The cost-efficiency of ecological restoration is examined, exemplified by a Latin American forest restoration study.

Lastly, several findings also critique mainstream environmental economics' normative economic valuation of ecosystem benefits and proposes a balanced approach for decision support, illustrated through an Indian wildlife sanctuary case study. This comprehensive methodology accentuates the need to develop economic, social, and governance systems that safeguard life-support mechanisms for sustainable human prosperity. The previous research under the theme of cost benefit analysis from the ecosystem services have collectively emphasise the imperative of interdisciplinary methodologies, merging ecological, economic,

and social aspects, underscoring the challenges in policy execution and the formation of robust valuation and decision-making frameworks for sustainability and conservation initiatives.

3.2 Ecological Economics Valuation

The bibliometric analyses under the phrase ecological economics valuation provides a comprehensive examination of the valuation and accounting of ecosystem services and natural capital. A pivotal study estimates the economic value of 17 ecosystem services for 16 biomes to be between US$16-54 trillion per year, suggesting that the planet's ecological systems and natural capital stocks form an essential component of the Earth's life-support system and contribute significantly to human welfare. This value surpasses the global gross national product, emphasising the substantial, yet often unaccounted for, contribution of ecosystem services to the global economy.

Another finding delves into the methodologies for measuring passive use values, a key issue in environmental economics. It compares choice experiments and contingent valuation, concluding that choice experiments are particularly useful for eliciting preferences that inform the valuation of environmental states. The discussion extends into wetland ecosystem restoration, employing a latent class choice model to evaluate the effects of different ecological characterizations on individual preferences and values for restoration projects, with a case study focusing on the Greater Everglades.

The need for standardised environmental accounting units is also highlighted, advocating for consistently defined units to measure nature's contributions to human welfare. Such units would facilitate comparability with conventional goods and services within GDP and other national accounts, thus bridging the gap between ecological contributions and economic assessments. In a critical discourse, the question of whether to monetarily value nature is debated, with a reframed approach that asks when and how to apply such valuations. This approach is guided by principles of environmental improvement, distributive justice, the preservation of pluralistic value-articulating institutions, and a consideration of the socio-political context of valuation.

The findings collectively underscore the importance of integrating ecosystem services into economic valuation and decision-making processes. It calls for refined tools and metrics that accurately reflect the value of the natural environment, thereby ensuring that it is preserved and enhanced for future generations.

3.3 Economics Valuation for Ecosystem Services

The latest studies in the field of ecosystem services and natural capital valuation demonstrate a substantial collaborative endeavour to measure and incorporate ecosystem values into economic frameworks. A specific research paper estimates the value of global ecosystem services, proposing a baseline value between US$16-54 trillion annually, a figure that exceeds the worldwide gross national product. Another piece of research emphasises the substantial non-tradable public benefits provided by ecosystems and warns against their over-exploitation, which jeopardises the livelihood of the poor and future generations. A further study updates the global value of ecosystem services to $125-145 trillion per year, with considerable losses due to land use change since 1997, highlighting the need for better accounting to inform decisions on biodiversity conservation and sustainable management.

The role of benefit transfer in ecosystem service valuation is also examined, as it provides a method to generate timely monetary estimates for nonmarket goods and services. Additionally, a conceptual framework is proposed to categorise and value ecosystem functions, goods, and services in a coherent manner, facilitating ecological economic analysis. Moreover, the articles recognise the importance of including ecosystem services in decision-making, especially in the conservation sector, where recognising the value of nature could potentially foster significant investments in conservation.

A quantitative review calls for a methodological blueprint for ecosystem services research, identifying key facets that include biophysical realism, consideration of local trade-offs, off-site effects, and stakeholder involvement. Furthermore, the ecosystem services agenda is poised to bridge gaps between natural science, economics, and public policy, with a strong focus on improving knowledge and the use of that knowledge in policy and practice. This includes mapping and modelling ecosystem services for better integration into national accounts and policy decision-making.

