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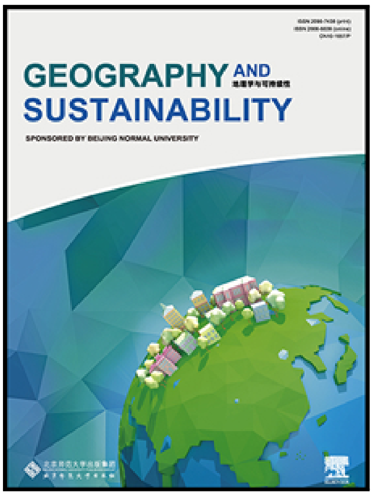

Geospatiality of climate change perceptions on coastal regions: A systematic bibliometric analysis

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Highlights

- A geospatiality analysis approach is used to study the climate change perception
- Scientific literature on climate change perception from big data database
- Analysis of topic trends for language, countries, and research
- A network of most frequent keywords to identify hotspot topics of research
- Highlighted of stronger research designs and methods for use in future studies

Geospatiality of climate change perceptions on coastal regions: A systematic bibliometric analysis

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Abstract

Climate change requires joint actions between government and local actors. Understanding the perception of people and communities is critical for designing climate change adaptation strategies. Those most affected by climate change are populations in coastal regions that face extreme weather events and sea-level increases. In this article, geospatial perception of climate change is identified, and the research parameters are quantified. In addition to investigating the correlations of hotspots on the topic of climate change perception with a focus on coastal communities, Natural Language Processing (NLP) was used to examine the research interactions. A total of 27,138 articles sources from Google Scholar and Scopus were analyzed. A systematic method was used for data processing combining bibliometric analysis and machine learning. Publication trends were analyzed in English, Spanish and Portuguese. Publications in English (87%) were selected for network and data mining analysis. Most of the research was conducted in the USA, followed by India and China. The main research methods were identified through correlation networks. In many cases, social studies of perception are related to climatic methods and vegetation analysis supported by GIS. The analysis of keywords identified ten research topics: adaptation, risk, community, local, impact, livelihood, farmer, household, strategy, and variability. “Adaptation” is in the core of the correlation network of all keywords. The interdisciplinary analysis between social and environmental factors, suggest improvements are needed for research in this field. A single method cannot address understanding of a phenomenon as complicated as the socio-environmental. This study provides valuable information for future research by clarifying the current context of perception work carried out in the coastal regions; and identifying the tools best suited for carrying out this type of research.

Keywords: Climate change, Perception, Coastal, Machine learning, Big data

1. Introduction

Climate change is predominantly generated by anthropogenic greenhouse gas emissions (IPCC, 2013) and it has both short- and long-term impacts. The long-term variation is reflected in climatic variables such as temperature increases. The short-term variation materializes in the frequency of anomalous climatic events, such as sea-level rise, floods, droughts, heatwaves, and storms (Baills et al., 2020; Wu et al., 2018). Although the impact is global, coastal areas are most vulnerable to climate change due to extreme weather events and coastal degradation (Fig. 1).

Figure. 1. Photographs of climate change impacts. 1-A Erosion and Flooding in Ilaje, Nigeria (Akinsemolu and Olukoya, 2020). 1-B Coral bleaching on Rangiroa, French Polynesia (Goeldner-Gianella et al., 2019). 1-C Coastal vegetation at a beach before "Matthew" impact in the southeastern region of Cuba (Montero and Batista, 2020). 1-D Coastal deforestation after "Matthew" impact in the same beach. (For color reference interpretation in this figure, the reader is referred to the on-line version of this article.).

The environmental, economic, and social effects of climate change have led the scientific community to examine on its effects, consequences, and adaptation/mitigation measurements. Research on climate change consequences have focused on environmental and economic aspects including: food security (Parvin and Ahsan, 2013); water (Yang et al., 2018); health (Madeira et al., 2018); biodiversity (Fei et al., 2017); and energy (Wang et al. 2018). This perception study is important to supporting and informing the local population, technical experts, and policymakers about risks (Funatsu et al., 2019). The knowledge of the terrestrial surface is varied, and the way people evaluate these realities is diverse. Cultural conceptions regarding climate vary based on environmental processes and worldview as inhabitants are key nature and climate change observers. Civilization and its development (Moser, 2020), have evolved in a global natural context of multiple variations. Thus, human actions are changing the natural rhythm of terrestrial flows towards unknown scenarios (Pollack, 2004).

Climate change perception is a complex issue with subjective visions based on environmental and cultural characteristics. However, it is an important issue for scientists and those formulating adaptation and mitigation strategies and policies (Armah et al., 2017). Although many articles cover varying perspectives of climate change perceptions in coastal areas, it is essential to have a thorough literature review to help academics assess current research progress and to identify future research directions. As these publications are geospatially distributed, our analysis will show how prevailing conditions are spatially related (Shoorcheh, 2019).

Big Data and machine learning make processing large scientific climate change research collections more manageable and help to provide better insights into how the results of previous research are related to the current literature (Callaghan et al., 2020). Bibliometric analysis has proven to be useful for natural and urban research among others (Wu et al., 2018). This method helps to reveal research trends and academic publication characteristics. Big data represents a technological paradigm for data that is generated at high velocity and volumes (Lee, 2017). In bibliometric analysis, big data is defined as "big literature", which is characterized by high velocity, volume, and variability (Nunez-Mir et al., 2016). To illustrate, 406,191 documents were published through 2018 on the Web of Science related to "climate change" (Grieneisen and Zhang, 2011).

