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Innovative climate information services: a scoping review and bibliometric analysis for climate change decision-making

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ABSTRACT

This research aims to develop innovative information services to strengthen decision-making in climate change mitigation through a scoping review and bibliometric analysis (ScoRBA). A systematic search of the Scopus database identified 1,214 publications from 2009 to 2023, with 383 meeting inclusion criteria. Using the patterns, advances, gaps, evidence, and recommendations (PAGER) framework, this research provides a transparent synthesis of evidence on climate information services (CIS). The analysis reveals four major thematic clusters: i) emerging technologies and innovations, ii) climate and environmental studies, iii) information systems and decision-making, and iv) context awareness and applications. Technologies such as service-oriented architecture (SOA), internet of things (IoT), and cloud computing are key enablers for improving CIS accuracy and efficiency. Evidence shows that these technologies have been successfully applied in agriculture and aquaculture across Vietnam, Bangladesh, and Australia. North African countries have adopted IoT-based water management systems to address water scarcity, while India employs similar technologies to optimize agricultural resources. Integrating local knowledge with scientific data—particularly in Africa, Southeast Asia, and South America—has proven essential for effective adaptation strategies. This research advances theoretical and practical understanding of CIS, offering evidence-based insights to guide the development of adaptive and equitable climate information frameworks.

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1. INTRODUCTION

Climate change is arguably the most severe problem that the world faces, and it is impacting the living environment, the economy, and society. Humanity is overhearing on all sides about how the earth's surface has become warmer by up to between 1.5 °C and 2 °C as compared to times before the industrial revolution, according to the Intergovernmental Panel on Climate Change (IPCC), and the heating is still going on since we keep pumping greenhouse gases into the atmosphere [1]. To have a truthful picture of the situation, one can say the changes in the climate are shifting the frequency and intensity of floods, droughts, and tropical cyclones in multiple places. Agriculture, infrastructure, and public health are among the most affected sectors to be reckoned with assessment report for climate change [2].

Therefore, it is necessary to deploy the most effective evidence-based decision-making to overcome risks and further strengthen adaptive capacity. One of the most important steps towards that is climate information services (CIS). Research supports the substantial economic and operational benefits of these systems. Thus, studies by Vo *et al.* [3] show the improved agricultural value of the seasonal rainfall forecast in Vietnam was up to USD 220 per hectare, and a CIS framework for the aquaculture sector in Bangladesh enhanced efficiency and risk management [4]. They combine to show the ways that data-driven climate solutions speed up adaptation and contribute to the fulfillment of the Paris Agreement's resilience goals [5]. On the other hand, Africa has limited access to CIS, which is a barrier to the adaptive decision-making process, especially for smallholder farmers [6], [7].

According to Myeni *et al.* [7] lack of weather data was one of the factors that led to a reduction in crop yields in South Africa. Making CIS more accessible to everyone can help build up the resistance of the earth and decrease the odds that the entire world will be vulnerable [8], [9]. In their work, Kumar *et al.* [8] demonstrated that the visualization of forecasts increases the preparedness of communities living in the Bengal Delta, whereas Vescoukis *et al.* [9] pointed to the significance of the incorporation of climate data in urban development planning as a way to lessen the exposure to disasters. The Paris Agreement recognizes urban climate adaptation as a primary tool for significantly reducing climate-related risks [10]–[12].

Information services expand the analytical capacity necessary for adaptation as well. According to research by Smith *et al.* [13] and Keshavarz [14], user-centric data access with the support of hermeneutic phenomenology leads to better use. Prado [15] highlighted the positive impact of training in data handling skills on decision-making, while Amaral [16] concluded that a deep understanding of climate data expedites the adaptation process. Mathiassen and Sørensen [17], as well as Schumann and Stock [18], have presented theoretical models for assessing organizational information services that are in line with sustainable development goals 13 (SDG 13) on capacity building and technology transfer to developing countries [19]. In more general environmental scenarios, Schröter *et al.* [20] established a link between the susceptibility of natural services and the choices of management. Nonaka and Takeuchi [21] and Mahalle and Dhotre [22] highlighted the role of innovation and context-aware technologies in the progression of CIS. As the Paris Agreement puts it, technological innovation is the main driver for data-based climate action [5]. Nevertheless, there are still large holes. Warner *et al.* [23] and Diallo and Yovo [24] have mentioned that the difficulties encountered in incorporating CIS into policies are brought about by the lack of enough contextual understanding and that dissemination to decision-makers is done ineffectively. In addition, the existing reviews have not yet addressed the challenge of the global transition and utilization of CIS through unified scoping review and bibliometric analysis (ScoRBA) and patterns, advances, gaps, evidence, and recommendations (PAGER) frameworks, which is the missing point this research is aimed at to help the climate adaptation strategic decision-making process.