The review concludes by advocating for a comprehensive valuation approach sensitive to various actions affecting water quality, acknowledging that water quality is a critical contributor to many services from recreation to human health. Lastly, the valuation of ecosystem services is not just an academic exercise but a critical component in guiding real-world decisions and policies, where it must be aligned with broader goals of environmental sustainability and poverty alleviation.

3.4 Ecosystem Services Assessment

The extensive body of research on ecosystem services, as outlined in the provided studies, underscores a unified theme: the intricate value and indispensability of ecosystem services to human welfare and the global economy. The economic valuation of these services is vast, with conservative estimates suggesting an annual worth of $33 trillion for the biosphere, a figure that dwarfs the global gross national product. This valuation, however, is acknowledged as a baseline due to the complexities involved in precise quantification.

A critical area of focus within these studies is the supply and demand dynamics of ecosystem services. Human land use and the resultant changes significantly influence ecosystems' ability to deliver services that are vital for the sustainability of human-environmental systems. The research emphasises the need for robust indicators and data, both quantitative and qualitative, to match ecosystem service supply with societal demand, considering the significant spatial and temporal scales involved.

Biodiversity's connection to ecosystem services features prominently, with the degradation of ecosystem services identified as a significant barrier to achieving developmental goals. The literature explores the utilitarian value of biodiversity, its contribution to human livelihoods, security, and health, and the need for its integration into environmental management and policy through the Ecosystem Approach.

The classification and typology of ecosystem services are recurrent themes, highlighting the scattered nature of data and the incompatibilities across disciplines. This fragmentation has prompted calls for a standardised framework to assess ecosystem functions, goods, and services comprehensively. Such frameworks are not only essential for ecological economic analysis but also for facilitating comparative studies across different ecosystems.

Stakeholders' varying values and perspectives on ecosystem services necessitate frameworks that can capture this diversity. The valuation of ecosystem services often involves multiple stakeholders, each attributing different values based on their spatial and institutional contexts. Thus, enhancing valuation frameworks to accommodate these differences is crucial for ecosystem management. Methodological challenges in integrating ecosystem service assessments into landscape planning, management, and decision-making are central concerns. The literature points to the need for operational definitions and classification schemes relevant to decision-making contexts to address these challenges effectively.

Mapping the demand for ecosystem services has emerged as a critical tool for conservation planning and land-use management. A clear conceptual understanding of ecosystem service demand, its drivers, and temporal dynamics is essential for policy and management decisions. Human impact on ecosystems has been substantial, with a significant portion of Earth's land surface transformed, affecting the availability and quality of ecosystem services. This human domination of ecosystems highlights the urgency of implementing effective management and conservation strategies.

Frameworks for ecosystem service assessment are being developed to support sustainable management and decision-making. Identifying and mapping ecosystem service flows, capacities, demands, and trade-offs is essential for informed policymaking and effective conservation. Methodological advancements in the field are diverse, spanning biophysical modelling, spatial analysis, and the incorporation of socioeconomic data. Despite progress, there is a call for standardised, interdisciplinary approaches to improve the accuracy and applicability of ecosystem service assessments. These previous studies have indicated collectively underscore the critical role of ecosystem services in sustaining human life and the global economy. They call for integrated, standardized methodologies to ensure accurate valuation and sustainable management of these precious resources.

3.5 Ecosystem Services Pricing

The bibliometric analysis highlights the multifaceted and integral role of ecosystem services and natural capital in human welfare and the global economy. The total value of these services is estimated to be as high as $54 trillion per year, which is significantly higher than the global gross national product. These services encompass goods such as seafood, forage, timber, and the processes of cleansing, recycling, and renewal, all of which are essential for life and economic activities.

The literature underscores the importance of quantifying these services accurately, given their substantial contribution to human well-being. These ecosystem services have been systematically evaluated by scientists from diverse disciplines to understand their character, value, and the impact of their degradation on human society. The findings emphasise the pressing need to protect the earth's life-support systems. The studies also discuss the challenges in measuring the values of environmental changes, with a focus on methodologies like the contingent valuation technique, property value models, and the travel cost approach. They address the issues of optimality principles in biology, production, consumption, externalities, and the integration of environmental considerations into economic systems.