The objective of this study is to show how geospatiality affects climate change perception publication trends. To test this idea, we first analyze the language in which the articles were published. The publications and their spatial distribution by production in continents was quantified over time. Finally, we analyzed the influencing topic keywords by correlating the number of occurrences found in the reviewed literature and identified and classified interactions among keywords.

2. Materials and methods

2.1. Data Source

In this study, a systematic method was used combining bibliometric analysis with machine learning and natural language processing (Fig. 2). This consisted in a conceptual analysis, database selection and preparation of the search syntax. To accommodate the lag in publication indexing, publications from 2020 were not included.

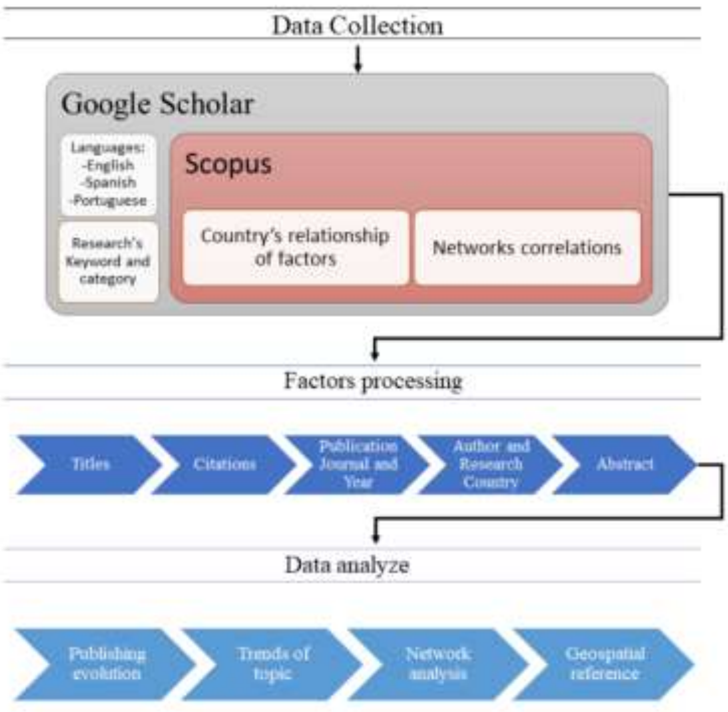

Figure. 2. Flowchart of systematic bibliometric review.

There are citation limitations in human and social sciences whereby production is through theses, monographs and books and most are written in their native language (as Spanish and Portuguese) (Vieira and Wainer, 2013). Google Scholar (GS) was initially used to analyze Open Access (OA) publications across all languages and research fields annually since 2000 (Martín-Martín et al., 2018). Unlike Scopus, GS does not have a strong quality control process and includes any publication that is found on academic-related websites (Harzing, 2007). Scopus has a larger proportion of exclusive journals and indexed journals than the Web of Science (Mongeon and Paul-Hus, 2016). For this reason, Scopus was used to study the publications and their relationship across countries and continents. Consequently, a detailed text analysis was obtained through machine learning with an annual search beginning in 1990 when the first perception publications appeared.

2.2. Search strategy

To ensure an accurate search our theoretical and methodological approaches considered the historical and global evolution of what is now understood as climate change perception research. The systematic search for information was simultaneously carried out in Spanish, Portuguese and English using GS. Two independent variables, climate perception and change, were defined as the keywords. They were grouped into three categories: ecosystems; climate studies; and social. The following search strategy was used:

[Title, Abstract or Keyword]:

1. (Mangroves) OR (Coasts) OR (Wetlands); 2. (Climate) OR (Temperature) OR (Precipitation) OR (Extreme events); 3. (Public perception) OR (Social perception) OR (Coastal communities) OR (Fishermen) OR (Livelihoods); AND (Perception / Climate Change); 4. (Perception) AND (climate change) AND (coastal*) OR (Livelihood). This used the Scopus database was used for a more detailed analysis.

2.3. Selection criteria

The inclusion criteria considered:

all publications from 1 January 1990 or 2000 (when the topic of climate chance perception began to appear) to 31 December 2019; the search terms mentioned in the Title, and/or Abstract and/or Keywords; document type was restricted to original articles or reviews; and geographical or topic restrictions were not applied.

Publications from unrecognized or former countries or with any incomplete author affiliation indexed information were omitted from the distribution-related analysis. Subsequently, the following inclusion criteria were established for the bibliographic analysis: scientific articles; scientific articles with DOI; scientific articles with abstract available in the database; and those included in Scopus.

2.4. Data processing

Lists of publications were retrieved from GS and Scopus using Harzing's Publish or Perish (Harzing, 2007), a program for citation data that presents a series of interest results through pre-defined indicators. Data analysis was conducted with the Python programming language using NumPy and Pandas libraries, with visualizations created with the Seaborn data visualization package., Geopandas tool was used for map generation and heat maps for visualizing citations (Eq. 1).

$$CitesPerYear = \frac{Cites}{Age} \quad (1)$$

where: Cites=Total cites; Age= publication Year - Year search

Research topics were defined with machine learning connections and natural language processing. For instance, the scientific abstracts from database were analyzed using NLTK (Bird et al., 2009) and Scikit-learn (Pedregosa et al., 2011) Python libraries.