This research uses two different methods, the ScoRBA as recommended by Wijaya *et al.* [25], and attempts to fill this gap. ScoRBA allows deep gap identification in research and offers structured suggestions for the development of the field [26]. To complement, the PAGER framework introduced by Jones *et al.* [27] is used to support the systematic review by mapping research patterns, summarizing progress, and identifying strategic directions for improvement [28], [29]. In the end, this paper constitutes a full-fledged account of the CIS research environment and its capacity to support the adaptive response to the exacerbating effects of global warming.

2. METHODS AND DATA COLLECTION PROCEDURES

Building upon the conceptual rationale and research gaps identified in the introduction, this research employed a combined methodological design that employed a five-step scoping review with ScoRBA [25] to conduct a systematic literature review on the issue of how information services facilitate decision-making in adaptation to climate change. The research was designed by adapting Olsen *et al.* framework [30]. The selection methods where the researcher could map a large range of evidence whilst sustaining the transparency of the research methods.

Furthermore, this research uses VOSviewer to analyze and create a rigorous visualization of the findings of publication networks and co-occurrences [31]. Ellegaard and Wallin [32], also Öztürk *et al.* [33], both highlighted that the analysis would not only measure research output through the evolution of the themes, but they also allow the order of a solid base for evidence synthesis. The research was conducted from Scopus. The Scopus consists of a wide range of bibliographic records. Even though relying on a single database may have limited the extensive representation of publications in certain fields [28], [34]. To ensure reliable connections between the numerical data and the narrative descriptions, sensemaking techniques were used [35]. The technique facilitates the link between bibliometrics results with qualitative content analysis and expert interpretation [33], [35]. The triangulation of the methods creates a better understanding of how information services manoeuvre throughout the decision-making process. Thus, the main purpose of the research is to answer the question of how information services accelerate decision-making in managing climate change impacts.

The first step, exhibited in Table 1, covered an extensive process of literature search in the Scopus database in July 2024. The selection of Scopus as the database for the search was made due to its sizeable coverage and reputation as a dependable source of academic data [36], [37]. Wijaya *et al.* [38] emphasized that Scopus offers very detailed publication and citation data, which, in turn, increases the reliability of the data used in systematic reviews. In the second step, the researchers conducted a literature search with a systematic plan that aimed at identifying publications relevant to their topic. Figure 1 shows the procedure, which includes search terms and the number of documents found. The first question led to 1,214 documents published between 2009 and 2023, which were then filtered for relevance and quality to get 383 final articles. Boolean operators "AND" and "OR," according to Carcassi and Sbardolini [39], were used to combine the terms "information services," "decision-making," and "climate change" so that the search could capture all the different sides of the topic that were necessary.

Table 1. Research steps and methods by Arksey and O'Malley [40]

Step	Description
Research questions	Defined the main question: how do information services support decision-making in managing climate change impacts?
Research selection	Relevant, peer-reviewed articles were retrieved from the Scopus database, focusing on studies examining the use of information services in climate change management.
Data recording	Extracted and organized data using keyword co-occurrence analysis to visualize relationships and increase the perception of how information services impact climate-related decision-making.
Processing and reporting	Applied the PAGER framework [27]. to synthesize findings, summarize progress, and identify research directions.
Evaluation	Assessed methodological rigor and effectiveness in addressing objectives, and proposed directions for future research based on existing evidence.