One study offers a comparative static theory for ecological systems, suggesting that components of ecosystems behave to maximise resource storage, leading to equilibrium states

that mirror economic concepts. Meanwhile, other works propose frameworks and models that integrate ecosystems into economic analysis, revealing the importance of considering ecological constraints like spatial interdependence, irreversibility, and uncertainty in forest management. The debate on contingent valuation and its role in policymaking, particularly in the context of non-use benefits of forest biodiversity, suggests that substantial values are generated through efforts to enhance biodiversity. Similarly, the economics of extinction are revisited to offer a generalized framework for analysing issues related to endangered species and biodiversity losses.

Moreover, the research advocates for ecosystem-based management, highlighting the need for robust valuation methodologies and interdisciplinary collaboration to manage ecosystems effectively. It recognizes that the valuation of ecosystem services often lacks clarity, advocating for processes that involve open deliberative judgment rather than just monetary valuation. In a nutshell, these studies call for a comprehensive approach to ecosystem service valuation, incorporating economic principles and scientific understanding to foster conservation efforts and inform decision-making processes. They emphasise the need for a scientific basis and policy mechanisms to integrate natural capital into resource and land-use decisions to promote conservation and human well-being on a large scale.

3.6 Ecosystem Services Valuation

The bibliometric analysis underscores the complex and essential role of ecosystem services and natural capital in supporting human welfare and the global economy. This research encompasses a range of services, including the provision of goods such as seafood, forage, and timber, as well as crucial processes like cleansing, recycling, and renewal, which are indispensable for sustaining life and economic activities. This economic contribution is mainly derived from goods like seafood, forage, timber, and essential processes such as cleansing, recycling, and renewal, which are fundamental to human survival. Notably, these services are often not captured by market mechanisms, suggesting a need for innovative institutional approaches to manage these common asset resources effectively.

The findings underscore the importance of incorporating ecosystem service values into decision-making and policy formation to enhance biodiversity conservation and sustainable management. Valuation studies across various biomes reveal that the benefits of ecosystem services are largely public and non-tradable, necessitating improved accounting and management practices to inform better conservation strategies and decision-making processes. Challenges and methodologies in valuing ecosystem services are also a central theme, with discussions on contingent valuation, benefit transfer methodology, and the need for integrating economic valuation into effective landscape planning and management. Additionally, the findings highlight the attention to the necessity of preserving and restoring ecosystem services within urban areas to reduce ecological footprints, bolster resilience, and enhance the quality of life for urban populations.

The integration of ecosystem service valuation is emphasised as essential for comprehensive ecosystem management, combining economic principles with scientific insights to support conservation and informed policy-making. An inclusive approach to valuation is advocated, one that encompasses the diverse perspectives and values of stakeholders, particularly in the context of frameworks like the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES).

Moreover, the abstracts advocate for the consideration of cultural and social dimensions in ecosystem service valuation, often neglected in traditional economic valuation methods. They highlight the significance of understanding and incorporating these non-material values to ensure a holistic approach to ecosystem management. Lastly, the findings provide insights into the practical application of ecosystem service valuation in real-world decision-making, emphasising the need for robust policy and financial mechanisms that can integrate natural capital into resource and land-use decisions effectively.

In summary, the findings collectively argue for the critical need for interdisciplinary approaches, inclusive valuation methods, and the integration of ecosystem services into policy and decision-making. This is crucial for ensuring sustainable and equitable utilization of natural resources, recognising the full breadth of ecosystem services' contributions to humanity and the planet.

3.7 Environmental Economics of Ecosystem Services

The bibliometric analysis provided reflects a significant body of research on the economic and ecological valuation of ecosystem services worldwide. The overarching theme is the critical importance of ecosystems to human welfare, both directly and indirectly, and the substantial economic value they represent. These studies underscore the need for comprehensive approaches to mapping ecosystem service supply, demand, and flow, as well as the challenges and methodologies for integrating ecosystem services into decision-making and landscape planning.