3. Results

3.1. Bibliographic analysis

In GS 26,448 books, journals, conference articles, yearbooks, compilations, technical reports, reviews, and others were found. Based on this search, the results were classified into eleven keywords grouped into three languages: Spanish 2,336 (9%); Portuguese 1,189; (4%) and English 22,923 (87%) (Table SI-1). The publications raise concerns in all three directions: climate; ecosystems and social. However, it focused on vulnerable communities. The pressures exerted on coasts by increases in urban development create complex challenges, leading to a need for more innovative coastal management.

The publication trends are relevant for researchers regardless of the language, however there are some notable differences. The number of annual Spanish and Portuguese publications between 2000 – 2009 are similar with no growth trends. English publications, on the other hand, grew from 400 publications in 2000 to almost 1,000 publications in 2009 (Fig.3a). Between 2010 - 2019, the number of Spanish and Portuguese publications increased with Spanish publications increasing exponentially whereas Portuguese publications increased as a much lower rate. In contrast, English publications maintained their growth trend.

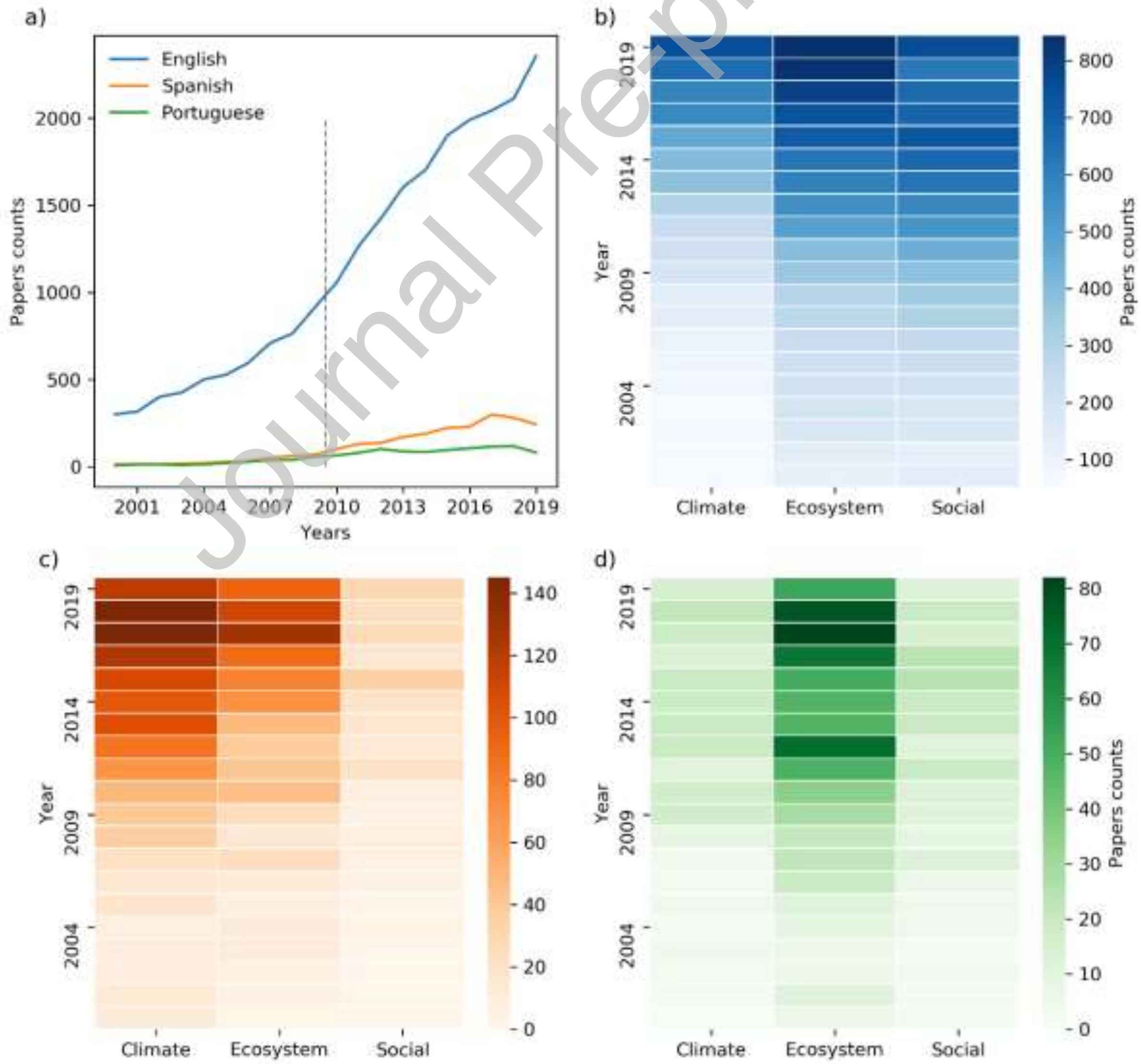

Figure. 3. Research of climate change perception in coastal communities by language: a) Evolution Year, b) English, c) Spanish and d) Portuguese.

