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Karst Environment Sustainability in Ecocentrism Ideology: A Systematic Literature Review

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ABSTRACT

The era of sustainable new environmental awakening is beginning to be seen in managing global karst areas. Sharp criticism of ecocentrism for anthropocentrists who have overexploited Karst has resulted in massive environmental damage. The ecosystem also feels losses in it. This research will reveal how to trace publications related to the sustainability of karst areas that are studied based on the perspective of ecocentrism ideology. The synthesis method of SLR uses PRISMA with the search string "Karst Environment" AND "Sustainability", "Karst" OR "Sustainability" AND "Ecocentrism", "Karst" OR "Sustainability" AND "Deep Ecology". The search focused on journals and conferences of proceedings indexed by Scopus, and the filtering results were used for 24 articles out of 407 related articles. The synthesis results show an increase in publications relevant to the sustainability of the karst environment based on the ideology of ecocentrism and various cases of karst management problems with an ecocentric approach. The distribution of relevant analyses is found in Asia, although other continents are also optimal for study. Challenges in disseminating the ideology of ecocentrism can be met through conservation, natural resource management, damage control, cultural values, environmental awareness through education, and ecocentrism regulations or policies. The existence of the karst sustainability movement and global ecocentrism policy can have implications for realizing the harmony of ecosystems, both biotic and abiotic, in the future.

1. INTRODUCTION

Karst is a landscape of readily soluble rocks characterized by holes, caves, and underground water flows. Karsr topography consists of Karst in the mountains, Karst in the highlands, Karst in the plains, and Karst that appears on the islands [1]. Karst is a source of survival and ecosystem for living things. The consumption of diverse living things' needs shows that Karst's function can support the systems that work in it. Using Karst raises pros and cons, where the debate over its management is related to the life cycle of living things in it. Views on the use of karst areas give rise to conflicts between those who want to preserve nature and those who exploit nature to fulfill the welfare of human life. Karst's vulnerability to various overexploitation has made humans start to regulate their sustainability strategies [2]. These views have given rise to various interdisciplinary studies in countries such as the United States, China, Croatia, Iran, Indonesia, and other countries with Karst.

Karst is part of the geopark as an object of research development and its application in the lives of living things. For this reason, karst management is carried out inclusively [3]. There are two contradictory approaches, namely the anthropocentrism and ecocentrism approaches. From a philosophical perspective, both determine the direction and development of Karst in various countries. The debate between the two camps of anthropocentrism and ecocentrism is also a spectrum on social media, which discusses their respective ideologies as claims and radicalities of arguments [4]. The anthropocentric view is that the source of life in Karst is a gift from God that humans can manage to be a source of economy and welfare. This phenomenon causes much opposition due to excessive exploitation, which results in environmental damage. Various other negative impacts of karst exploitation include increased carbon emissions, soil and water pollution, endemic biota death, environmental pollution, landslides, soil cracks, etc. Of course, with good management, Karst will increase the economy, but it will still pay attention to environmental sustainability.

Sustainability theory begins to consider the sustainability of karst ecosystems. The growth of the population of living things and the increasing pressure on resource exploitation prompted the creation of the Karst Sustainability Index (KSI) [5]. This matrix is used as an instrument for the sustainable development of the entire Karst region. This good practice is an answer to the view of ecocentrism that has strengthened after the overexploitation carried out by anthropocentrism. Back to nature is a term encouraging the promotion of

ecocentrism ideology to researchers, the government, and the public. Karst is important to protecting living and other resources such as water, air, gas, soil, etc. The new geological era regulates human activities, emphasizing the realistic and non-human and ecologically and ethically related to living things and their ecosystem as part of long-term sustainability [6]. The concept of sustainability will be a contemporary life cycle that lives the ecosystem sustainably.

Ecocentrism as an ideology reflects a person's characteristics and principles when interpreting the existence of Karst. Deep ecology is important in regulating ecosystems' survival in Karst. The debate between two views related to the nature of nature has caused misunderstandings in the process of using nature. The economist view sees nature as a resource that prospers humans, while deep ecology sees nature as a harmonious system and eternal balance [7]. If Karst as a natural asset is seen as economic, then the continuity of life in Karst will be nil [8]. There is also a thought that discovers new concepts and systematics of ecocentrism in business decision-making [9]. Conventional dualistic thinking and logic partly resulted in acculturated ecocentrism. The link between karst management and ecological sensing provides a broader range of sustainability. This means that understanding Karst as an integrative ecosystem requires the deepening of an implementable and helpful study.