Several papers highlight the complexity of defining and classifying ecosystem services, the relationships among them, and the trade-offs that often occur when prioritising certain services over others. The research suggests that urbanisation and land-use changes have considerable impacts on the provision of ecosystem services, often leading to a mismatch between supply and demand. This is particularly evident in studies focusing on urban areas, where ecosystem services are crucial for maintaining quality of life. The research also points to the need for a multidisciplinary approach to assess and manage ecosystem services, incorporating spatial analysis, socio-economic factors, and environmental policy objectives. Some studies specifically address the valuation of services such as mangrove ecosystems in Southeast Asia or river restoration projects, demonstrating the practical implications of ecosystem services valuation. In sum, the collected research emphasizes the indispensable role of ecosystems, the need for sustainable management practices, and the integration of ecosystem service valuations into broader socio-economic planning and policy frameworks to ensure the well-being of current and future generations.

3.8 Environmental Valuation

The bibliometric findings delve into environmental valuation, a field that intersects ecological, economic, and social dimensions within public decision-making. Central to these studies is the exploration of environmental appraisal methods, including their institutional contexts and the intricate valuation of ecosystem services and natural capital. These works cover a wide range of topics, starting with the various methods used for environmental appraisal, acknowledging that the choice of method can significantly influence decision outcomes. They highlight the importance of understanding individual versus social rationality in environmental decisions. Benefit transfer principles are also discussed, emphasising the need for appropriate methods tailored to specific contexts, especially when sites under consideration are dissimilar.

A notable theme is the concept of weak comparability of values within ecological economics, focusing on the tools needed to handle value incommensurability in decision-making at different scales. The complexity of summing public good demand curves is addressed, particularly the challenge of aligning political and economic jurisdictions for natural resource public goods valuation.

The metaphor of "ecosystem services" is critically examined, suggesting that while it has brought attention to the relationship between humans and nature, it risks oversimplifying the complexity of the environmental challenges. The findings propose more comprehensive frameworks for ecosystem service assessments, integrating economic theories and methodologies to capture the full range of ecosystem values. Comparisons between survey and hedonic approaches to valuing quasi-public goods call for validation and consistency in valuation methodologies. The role of ethical considerations in environmental management is exemplified by a focus on fisheries management, introducing an ethical scenario process for future strategy development.

The debate over the use of prices in biodiversity management is also present, questioning the effectiveness of monetary valuation in environmental decision-making and suggesting alternative approaches. The concept of social multi-criteria evaluation (SMCE) is explored, discussing its methodological foundations and how it can inform operational practices. The challenges faced by the TEEB initiative in framing the economics of ecosystems and biodiversity are underscored, aiming to underline the global economic benefits of biodiversity conservation. Spatial preference heterogeneity in environmental valuation is examined, especially in the context of forest recreation and onshore wind power, showing how spatial factors influence willingness to pay. Lastly, the integration of revealed and stated preferences in environmental valuation is presented, with applications ranging from beach recreation to assessing the impacts of forest logging, highlighting the need for interdisciplinary approaches and the consideration of spatial and social dimensions in valuation processes. The findings collectively underscore the need for nuanced, interdisciplinary approaches to environmental valuation that are informed by economic theories and methodologies, and that take into account the spatial and social complexities of ecosystem valuation in policy-making.

3.9 Nature Capital Valuation

The findings under the theme of nature capital valuation provide insights into the valuation of the world's ecosystem services and natural capital, emphasising their critical role in supporting Earth's life-support system and human welfare. One of the research estimates the economic value of ecosystem services for various biomes, suggesting a substantial worth that surpasses the global gross national product. The other research highlights the fragmented nature of information on the value of ecosystem goods and services, proposing a standardised framework for assessment to enable a more coherent ecological economic analysis. Other findings also critique current valuation efforts as metaphorical rather than practical, offering a method to approximate the value of natural capital that considers ecological and economic estimates and real-world management conditions.