Publications in English (Fig. 3b) had an accelerated and prolific pace in all three categories. Ecosystem publications maintained a steady growth rate over the past 20 years; social research shows a surge of publications between 2015 and 2019; and climate, publications accelerated in 2014 and reached its maximum in 2019. There are more countries interested in publishing their findings in English and the global concern on this issue has dramatically increased. The publications in Spanish (Fig. 3c) focus on climate, reflecting a sustained growth since 2010 that reached its highest level in 2017/2018. Ecosystems have been studied more intensely since 2010, reaching their peak in 2017 and then declined in 2018 and 2019. Social publications have not achieved much relevance over the past 20 years, however in 2011, more publications were registered, and they have reached significant levels in 2015 and 2019.

The geopolitical location of Spanish-speaking countries demonstrates they are worried about climate issues, particularly the effects of sea-level rise and extreme events. On the other hand, Portuguese publications (Fig. 3d), have historically focused on ecosystems. Publications are concentrated in 2011–2013 and 2016–2018. Social investigations peaked between 2014 and 2017 and publications on climate have been growing since 2009. As the Brazilian coast has a length of about 7,500km encompassing large areas of aquatic ecosystems, there are many publications on this topic.

3.2. Geospatiality of publications

One aspect of this research was to determine the author`s country and the country where the research was conducted, resulting in 71 and 117 countries, respectively. Figure 4 shows the evolution of publication based on where the research was conducted for the top 30 countries. In systematizing publications and understanding the progress of publications, three periods can be distinguished: 1993 - 1999; 2000 - 2009; and 2010 - 2019.

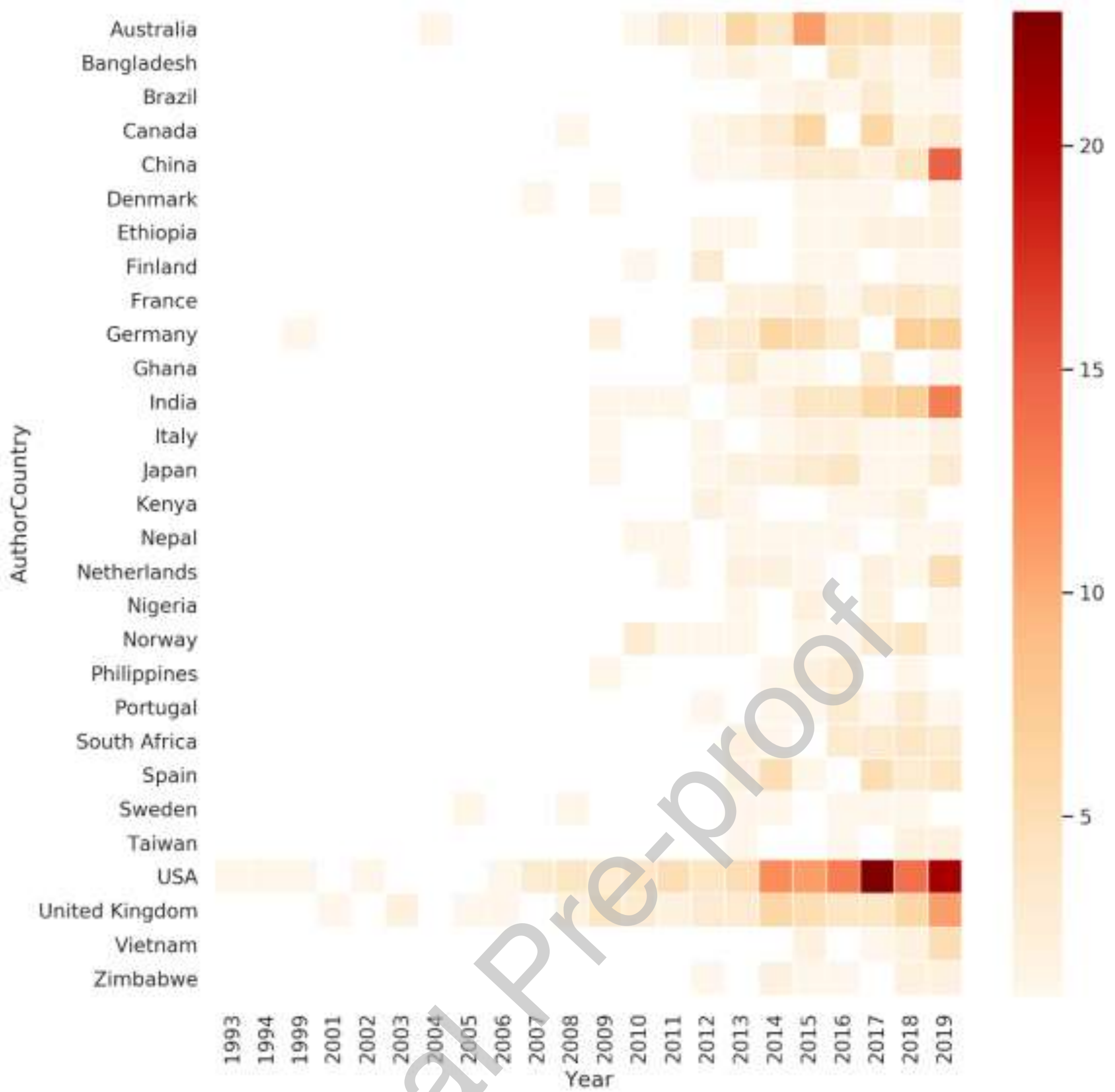

Figure. 4. Top 30 countries with publications (1990 - 2019).