This research reveals how karst sustainability at the global level is based on the perspective of ecocentric ideology. Researchers hypothesise that ecocentrism in karst sustainability will strengthen and defeat anthropocentric arguments. The purpose of this study is to provide evidence of the rise of ecocentrism in restoring the role of nature as a balancer of ecosystems and living things. The description of this research will rediscover the past transformational eras of how anthropocentrism experienced lost opportunities in the future due to human destructive actions against nature [10]. This research covers matters related to the karst environment, sustainability, ecocentrism, and deep ecology. The study results can be a reference for other researchers who are massively promoting ecocentrism in the sustainability of karst management.

2. METHOD

2.1 Study area

This research focuses on global ecocentrism groups that publish their ideas and criticisms of using Karst. Referring to UNESCO data in 2022, there are 177 geoparks [11], and the number will increase by 2024 and include Karst, totaling 213 geoparks spread across 48 countries (https://www.unesco.org/en/iggp/geoparks).

The global literature study area can provide insights and recommendations on how the sustainability of karst studies from the perspective of ecocentrism ideology can reappear. Global data on karst management based on previous or published studies can open up insights for further research in encouraging the sustainability of ecocentrism. However, this study limits Karst as an object of study that needs to be protected and reveals how anthropocentrism significantly dominates the chances of karst environmental damage. The position of Karst as a source of life for living and dead organisms needs to be revived in the chain of ideological synthesis and environmental ethics [12]. This contradictory study for anthropocentrism will delve into trends related to ecocentrism, sustainability, deep ecology, and the karst environment.

2.2 Data collection and analysis

The research method used is a Systematic Literature Review (SLR). This study is important for researchers, practitioners, and professionals considering managing karst areas with an ecocentric approach. The SLR study uses the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) updated in 2020 [13]. This method is carried out from a systematic, structured, transparent, and credible source.

This study only examines the management of Karst and its sustainability based on the ideology of ecocentrism. The source of information in this study is not limited to the year of publication and a technique or a concept that requires a comprehensive understanding. However, the basis of this research refers to articles such as journals and conference proceedings in English that are indexed by the Scopus database. The selection of this database is based on the depth and recency of articles relevant to the keywords. If combined with other indexing databases, there is a tendency to duplicate the same article in Scopus to dominate the results. Uniquely, research discussing the sustainability of karst from an ecocentrism perspective is only found in articles indexed by the Scopus database.

The Scopus article was identified from Elsevier sources, and the research topics were relevant to the researcher. The distribution, clustering, and filtering of Scopus articles that are determine are the subjectivity of the researcher based on suitability with the relevant topic, the language used, and clarity in the title, abstract, and keywords.

The strategy in SLR refers to the Scopus article database from 1993 to 2025. The main search lines used are "Karst Environment" AND "Sustainability", "Karst" OR "Sustainability" AND "Ecocentrism", and "Karst" OR "Sustainability" AND "Deep Ecology". To obtain relevant repositories, it is necessary to conduct screening in stages: (1) determine the primary database; (2) set keywords; (3) filter articles based on specific criteria; (4) implement PICO (Problem, Intervention, Comparison, and Outcome) procedures. PICO's techniques ensure that data collection has used the right standards [14], and the search based on the words "title", "abstract", and "keyword" is related to the strings of environmental Karst, sustainability, ecocentrism, and deep ecology. These search words support exploring the application of karst sustainability, which is studied based on the ideology of ecocentrism. Several criteria review filtering, namely: (1) the article is a journal or conference proceeding indexed by Scopus; (2) it speaks English; (3) it focused on titles, abstracts, and keywords; and (4) manuscripts that can be downloaded in full-paper. One hundred forty-seven (147) articles have been carefully identified based on keywords relevant to the research problem.

The data identified from Table 1 results from the researcher's identification by matching the relationship between the title, abstract, and keywords with the substance of the research topic. If not filtered from the beginning, 407 mixed articles create bias in the identification results. The careful and comprehensive selection of data is carried out by screening titles, abstracts, and keywords by referring to inclusion or exclusion criteria or articles indexed in the Scopus database that can be used as a source of valid and credible

information according to the substance of the research. The explanation is outlined in the following Table 2.