A common limitation across these sources is the inherent uncertainty and the scattered nature of data, which leads to challenges in creating a standardised, comprehensive valuation framework. The findings also suggest the limitation lies in the uncertainty of the estimates, emphasising that the provided figures should be considered a minimum due to the non-

market nature of many ecosystem services. Moreover, the findings also highlight the lack of coherence in existing data, which is dispersed across disciplines and often incompatible in scale and classification, hindering comparative analysis. Furthermore, it also implies that existing valuation methods are largely metaphorical and do not adequately account for inefficient management institutions, necessitating a more integrated approach that considers the dynamic interplay between natural capital stocks, human behavior, and institutions. While these works advance the understanding of ecosystem valuation, it also calls attention to the need for more accurate and integrative approaches that reflect the complexity and interdisciplinary nature of ecosystem services and natural capital. It also advocates for advancements in methodology that can bridge the gaps between theoretical, ecological, and economic perspectives to achieve more practical and effective valuation.

3.10 River Ecosystem Services

The collection of research articles examines the intricate dynamics of ecosystem services (ES), emphasising the valuation, the influence of land use changes, and the incorporation into decision-making processes. The studies collectively recognise the critical role that ES play in supporting human welfare and the Earth's life-support systems. There is an effort to quantify their economic value, which, in certain cases, is found to exceed the global gross national product. Central to these discussions is the necessity for a standardised framework that can classify, describe, and value ES. This need arises from the observation that current data on ES are dispersed across various sources and lack a cohesive structure. The relationship between the supply, demand, and flow of ES is scrutinised, particularly concerning the sustainability of their provision. Urbanisation's impacts on ES are also a focal point; it is noted that urban expansion can alter ecosystems' productivity, sometimes enhancing regional net primary production (NPP) but also disrupting natural plant growth cycles tied to water and nutrient availability.

The use of Local Indicators of Spatial Association (LISA) emerges as a valuable tool in identifying spatial association patterns and assessing the impact of individual locations on global metrics. The multifunctional nature of ecosystems is acknowledged, necessitating careful management of trade-offs between various ES, especially in landscapes that are undergoing urban and agricultural transformations. There is a call for ecological insights to be more deeply integrated into decision-making to manage ES more effectively. This includes a focus on biodiversity's role in delivering these services. Moreover, meta-regression analysis is applied to synthesize the economic valuation of wetlands in developing countries, revealing factors like wetland size and type as significant determinants of their estimated values.

The research underscores the complexities involved in ES valuation and management and the need for interdisciplinary approaches that consider ecological, economic, and social factors. Identified challenges include creating a coherent framework for classification and valuation, better integrating ES into policy and decision-making, and gaining a more profound understanding of ES's spatial dynamics, particularly under the pressures of rapid urbanisation and environmental changes. The studies suggest that managing ES successfully requires not just scientific understanding but also innovative policy development that can respond to the dynamic interdependencies between ecosystems and human societies. There is an emphasis on ES's significance for human well-being and the necessity for sustainable management practices to ensure the resilience and continuity of these services in the long term.

3.11 Valuation of Ecosystem Services

The research under the theme of valuation of ecosystem services highlights the economic valuation of wildlife resources and ecosystem services, underlining their crucial role in human welfare and the Earth's life-support system. This body of work focuses on quantifying the economic importance of ecosystem services, demonstrating that their value significantly exceeds the global gross national product. However, these valuations are considered minimal estimates due to inherent uncertainties. The limitations of these studies include the complexity of ecological and economic systems, which are not fully captured by conventional valuation methods. Current valuation approaches are criticised for being too cumbersome and not widely applicable, with a tendency to be driven by short-term human preferences. This leads to a need for a system to compare one wildlife resource with another, ultimately correlating to monetary values, but also considering factors like resource scarcity, accessibility, and species diversity.

There is an urgent call to shift valuation from choosing among resources to valuing the avoidance of catastrophic ecosystem changes, acknowledging the non-linear dynamics and inherent complexity of ecosystems. The potential for catastrophic ecosystem change requires a new valuation perspective that prioritises long-term sustainability over short-term gains. Moreover, the research underlines the need for a standardised framework to describe, classify, and value ecosystem functions, goods, and services. Such a framework would help integrate economic and ecological concepts for valuing ecosystem services, making trade-offs more apparent and aiding decision-making processes aimed at sustainability.