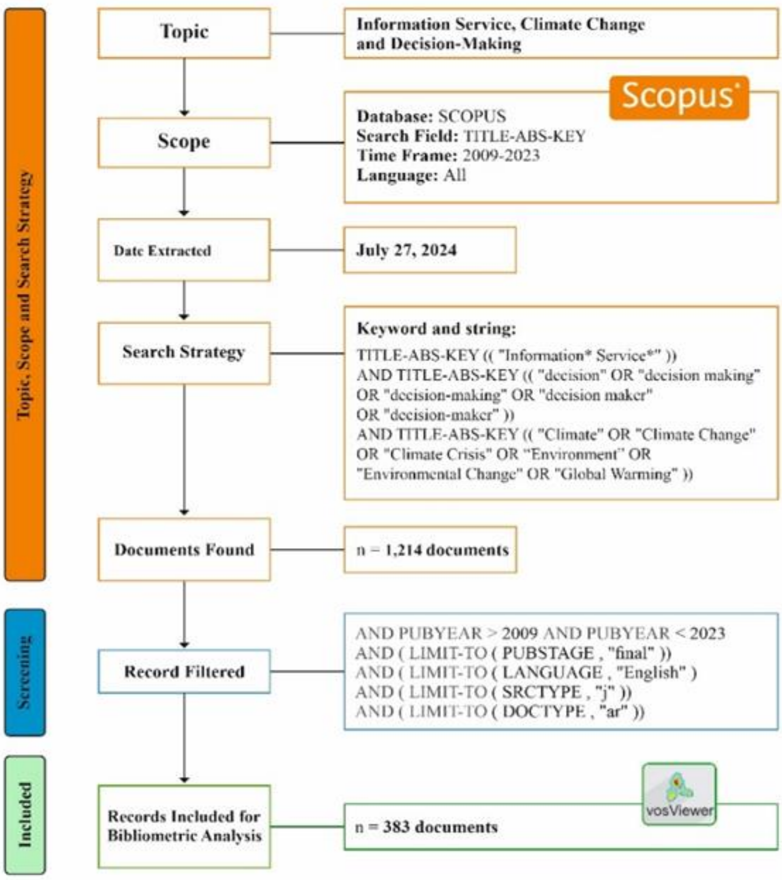

Figure 1. PRISMA flow diagram of the search strategy as adapted from Page *et al.* [41]

In the third step, Figure 1 depicts the inclusion and exclusion criteria that were applied using the PRISMA flow diagram [41] to ensure transparency and reproducibility in the article selection and screening process. The criteria focused on English-language, Scopus-indexed journal articles addressing information services, climate change, and decision-making from up-to-date sources [42], [43]. This stage yielded 383 peer-reviewed, high-quality research deemed suitable for analysis using ScoRBA. The fourth and fifth steps, which are further explained in the data-charting and discussion sections, respectively, reveal the means by which the authors compiled, categorized, and explained their data in order to determine their main points and the areas of the research where they were lacking. As a result, this method helped to clarify the nexus between information services, climate change, and decision-making in impact management by providing insightful material.

3. RESULTS

The results can be presented in figures, graphs, tables, and others that make the reader understand easily [44], [45]. The results of the initial literature search showed 1,214 documents between 2009 and 2023. Within 383 documents, finally meeting the inclusion and exclusion criteria for further analysis.

3.1. Publication output

The findings in Figure 2 show that the number of publications about information services, climate change, and decision-making has been steadily rising since 2009. The last six years have seen a very sharp rise. Such an increase is indicative of the expanding research interest in the interrelations of these three subjects. The year 2023 saw the number of publications reach their maximum at 38, which is a clear indication of the rising prominence of research that aims at deepening the understanding of climate change and supporting the issuing of more effective decision-making processes. Figure 2. show annual publication is consistent with the data provided by the IPCC [1]. This academic expansion mirrors the recognition in the Paris Agreement that CIS, as noted by Delbeke *et al.* [12] and Horowitz [5]. In addition, the distribution of research subjects is a significant factor in the trend depicted in Figure 3. The most significant contributors of climate change-related publications were computer science (20.9%) and engineering (14.2%), with 149 and 101 studies, respectively. Besides that, environmental science (13.4%) and earth and planetary science (11.6%) have also contributed substantially, with 96 and 83 publications, respectively.