Table 1. Search string for ecocentrism sustainability in karst environment

Search String	Articles Retrieved	Articles Reduced
"Karst Environment" AND "Sustainability"	22	9
"Karst" OR "Sustainability" AND "Ecocentrism"	79	30
“Karst” OR "Sustainability" AND “Deep Ecology”	46	21
Total	147	60

Table 2. Include and exclude criteria in making decisions on the use of articles

Criteria	Decision
Keywords are partially available but relevant or full	Include
The substance of the article is published in English	Include
A study of articles related to ecocentric, sustainability, and deep ecology in the karst environment	Include
Articles that are duplicated in the search string are excluded	Exclude
Studies have nothing to do with ecocentrism	Exclude
The study had nothing to do with Karst	Exclude
Articles cannot be accessed in full paper	Exclude

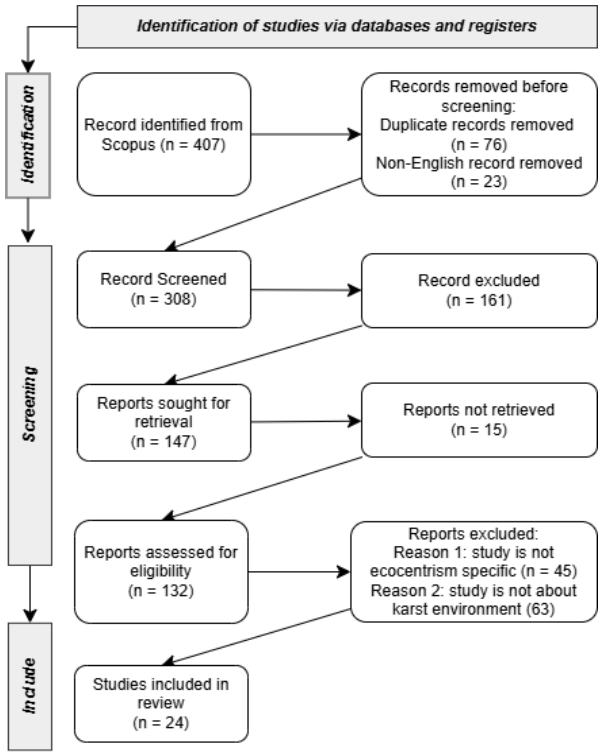

Figure 1. Results of the selection process of study articles with PRISMA

The decision criteria in Table 2 guide determining whether an article is selected or eliminated. PICO determines the clustering of variables based on problems, interventions, comparisons, and measures (see Table 3). The PICO is generated in the PRISMA flow as a reference for determining the articles used in the analysis.

Table 3. PICO logic in SLR analysis

Problem (P)	Intervention (I)	Comparison (C)	Outcome (O)
Karst Environment	Ecocentrism	Deep Ecology	Sustainability
Karst Environment	Ecocentrism	Ecocentric	Conservation

Figure 1 shows that 24 articles from Scopus are used to explore their suitability with karst sustainability from the perspective of ecocentrism. The synthesis method uses typeset.io, scite.ai, and Microsoft Excel. In synthesizing articles, researchers have limitations in obtaining inductive analysis based on the relationship with the theme and organization of the manuscript. Iterate analysis and extensive consultation with experts to obtain validation of the findings of the synthesis analysis on the established articles.

3. RESULTS

3.1 Bibliography synthesis articles

Findings based on PRISMA calculations show that 24 articles are relevant to the problems and issues of karst ecocentrism sustainability. The results of the filtering resulted in the first year of Scopus-indexed articles that discussed the sustainability of ecocentrism in 2005 [7, 15] and the latest year, 2023 [4, 16]. In the early years, the sustainability of ecocentrism was introduced in the form of narrative and dialectical to explain ecocentrism in building an intact ecosystem. Meanwhile, karst areas' ecosystem sustainability and ecocentrism have become a global concern in recent years. Tangible changes can be seen in how the challenges, opportunities, and threats in the sustainability of ecocentrism karst are increasingly open. Regarding the year of publication, the distribution of Scopus publication years is related to the research topic in Figure 2.