These periods illustrate the evolution of how interests in the perception of climate change in coastal communities have developed. In the first period (1993-1999), the USA was the first country to publish on this topic. In the second period (2000-2009) publications from the UK, Australia, Sweden, Denmark, and Canada first appeared followed toward the end of the period with India, Italy, Japan, and the Philippines. Finally, in the third period (2010-2019) publications from China, India, Kenya, Nigeria, Zimbabwe, Brazil, the Netherlands, France, and Spain appeared. With respect to the corresponding author's country of origin, the USA was the most frequent at 16%, UK 7%, India 5%, and China 4%.

A geographical representation of where the research was performed is shown in Fig. 5. using the average citations per year. The annual citations is a bibliometric indicator to determine the importance of scientific works (García-Gómez and Ramírez-Méndez, 2015).

The USA leads the citations related to climate change perceptions in coastal communities, followed by the UK, Australia, Canada, China, India, Ghana, Nigeria, and Norway. From 192 countries with coastal regions, 52% have not published anything on climate change perceptions, indicating that there are poorly studied and are not considering perceptions in their public policy design.

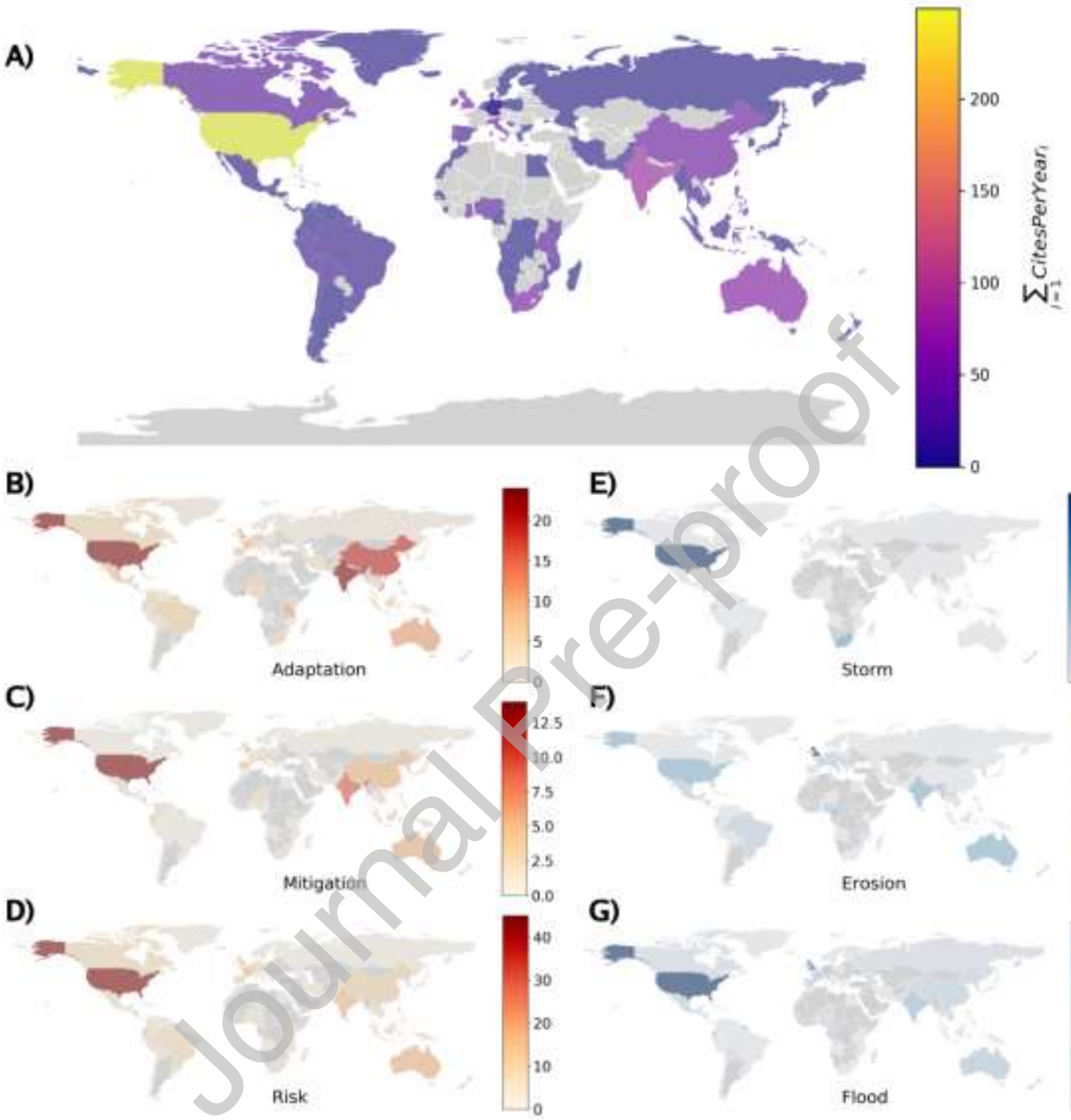

Figure. 5. Global research on climate change perceptions. (A) Citations per year in countries where climate change perception has been investigated between 1990 - 2019. Strategies: B) Adaptation, C) Mitigation, D) Risk. Effects on the coasts: E) Storms, F) erosion and G) Floods.