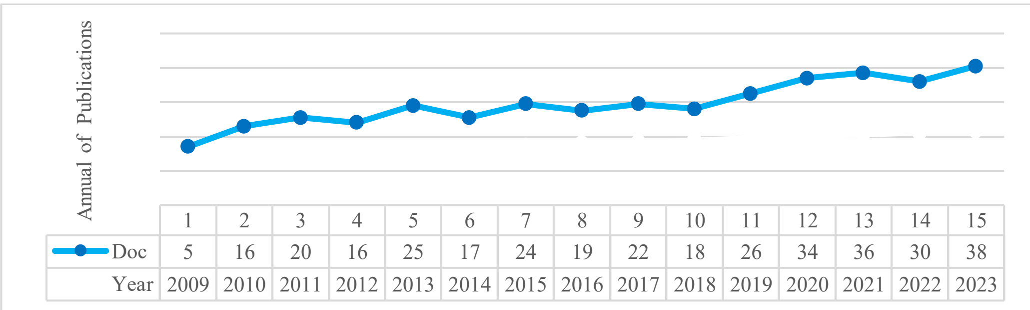

Figure 2. Annual publications based on the Scopus database (2009-2023)

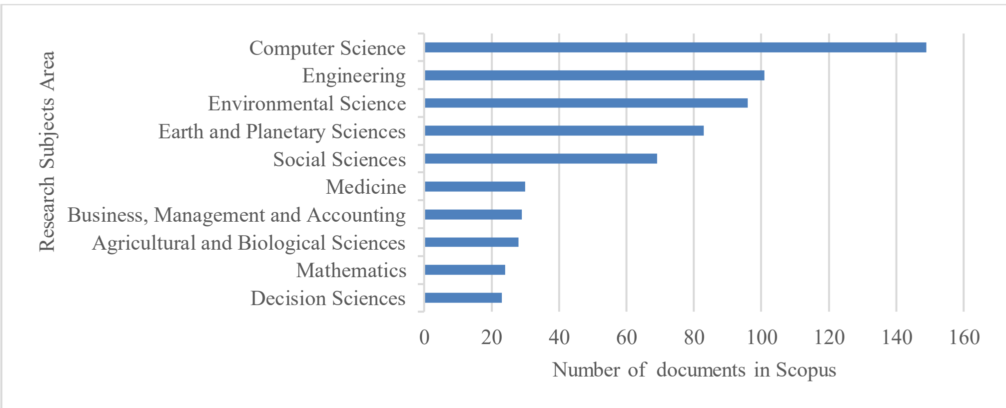

Figure 3. Top 10 research subjects in the Scopus database

3.2. Thematic themes

The fourth step in this research was thematic analysis. The analysis combined co-occurrence and keyword analyses for a quantitative mapping of complex keyword networks. The method used here uncovers latent correlations and thematic relationships that are not discerned by conventional narrative reviews, as per the description of Olsen *et al.* [30].

This research conducted a bibliometric analysis on 383 papers, retrieved from the Scopus database using VOSviewer [46]. Among 1,366 author keywords, 172 appeared at least twice and were included for further analysis. The resulting keyword network, visualized in Figure 4, shows the four thematic clusters that stand for the interrelated relationships between information services, climate change, and decision-making. The application of the ScoRBA framework [25] has helped this research to unveil the direct and strong connections between CIS and environmental management, which is paving the way for the next interdisciplinary research and policy development grounded in the evidence.