Based on Figure 2, it can be interpreted that the trend of research on the sustainability of karst management by paying attention to the ideology of ecocentrism has increased. A significant increase occurred in 2020 - 2024. Based on this increasing trend, research related to karst sustainability from an ecocentric perspective is predicted to also increase. Some studies strongly support shifting anthropocentrism in karst management [10, 16]. This is reflected in the many studies criticizing human limitations in exploiting karst land [17, 18].

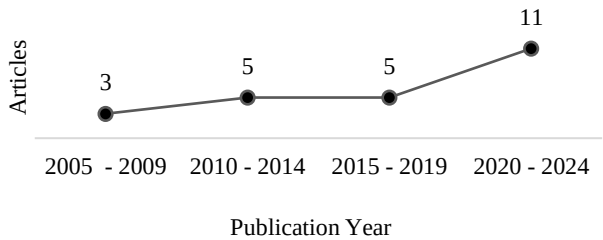

Figure 2. Number of publications related to karst sustainability based on ecocentrism ideology

The shift from anthropocentric to ecocentric in using karst land has become a global concern for humankind. The study results of 24 articles based on research objects in various

countries are dominated by the Asian continent, Europe, and America. The distribution of the articles used in the synthesis analysis is illustrated in Figure 3.

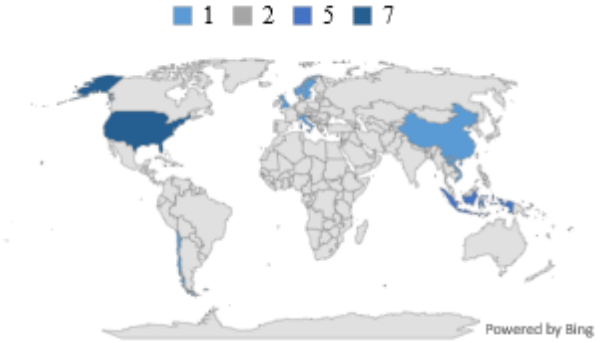

Figure 3. Map of the distribution of karst sustainability study objects within the framework of ecocentrism

The results of the distribution of karst sustainability studies dominate the Asian continent the most. This finding is because many karst areas with an ecocentrism approach have been mentioned in this region. This increase in number is due to UNESCO's support in recognizing many Asian geoparks that deserve to be preserved [11]. There are nine geoparks in Asia out of 48 other countries that UNESCO recognizes as landscapes that deserve to be conserved. This data is an exception for other continents, which is a limitation of research in terms of obtaining and filtering based on the assumptions of the language used. For this reason, this data strengthens how the area of Karst inherited in a country becomes a moral burden when utilizing Karst with an ecocentric approach.

3.2 Lesson learned in sustainability karst

Based on thematic analysis, good things can be obtained that can be developed in future research. These good things refer to the findings and suitability of the research topic as shown in Table 4.

Table 4. Karst sustainability view in ecocentrism

Sustainability Aspects	Explanation	Reference
Conservation of karst ecosystems	Karst areas are the source of life for living things.	[17, 19]
	Karst is a hydrology system that allows water infiltration and storing groundwater reserves.	[20, 21]
Natural resource management	Karst stores various natural resources that need to be regulated so that ecocentrism becomes the core of regulation as a favor for the ecosystem.	[22, 23]
	All activities that use Karst need to consider the principle of sustainability.	[5, 24]
Environmental damage control	Karst topography is vulnerable to natural and environmental damage caused by humans.	[1]
Cultural values and geological heritage	Karst is a globally recognized culture and geological heritage	[18]
	Karst ecosystems shape society's culture, customs, values, morals, and ethics.	[25]
Education and environmental awareness	Karst as a medium for learning nature for the community	[21, 26]
	Encouraging community participation in managing karst areas	[27]
Regulations and Policies	Regulations regulate the planning and spatial planning of karst areas	[28, 29]
	Illegal mining activities will threaten Karst everywhere	[30, 31]

The discourse of re-embracing the ideology of ecocentrism in the promotion of sustainable policies for karst environmental management is echoed by various countries. This promotion will delimit anthropocentrism and restore the practice of ecological justice for all species, as outlined in the theory of deep ecology [32]. This means that the ecosystem, both inside and outside, is committed to protecting the karst environment sustainably. Without education [21, 26] and integrative policies [30], then this discourse cannot be massively promoted globally.