A classification was made on the focus of climate change perception research (Figs. 5b-5g). Two categories were identified: strategies (adaptation, risk, and mitigation) and the effects on the coasts (floods, storms, and erosion) based on the topic frequency of each publication. Adaptation measurement is the most frequent, followed by risk studies. The USA, China, and India are the countries with greatest focus on adaptation strategy, which reflects their historical leadership in the field. The works of Australia, the UK and France on risk perception are noteworthy. However, huge research gaps exist in some regions, for example, in developing countries, with few studies coming from Africa and South America.

Figure 6 shows the correlation between publication numbers by the author's country and the publication numbers by the country where the research was done. An estimate was analyzed using a simple linear regression function after grouping the data by continent. Asia and Africa had a high tendency to be studied by themselves and external countries, which explains their proximity to the y-axis. In contrast, North American had a 1:1 ratio between published articles by North American authors and studies carried out in the same continent. This suggests that they have the highest tendency to study themselves. On the contrary, Oceania and South America tend to self-study and receive international collaborations. Europe produces publications based on studying other countries. These investigations have reached different interest scales and levels of knowledge in the international community (Fig. SI-1).

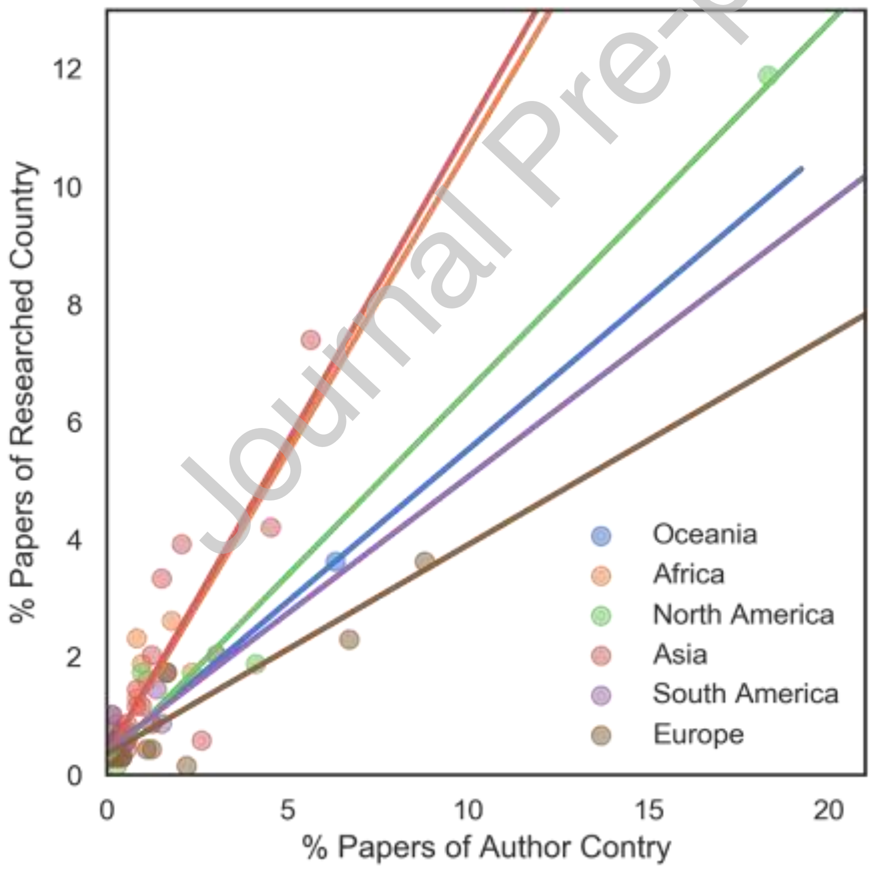

Figure. 6. Relationship between percentage of documents published in the corresponding author's country and the country where the research was conducted.

3.3. Research topics on geographic contexts

Using machine learning and natural language processing, 6,236 keywords were extracted from 690 publications. The system selected only the keywords that are bigrams and trigrams (Fig. SI-2), which are more effective for content understanding (Johnson et al., 2006). Keywords represent the academic article research focus, so word classification can help to identify the main and emerging issues in the field. To provide a clear visualization, keywords with a frequency greater than ten were categorized. To guarantee the reliability of the keywords selected by the analysis, a manual refinement was used to merge words with similar meanings.

Keywords were classified into four categories (Fig. 7): concepts (32.5%); study phenomena (37.5%); methodology (14%); and results (16%). Researchers appear to prefer studying climate change perceptions from the adaptation perspective under full consideration of climate variations. The overwhelming concern of scientists is on the socio-environmental impacts on communities and their livelihoods from extreme events such as sea-level rise and floods. The next most frequent concern is on the approach that can be understood from a socio environmental perspective with a focus on coastal regions.