The studies collectively emphasise the need for more refined valuation methods that appreciate the complexity of ecosystem services, including their non-linear and dynamic properties. They highlight the essential role that natural systems play in supporting human life and the need for greater efforts to protect these systems. There is also a recognition that as human impact on the environment grows, the importance of valuing ecosystem services to guide future human activity becomes increasingly critical.

4. CONCLUSIONS

The systematic literature review on ecosystem valuation in the Johor River context is poised to make a substantial contribution towards establishing a detailed taxonomy and a refined methodological approach for ecosystem valuation. This endeavour draws upon the extensive range of studies encompassing cost-benefit analysis, ecological economics valuation, and economic valuation for ecosystem services. Such a diverse knowledge base provides the foundation for developing a taxonomy that categorizes the array of ecosystem services and natural capital specific to the Johor River, facilitating systematic assessment and valuation. This taxonomy will classify services such as provisioning, regulating, cultural, and supporting services, along with their respective valuation methodologies.

In terms of methodological approaches, the review underscores the importance of integrating social, political and economic dimensions into valuation frameworks. This integration is crucial for addressing complex policy dilemmas and capturing public preferences. Methodologies like social multi-criteria evaluation and choice experiments can be adapted to the Johor River's unique context. This adaptation allows for a more comprehensive valuation process that includes non-market and

passive use values and considers the diverse perspectives of stakeholders within the socio-political landscape of the Johor River region.

Additionally, the review emphasizes the need for standardization in environmental accounting and aligning ecological valuation with conventional economic assessments. By adopting standardized units and methodologies that are in sync with global economic frameworks, the valuation of the Johor River's ecosystem services can be accurately compared and integrated into broader economic planning and decision-making. Such standardization is key to effectively communicating the economic and welfare significance of these services to policymakers and stakeholders. Moreover, incorporating biophysical realism and stakeholder involvement ensures that valuation methodologies are not only ecologically sound but also responsive to local community needs and preferences. This approach bolsters the relevance and applicability of the valuation in local conservation strategies, sustainable management practices and policy development.

Ultimately, the literature review lays the groundwork for increased investments in the conservation and sustainable management of the Johor River. By highlighting the economic value of ecosystem services and advocating for their inclusion in decision-making, particularly in conservation, the review serves as an essential tool for promoting these investments. It provides evidence-based justifications for prioritizing ecosystem services in regional development and conservation policies, thereby playing a pivotal role in informing sustainable management decisions and conservation efforts in the Johor River area.

The compendium of research on the cost-benefit analysis of ecosystem services reveals a multifaceted examination into the economic and ecological frameworks that underpin environmental policy and conservation efforts. It is evident that these analyses are indispensable for understanding the economic efficiency of conservation and the profound economic value of global ecosystem services, which is emphasised to surpass the global gross national product. Challenges in integrating ecosystem services into environmental governance are evident, particularly in addressing the complexity of public preferences for biodiversity conservation. The studies advocate for the incorporation of social and political dimensions into economic frameworks, such as the social multi-criteria evaluation, to navigate the intricacies of policy dilemmas. Furthermore, the research findings also underscore the need for clearly defined units of account in environmental valuation and suggest the adoption of multicriteria evaluation to manage the inherent weak comparability of values in ecological economics.

The body of work under ecological economics valuation offers a comprehensive perspective on the economic assessment of ecosystem services and natural capital. Highlighting the immense value ecosystems contribute to human welfare, studies estimate this economic contribution to be in the tens of trillions annually, far exceeding the global gross national product. The research delves into the methodologies for capturing passive use values and examines various valuation techniques such as choice experiments. It also calls for the standardization of environmental accounting units to align with conventional economic assessments. The collection emphasizes the need for valuation practices that are informed by principles of environmental improvement and distributive justice, reflecting a reframed approach that considers socio-political contexts.