Ecocentrism can continue through the role of farmers, ecological awareness and activities, network support from pro-environment, and the existence of indigenous peoples [16]. Due to urbanisation, this response also aligns with a study conducted in Jinan Karst, North China [33]. Urbanisation causes the area of agricultural land cultivated by residents in the karst area to change. Exploitation as a form of utilizing landscapes as urban areas is an obligation, and government regulation is required to protect karst sustainability [34]. The protection of karst sustainability concerns the government and public awareness. From the case study, the monetary stability of a country is not necessarily relevant to the protection of ecocentrism even though there have been efforts and the results are anthropocentric still exist in karst areas [35].

Another case is in Indonesia, in the karst area on the island of Java, where there is a dynamic debate [16]. On the left side, Karst is a source of local officials, community livelihoods, mining, and local economic needs. The right side, as an ecocentrism school, considers its dependence on aam as a form of awareness in activities with the environment. The government needs a juridical area that can regulate the right and left of the school, which gives rise to the debate.

4. DISCUSSION

Karst has an important role in water supply, mining and quarrying, tourism, agriculture, and conservation locally, nationally, and regionally, as applied to Caribbean Karst [36]. This Karst has various challenges and very high threats due to the disruption of the hydrological cycle with the increasing human population in the karst area. Climate change and human actions have decreased Karst's sustainability. Another example of how sustainable karst management can be done is the Slovenian Karst [37]. To protect water resources, they created water tunnels for karst aquifers. Proper land use planning and conservation encourage long-term sustainability efforts of ecocentrism ideology in karst management [38].

Prospective use of Karst as part of ecocentrism requires strong morals, ethics, and religious philosophies towards the environment. Environmental morals and ethics build the characteristics of human beings to reason with sustainability

in mind. This means that all actions taken by humans against using Karst will have a long-term impact. It is a religion that can limit human decisions to use Karst excessively [39]. Religious and moral values can increase human spiritual intelligence in acting and deciding [40] Whether using karst landscapes can damage the environment in the long term.

Simultaneous interaction between humans and the karst environment is an ethic of resilience and adaptive governance. The new era of generating deep ecology using Karst is an effort to promote sustainability in environmental conservation [25]. A holistic conception of connecting human-environment interactions and biotic and abiotic creatures can be done dynamically and ethically [41]. There needs to be decentralisation of management and regional autonomy so Karst can become a home for living things that coexist harmoniously. The essence of anthropocentrism shifted to biocentrism and led to ecocentrism. This stage is expected to be biotic and abiotic, as well as the sustainability of the karst area ecosystem.

Several studies provide recommendations for managing Karst using a holistic ecological approach. Pluralistic approach [15]. It is a slice of three schools: anthropocentrism, biocentrism, and ecocentrism. Three things must be protected together: environmental protection, protection of basic human needs, and economic improvement. However, efforts to implement this depend on ecological ethics and policies so that holistic ecology can overshadow sustainable karst management.

Life with the nuances of deep ecology introduces humans to the eco-semiotics of life's challenges in the 21st century [42]. The increase in the environmental crisis and maintaining the sustainability of the karst environment is a strong relationship between humans and non-humans. Karst technology and sustainability [18] It is important to regulate implementation; it can be flexible and useful in regulating the acceleration of ecocentrism promotion and restoring the karst function as an ecosystem. The progress of a country in managing Karst is highly dependent on its technology [43]. The technology is an effort to monitor ecocentrism so that the equitable distribution of karst environmental sustainability can be carried out effectively. With technological limitations, illegal use will thrive and damage the environment.

5. CONCLUSION

The trend of ecocentrism in karst environmental management has strengthened again after the brutality of anthropocentrism exploiting the natural resource reserves of karst areas. This result is confirmed by the increasing number of publications that discuss ecocentrism and its relationship with the karst environment. Ecocentrism is a dignified ideology that restores the karst ecosystem according to its mandate. Various studies have shown collaborative findings that the power of karst management is highly dependent on humans. Humans who give birth to policies, educational steps, exploration, and other aspects that cause karst conditions in the future are beneficial or become natural disasters for living things in them. The heritage of the landscape owned by each country and recognised by UNESCO is a joint duty and obligation, both biotic and abiotic, inside or outside the ecosystem. Because ecocentrism must carry out a holistic deep ecology, all those interested in karst areas must comply with the law of harmonised coexistence with nature.

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