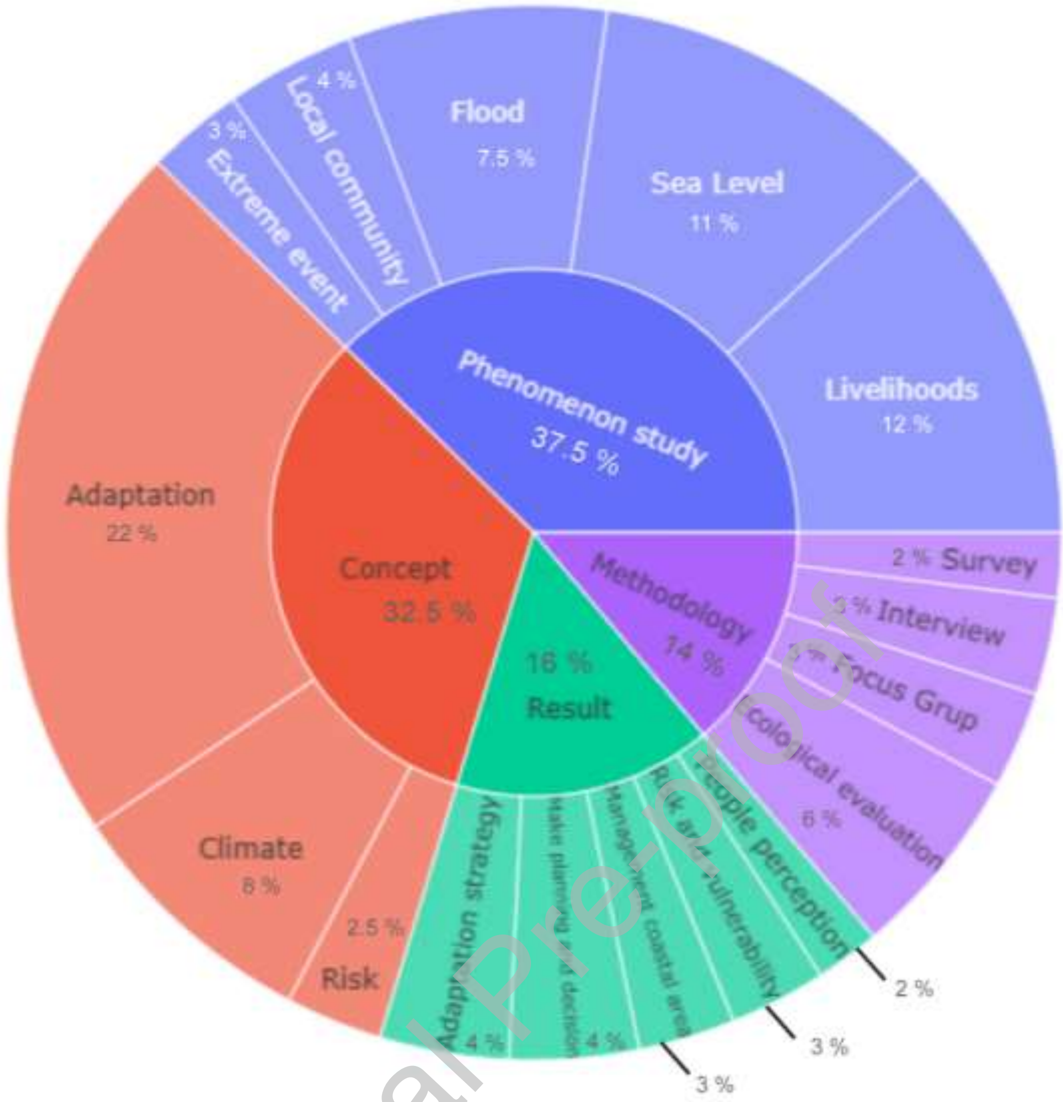

Figure 7. Keyword classification

Among the methodological tools, triangulation is used as summarized in Table 1. The most common instruments are semi-structured and structured interviews, group discussions, surveys and focus groups. In Tanzania (Mkonda and He, 2017), a systemic assessment of farmers' climate change perceptions was applied using meteorological analyses pointing to sound policies that improve resilient population livelihoods and their ability to adapt to climate changes. In addition, household surveys, interviews with key actors and discussions with focus on groups were used. This type of methodology is known as data triangulation, and it has been shown to be very useful for social-participatory studies that have a scientific-practical data component (Wang et al. 2018).

Table 1. Main methodologies to study the climate change perception in coastal areas.