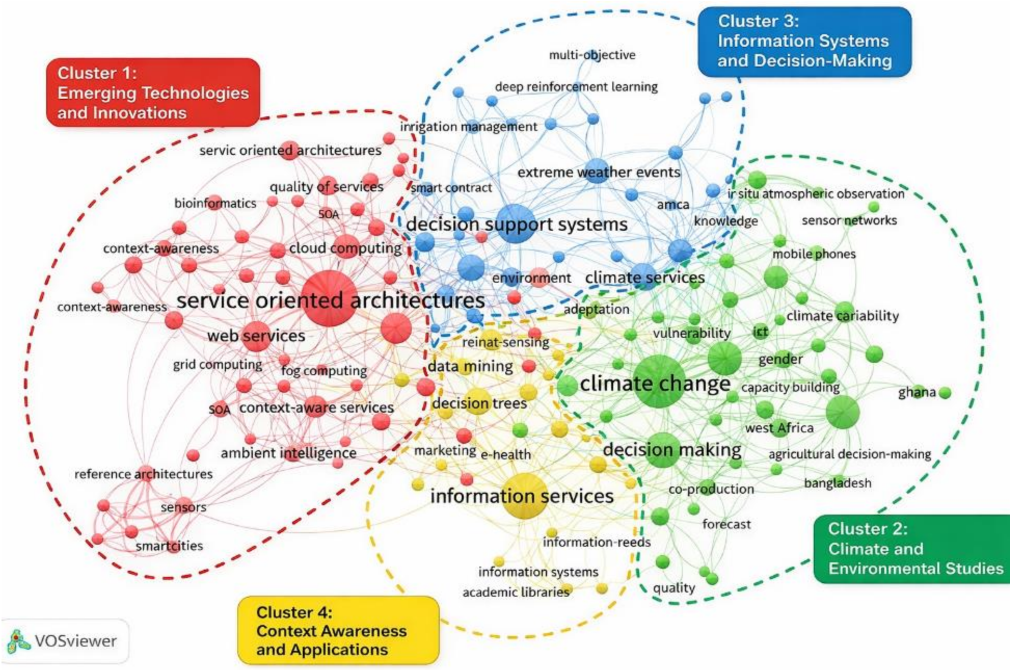

Figure 4. Visualization results of 383 co-occurrences of author keywords

The data summarized in Table 2 describe the composition and focus of the four identified clusters. These clusters in Table 2 illustrate how the three elements of the integration of information services, technological innovation, and climate understanding have been at the core of supporting adaptive, data-informed decision-making for the implementation of sustainable climate policies. The subsequent section takes these results further by using the PAGER framework to decode the conceptual linkages and the research directions that are behind the thematic patterns.

Table 2. Four thematic clusters and their main keywords were identified in this research

No	Cluster	Keyword	Focus	Main keywords
1	Red	62	Emerging technologies and innovations	Service-oriented architecture (SOA), internet of things (IoT), web services, cloud computing, context-aware services, ambient intelligence, and quality of service also interact with decision support systems.
2	Green	52	Climate and environmental studies	Climate change, climate change adaptation, CIS, public information services, decision-making, sustainable development, climate prediction, extreme weather, and agricultural decision-making.
3	Blue	32	Information systems and decision-making	Decision support systems, machine learning, climate services, information systems, knowledge management, agriculture climate services, industry 4.0, and extreme weather events.
4	Yellow	24	Context awareness and applications	Information services, decision trees, data mining, knowledge management, big data, remote sensing, and information needs.

4. DISCUSSION

The fifth step of the research focuses on four core themes of innovative information services for climate-related decision-making. The themes have summarized the recent research progress and pinpointed the gaps. They have given the empirical data for the practical implementation and articulated the suggestions for the upcoming studies, which are a reflection of the exhaustive findings of the PAGER analysis, as shown in Table 3.

Table 3. Results of the PAGER analysis of the clusters in this research by Jones *et al.* [27]