Research on the economic valuation for ecosystem services showcases an interdisciplinary effort to integrate the value of ecosystems into economic frameworks. The significant monetary value attributed to these services underscores their critical role in sustainable management and biodiversity

conservation. The literature points to the necessity of benefit transfer for nonmarket goods valuation and proposes conceptual frameworks for categorizing ecosystem functions and services. The inclusion of ecosystem services in decision-making, particularly in conservation, is highlighted as a means to foster significant investments. A call for methodological blueprints emphasises the need for biophysical realism and stakeholder involvement in ecosystem service research, aiming to bridge gaps between science, economics and policy-making for improved environmental sustainability.

REFERENCES

Ab Ghani, A., Weng, C. N., Roy, R., Samat, N., Hui, L. C., & Leong, T. M (2020). A Critical Evaluation of River Management Models in Malaysia. *European Proceedings of Social and Behavioural Sciences.*

Abdullah, M., Mamat, M. P., Ibrahim, T. M. T., Yacob, M. R., Hussain, F. N. T., & Hassin, N. H. (2022), Economic Valuation of Forest Ecosystem for Watershed Services in Kelantan, Malaysia. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1102, No. 1, p. 012031). IOP Publishing.

Abidin, N. A. Z., Cushing, D., & Lawson, G. (2020). Strategizing the methodology in assessing Malaysia's heritage urban river corridor landscapes. In *IOP Conference Series: Earth and Environmental Science* (Vol. 409, No. 1, p. 012014). IOP Publishing.

Arman, N. Z., Salmiati, S., Said, M. I. M., & Aris, A. (2019). Development of macroinvertebrate-based multimetric index and establishment of biocriteria for river health assessment in Malaysia. *Ecological indicators*, *104*, 449-458.

Arsad, A., Abustan, I., Rawi, C. S., & Syafalni, S. (2012). Integrating biological aspects into river water quality research in Malaysia: An opinion. *OIDA International Journal of Sustainable Development*, *4*(02), 107-122.

Atkinson, G., Bateman, I. J., & Mourato, S. (2014). Valuing ecosystem services and biodiversity. *Nature in the balance: The economics of biodiversity*, (101-134).

Binoy, B. V., Naseer, M. A., Anil Kumar, P. P., & Lazar, N. (2022). A bibliometric analysis of property valuation research. *International Journal of Housing Markets and Analysis,* 15(1), 35-54.

Browne, M., Fraser, G., & Snowball, J. (2018). Economic evaluation of wetland restoration: A systematic review of the literature. *Restoration Ecology*, *26*(6), 1120-1126

De Oliveira, O. J., da Silva, F. F., Juliani, F., Barbosa, L. C. F. M., & Nunhes, T. V. (2019). Bibliometric method for mapping the state-of-the-art and identifying research gaps and trends in literature: An essential instrument to support the development of scientific projects. In *Scientometrics recent advances*. Intech Open.

Do Carmo Martinelli, G., & Gimenes, R. M. T. (2023). Analyzing ecosystem services valuation methodologies: A systematic review. *Organizações Rurais & Agroindustriais*, *25*, e1954-e1954.

Ellegaard, O., & Wallin, J. A. (2015). The bibliometric analysis of scholarly production: How great is the impact?. *Scientometrics*, *105*, 1809-1831.

Guleria, D., & Kaur, G. (2021). Bibliometric analysis of ecopreneurship using VOSviewer and RStudio Bibliometrix, 1989–2019. Library Hi Tech, 39(4), 1001-1024.

Gölgeci, I., Ali, I., Ritala, P., & Arslan, A. (2022). A bibliometric review of service ecosystems research: current status and future directions. *Journal of Business & Industrial Marketing*, *37*(4), 841-858.

Hussain, A., Fatima, N., & Kumar, D. (2011). Bibliometric analysis of the 'Electronic Library'journal (2000-2010). *Webology*, *8*(1), 87.

Kannan, P., & Thanuskodi, S. (2019). Bibliometric analysis of library philosophy and practice: A study based on Scopus Database. *Library Philosophy and Practice*, 1-13.

Lee, S. L., Then, A. Y. H., Goh, H. C., Hattam, C., Edwards-Jones, A., & Austen, M. C. (2022). Strengthened multi-stakeholder linkages in valuation studies is critical for improved decision making outcomes for valuable mangroves–The Malaysian case study. *Frontiers in Marine Science*, *9*, 1033200.