Pattern	Advances	Gaps	Evidence for practice	Research recommendation
Emerging Technologies and Innovations	1) Development of SOA to increase CIS flexibility and scalability [47]. 2) IoT integration for real-time, accurate climate data collection [48]. 3) Cloud computing for large-scale data storage and analysis [49].	1) Interoperability challenges between technologies [50]. 2) Need for standardization in applying new technologies for CIS [51].	1) SOA improves data integration in national CIS [47]. 2) IoT sensors enhance weather and climate monitoring in remote areas [52]. 3) Greater efficiency and accuracy in short-term climate prediction [53]–[55].	1) Develop frameworks for IoT–cloud–CIS integration. 2) Research artificial intelligence (AI) applications in IoT-based data analysis. 3) Adopt open standards for interoperability. 4) Invest in capacity building for advanced technology use.
Climate and Environmental Studies	1) Comprehensive, contextual adaptation model development [56]. 2) Improved accuracy in extreme weather prediction [57]. 3) Integration of local knowledge in CIS [58].	1) Limited detailed historical data for some regions [59]. 2) Incomplete understanding of climate–socio-economic interactions [60].	1) CIS use in agriculture increases resilience in developing countries [61]. 2) Seasonal forecasts improve water management [62]. 3) Efficient resource use under climate variability [63], [64].	1) Interdisciplinary studies on climate-economic linkages. 2) Integrate long-term projections into sustainable planning. 3) Strengthen collaboration between scientists, policymakers, and communities. 4) Invest in community-based early warning systems.
Information Systems and Decision-Making	1) Use of machine learning to enhance prediction accuracy [53]. 2) Decision-support systems integrating climate and socio-economic data [4]. 3) Knowledge-management systems for adaptation sharing [65].	1) Limited interpretability of machine learning results for policy [66]. 2) Lack of standardization in DSS development and evaluation [3].	1) AI-based DSS improves irrigation efficiency in drought areas [9]. 2) Knowledge platforms share adaptation practices globally [67]. 3) Enhanced efficiency in agriculture and water use [68].	1) Integrate multi-source (climate, social, economic) data in DSS. 2) Study ethics and governance in AI-based CIS. 3) Develop training for CIS user capacity. 4) Foster public–private collaboration in AI-driven CIS.
Context Awareness and Applications	1) Data mining for pattern extraction in large climate datasets [69]. 2) Remote sensing integrated with in-situ data for higher spatial resolution [70]. 3) Big Data architecture for multi-source data analysis [71].	1) Limited understanding of diverse user information needs [72]. 2) Data quality and consistency challenges across sources [70].	1) Data mining identifies extreme weather patterns [73]. 2) Big Data integrates climate, hydrology, and land-cover data [62]. 3) Improved high-risk area identification [70].	1) Combine local and scientific knowledge for CIS. 2) Research advanced data visualization to improve user comprehension. 3) Frameworks for continuous CIS data-quality improvement.

4.1. Emerging technologies and innovations

Following the PAGER framework, this section interprets the first thematic pattern—'emerging technologies and innovations'—that is, the main themes, the gaps, the evidence, and the suggestions resulting from the evolution of CIS. The core of future CIS lies in new technologies such as SOA, IoT, and cloud computing. The research by Boumahdi *et al.* [47] showed that SOA makes CIS more flexible and scalable by unifying multi-source data, and at the same time, IoT pushes the frontier of real-time climate monitoring, thereby enhancing the accuracy of data and spatial coverage [48]. With cloud computing, large-scale storage and analysis can be done for almost real-time interpretation of worldwide climate phenomena [49].

Several overseas empirical examples illustrate the revolutionary potential of such systems for the climate sector. Specifically, Ademe *et al.* [59] in North Africa implemented an IoT-based water management system to not only monitor water availability but also water quality in real time—this method can be used for any other dry area like the Middle East. These types of devices have been operated in the nations within Southeast Asia too, where the agricultural industry is notably inclined to most of the intense climatic occurrences. For example, in Vietnam, Vo *et al.* [3] confirmed the instrumental value of more precise rainfall estimates in the development of the Vietnamese agricultural sector, thus verifying CIS's economic possibilities in calculated growth.

Regardless of this advancement, the industry would still encounter obstacles. Gunasekera *et al.* [50] and Xiong *et al.* [51] debated that, on top of many challenges, the lack of interoperability and stability would be the main issues causing incompetence and lack of technological cooperation. Yet, there was a number of evidence that have proven that the SOA has already been optimistic in fire deterrence in Greece [47], while the use of visualization instruments aids in disaster training and assistance for a quick forecast in regions like the Bengal Delta and Australia [52]–[54].

Upcoming efforts should expand models and frameworks that could successfully utilize the IoT, cloud computing, and AI-based CIS. Some of the interesting propositions to exercise would be the implementation of open standards, the guarantee of constant training, and the creation of prospects for research and learning so that the interoperability and flexibility of cutting-edge climate technologies can be reinforced [55]. From a conceptual standpoint, these innovations may be understood as a move to anticipatory rather than reactive CIS architectures—these systems not only provide data, but, in fact, they are capable of decision environments becoming adaptive, evidence-based climate governance.

4.2. Climate and environmental studies

Climate and environmental studies are booming and have placed a strong emphasis on data-driven adaptation and decision-making. Twinomuhangi *et al.* [56] pointed out that the development of local and detailed models of adaptation is the main factor in the building of resilience. Reporting on the subject, Mann *et al.* [57] reported that the increasing accuracy of extreme weather predictions has enhanced decision-makers' capacity to anticipate and respond effectively. Manteaw *et al.* [58] showed that the incorporation of local knowledge in CIS not only guarantees social-ecological system (SES)-based adaptation strategies but also that they match the cultural and social aspects of the community. Likewise, Hossain *et al.* [4] explained in their work how the implementation of a CIS system in Bangladesh improved aquaculture efficiency and risk management.

However, critical gaps remain. Ademe *et al.* [59] depicted how, in some places, the scarcity of very accurate and detailed historical data has become a major obstacle when it comes to looking at trends. Wang *et al.* [60] mentioned that a lack of knowledge about the interplay between climatic and socioeconomic matters slows down the process of designing effective policies. Both researchers debated the need for interdisciplinary research. The interdisciplinary approach would justify the trend of papers related to climate change in relation to economic, as well as social and environmental issues.

Practically, CIS plays a major role in agricultural development. It is also the key navigator in water management. Djido *et al.* [61] and Wang *et al.* [62] both have eventually agreed and concluded that single-season climatic forecasts were essential in the operation of productive resource utilization and flexible development efforts. A hybrid model developed by variability would be an example of real-time prediction that exploits IoT. Friedman *et al.* [63] and Guido *et al.* [64], through their works, demonstrated the way in which a brief but nevertheless highly accurate prediction could be a great instrument to increase the output in the agricultural sector. Thus, the idea could be effective in areas where there are none or maybe limited meteorological resources.

Therefore, future research should predominantly attempt to study the issue using interdisciplinary studies by linking climate predictions to SDG-compliant development. To do so, there is a need for a close partnership among scientists, policymakers, and communities. The research process needs to evolve from a reactive approach to a more proactive conduct of resilience-building, where CIS serves as mediators in accelerating the relationship between environmental-based knowledge and socio-economic revolution.

4.3. Information systems and decision-making

The decision-making process in climate change has been mainly influenced by a number of factors. Among them, information systems, knowledge management, AI, and machine learning played a significant role in the transformative decision-making. Wang *et al.* [53] demonstrated that the use of machine learning in climate models significantly improves their predictive accuracy, thus facilitating planning and risk mitigation. Similarly, AI-driven decision systems for irrigation in drought-prone areas [9] and cloud-based aquaculture management in Australian areas [52] are leading examples of how AI and cloud computing can be utilized for real-time resource management optimization. The fusion of climate and socioeconomic data has also empowered grassroots-level responsiveness, as evidenced by Hossain *et al.* [4], who state that knowledge management systems expedite the exchange of knowledge and collaboration between stakeholders [65].

Despite these advances, challenges persist. Kabachenko *et al.* [66] have found that there are difficulties in the interpretation of the machine learning results considered for policymaking, and Vo *et al.* [3] have underscored the necessity for uniformity when judging decision-support systems. Variations in frameworks can lead to a decrease in the trust of stakeholders and a slow pace in the implementation of new initiatives.

Empirical applications confirm AI can be used to improve the efficiency of water and agriculture [9], facilitate the adaptation of knowledge transfer [67], and allow the integration of diverse data streams [4]. Nonetheless, the research to come needs to grapple with the moral and governing aspects of AI usage in a way that is congruent with training programs and public-private collaboration [68]. Collectively, these changes indicate a shift from mere data-centric tools to knowledge-driven decision ecosystems, a stage where CIS and AI are cooperative partners in the provision of anticipatory, transparent, and ethically governed climate decisions.