Liu, W., Wang, J., Li, C., Chen, B., & Sun, Y. (2019). Using bibliometric analysis to understand the recent progress in agroecosystem services research. Ecological Economics, 156, 293-305.

Mamat, M. P., Abdullah, M., Hassin, N. H., & Hussain, F. N. T. (2020, August). Economic valuation of nature area of Sultan Ismail Petra ecosystem protection park (Pergau Lake), Malaysia. In *IOP Conference Series: Earth and Environmental Science* (Vol. 549, No. 1, p. 012092). IOP Publishing.

Matthew, N. K., Shuib, A. H. M. A. D., Ramachandran, S. R. I. D. A. R., & Afandi, S. H. M. (2019). Total economic value of ecosystem services in Malaysia: A review. *Journal of Sustainability Science and Management*, *14*(5), 148-163.

Moresi, E. A. D. (2019, April). Bibliometric Analysis: A Quantitative And Qualitative Approach. In *18th Contecsi-International Conference On Information Systems And Technology Management Virtual*.

Nijkamp, P., Vindigni, G., & Nunes, P. A. (2008). Economic valuation of biodiversity: A comparative study. *Ecological economics*, *67*(2), 217-231.

Pandeya, B., Buytaert, W., Zulkafli, Z., Karpouzoglou, T., Mao, F., & Hannah, D. M. (2016). A comparative analysis of ecosystem services valuation approaches for application at the local scale and in data scarce regions. *Ecosystem Services*, *22*, 250-259.

Rahman, S. A., & Yaakub, S. M. (2020). Socio-economic valuation of seagrass meadows in the Pulai River Estuary, Peninsular Malaysia, through a wellbeing lens. *Marine and Freshwater Research*, *71*(8), 877-891.

Reynaud, A., Lanzanova, D., et al. (2017). A Global Meta-Analysis of the Value of Ecosystem Services Provided by Lakes. *Ecological Economics,* 137, 184-194. https://doi.org/10.1016/j.ecolecon.2017.03.001

Rousseau, R. (2001). Indicadores bibliométricos y econométricos en la evaluación de instituciones científicas. *Acimed*, *9*, 50-60.

Santos, A., Castro, J. D. A., Silva, M., & Andrade, R. (2023). Environmental valuation: A systematic review using bibliometrics: Valoração ambiental: uma revisão sistemática através da bibliometria. *Concilium*, *23*(15), 328-345.

Smetschka, B., Wiedenhofer, D., Egger, C., Haselsteiner, E., Moran, D., & Gaube, V. (2019). Time Matters: The Carbon Footprint of Everyday Activities in Austria. *Ecological Economics,* 164, 106357. https://doi.org/10.1016/j.ecolecon.2019.106357

Toman, M. A. (1997). Ecosystem valuation: An overview of issues and uncertainties. *Ecosystem Function & Human Activities: Reconciling Economics and Ecology*, 25-44.

Thanuskodi, S. (2010). Bibliometric analysis of the journal Library Philosophy and Practice from 2005-2009. *Library Philosophy and Practice*, *1*(7).

Turner, R. K., Paavola, J., Cooper, P., Farber, S., Jessamy, V., & Georgiou, S. (2003). Valuing nature: lessons learned and future research directions. *Ecological economics*, *46*(3), 493-510.

Turner, R., Morse-Jones, S., & Fisher, B. (2010). Ecosystem valuation. *Annals of the New York Academy of Sciences_*, 203. https://doi.org/10.1111/j.1749-6632.2009.05280.x

Velasco-Muñoz, J. F., Aznar-Sánchez, J. A., Schoenemann, M., & López-Felices, B. (2022). The economic valuation of ecosystem services: bibliometric analysis. *Oeconomia Copernicana,* 13(4), 977-1014. https://doi.org/10.24136/oc.2022.028

Zupic, I., & Čater, T. (2015). Bibliometric methods in management and organization. *Organizational research methods*, *18*(3), 429-472.