4.4. Context awareness and applications

The transformation in climate information delivery has shown a user-centered approach where context-aware technologies have been constantly utilized. Tang *et al.* [69] demonstrated that multiple techniques of the data mining process have become a way to develop models from massive climate datasets. The models would be essential to exhibit the trend detection and forecasting of the climate. Combining remote sensing data with on-site studies [70] improves spatial resolution and makes locating risky areas more accurate. With similar arguments, Liu *et al.* [71] instigated cloud-based territorial web services for disaster management in China, a technique that can be simulated in other data-scarce regions such as Southeast Asia for real-time climate observation. On top of that, their studies revealed that the application of big data frameworks aids the incorporation of multi-source data as well as the frequency of the analytics reaction, making CIS substantially adaptable to the new ecosystem challenges.

However, major obstacles continue to decrease the tailoring of information services to diverse user requirements. Nesheim *et al.* [72] stressed that inadequate contextual variations, such as neglecting local weather conditions and farming situations, can weaken the system's effectiveness. Venter *et al.* [70] stated that the difficulty of keeping the quality and consistency of data across a variety of sources would eventually affect the reliability of the information services.

Empirical evidence has proven the significance of contextualization in the study. Data mining, for example, would be essential in assisting the identification of extreme weather patterns for risk mitigation [73], while big data combination would uncover the interactions between climate, hydrology, and land coverage [62]. AI-driven ecological monitoring systems used visual forecast tools, which reduced the inaccuracy and improved the readiness for more valid forecasting in sites that are very vulnerable to climate change [70]. Moreover, the Paris Agreement also emphasizes that CIS should be integrated into urban policy frameworks as one of the modification strategies for climate-related risks. Future research should blend local knowledge with scientific data [58] and enhance data visualization to increase end-users' understanding. Some of the practical details on the agenda are to create constant assessment frameworks and intuitive user interfaces for CIS, which will ensure that climate data still applicable, comprehensive, and context-aware.

4.5. Limitations

Despite advancements in IoT, SOA, AI, and cloud computing for CIS regions, especially those in developing countries, they still face major obstacles. The nonexistence of common standards has led to the delay in utilization and cross-institutional integration. Limited historical climate records have become another constraint towards predictive accuracy, while fiscal and technical hurdles limit large-scale implementation. Ethical and governance issues around AI-driven decision-making—such as precision, liability, and data equity—persist in being vague. These restrictions highlight the crucial need for global governing alignment, multi-sector partnership, and resilience climate information dissemination.

5. CONCLUSION

This research stresses the role of the CIS, which continues to be the essential medium to aid evidence-based decision-making in agriculture, water, and urban planning sectors. The use of IoT, AI, and cloud computing has led to advances in weather forecasting, which has led to savings in assets and the ability to adapt to climate risks. Nevertheless, a variety of challenges, such as inconsistent data standards and unequal access to technology, continue to hinder the operation of CIS on a large scale, particularly in developing regions. However, the community has accepted CIS as not only a technical instrument but also an essential climate control infrastructure that links scientific data, technological invention, and institutional decision-making. Moving forward, policy frameworks must be developed with the focus on standardization of CIS protocols, the ethical utilization of AI, and the distribution of resources to capacity-building projects to accelerate fair admission to technology. In order to achieve interoperability and trust among the systems, it is fundamental that governments, academia, and the private sector must work together. Furthermore, the research should incorporate the growth of AI-powered predictive models that source local knowledge, community data, and social variables to establish the most significant perspective. On top of that, the engagement and participation of the local stakeholders can ease making CIS data understandable and functional for community-driven adjustment planning. Ultimately, reinforcement in CIS through global partnership, proper governance, and clear innovation would be vital in the alteration from reactive to proactive and knowledge-based climate resilience, thereby sanctioning the Paris Agreement and the United Nations' SDG 13.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The data that support the findings of this study are derived from the Scopus database and are available from the corresponding author, [JH], upon reasonable request. No new data were created or analyzed in this study.

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