Method	Tools	Topic	Reference
Discreet choice experiment	Survey	Community-based adaptation	(Hagedoorn et al. 2019)
Cobb-Douglas Production Function (CD)	Biophysical and environmental variables	Climate change impacts on sustainable livelihoods	(Tran et al. 2019)
Snowball	Interviews and Focus groups	Innovation processes in climate adaptation	(Madsen et al., 2019)
Participatory Rapid Assessment (PRA)	Semi-structured interviews and visual recognition.	Perceptions of relationships and risks in mangroves	(Munji et al., 2014)
Triangulation method	Surveys with open questions and Likert scale	Perception of the extreme events effects	(Burger and Gochfeld, 2017)
Local perceptions through triangulation	Survey, focus groups and hazard mapping	Adaptation to climate change variability	(Shameem et al., 2015)
Snowball Effects	Semi-structured interview and Participatory observation	Livelihood change and vulnerability perceptions	(Rybråten et al., 2018)
Livelihood vulnerability index (LVI)	Interviews and Structured questionnaire	Household perception and livelihood vulnerability to climate change	(Amos et al., 2015)
Speech analysis	Interviews and Snowball	Stakeholder perceptions	(Mani-Peres et al., 2016)
GIS modeling	Satellite images and Interviews	GIS modeling land used trend	(Saïdi et al., 2016)
Systems Approach Framework (SAF)	Survey, Interview, and Ecological-social-economic evaluation	Coastal protection against climate change	(Schernewski et al., 2018)
Mixed methods of structured survey by massive mails	Vulnerability assessment from a biophysical perspective	Public risk perception	(Button and Harvey, 2015)
Stakeholder identification	Definition of key actors, survey, and structured questionnaire	Climate change vulnerability	(Roy and Sharma, 2015)
Intentional spatial sampling	Questionnaires	Impacts and risks associated with climate change	(Appiotti et al., 2014)

In addition, ecological assessments are presented in Table 1 as methodological tools to support perception research using biophysical indicators. For their construction, some indexes like Livelihood Vulnerability Index (LVI) were included (Amos et al., 2015). Furthermore, inhabitant’s perceptions and their location are considered. It allows assessing livelihood capacity, resulting in consideration of changes in climate patterns, seasonality, and environmental changes. On the other hand, the Coastal Vulnerability Index (CVI) uses seven physical parameters: geomorphology; coastal slope; coast exchange rate; sea-level change rate; average tidal range; bathymetry; and storm height.

The CVI uses these parameters to classify vulnerability into one of six levels (Ashraful Islam et al., 2016), which can be used as a tool for coastal management.

Holistic transdisciplinary research involves the assessment of the stakeholder perceptions (Mani-Peres et al., 2016). In a coastal region, it can be useful to identify environmental impacts that occurred in the past, especially in the absence of past data and effective monitoring. Indeed, involving stakeholders in the discussion of local transformations can contribute to the development of shared management strategies regarding the knowledge and stakeholder opinions based on where they live.

The use of remote sensing and geographic information systems (GIS) is also frequently associated with studies of climate change perception. In northern Egypt, information was extracted from ecosystem indicators (climate, soil and vegetation cover) and the use of environmental components (Saïdi et al., 2016) that demonstrated considerable and rapid changes in agricultural and biotic components. Importantly, the findings of rain periods (1985-1995) and drought (1996-2011) were perceived by the local population.

Multi-model and multi-parameter approaches involve combining global and regional data from climate models (Vormoor et al., 2015), multi-time and multi-scale approaches using historical maps and remote sensing to detect mangrove coverage (Ghosh et al., 2019). Interferometric measurement of synthetic aperture radar and global satellite navigation system data has been used to show sinking rates of approximately 2mm/year in coastal areas of San Francisco Bay (Shirzaei and Bürgmann, 2018).

Among the new technologies there is DESYCO (Torresan et al., 2016), which is a Decision Support System (DSS) based on GIS that provides an integrated evaluation of multiple climate change impacts on vulnerable coastal systems (Shirzaei and Bürgmann, 2018; Torresan et al., 2016). There is also the Regional Risk Assessment (RRA) methodology that is an integrated analysis of different parameters such as danger, exposure, vulnerability, and risk. It allows users to identify and prioritize objectives and areas that are likely to be affected by flooding risk due to heavy rainfall (Sperotto et al., 2015).

Other novel methodologies have been used to study the climate change perception in coastal regions. One is the Systems Approach Framework (SAF) (Schernewski et al., 2018). which combines local planning, media analysis, surveys, and interviews with key actors to identify criteria for better long-term climate change outcomes. Another methodology is the Integrated Participatory Climate Services for Agriculture (PICSA)

(Dayamba et al., 2018). It uses historical climate records, participatory decision-making tools, and forecasts to identify and plan livelihood options for adapting to local climatic characteristics and individual farmer circumstances. Some of the proposed actions include: changes in the time of activities, like planting dates; implementation of soil management practices and water; crop variety selection; fertilizer management; and plan adaptation according to season. The application of this method has proved to be useful for farmers because it broadened their approach to harvesting crops and facilitated collaboration and information sharing among farmers.

Likewise, the livelihood work methodology (MOTA) (Nguyen et al., 2019), uses multivariate analysis to determine the support that communities need to boost their knowledge, skills and financial capabilities, as well as interventions to reduce risks of new livelihood models. Notably, knowledge of climate change, its adaptive pathways (DAPP) and the Analysis of Real Options (ROA) emphasize the collaborative value of the community combined with the decision-making processes to increase understanding of the change in risk over time, and the need to take early actions that allow a change in the path before those actions become ineffective (Lawrence et al., 2019). These actions require political leadership and governance to facilitate feasible and workable adaptation strategies.

3.4. Hotspots of research

To reveal the correlation characteristics and main keyword importance, a network analysis was used as shown in Fig. 8. The size of each node represents the frequency of the term as determined from the publication abstract (n = 690). A term with a larger node is an international interest hotspot. Similarly, the width of a connection line indicates the correlation frequency between terms. For example, the main node and the hotspots in the publications analyzed is adaptation which refers to adaptation strategies used to deal with climate change in coastal communities and secondly to the adaptation capacities employed by the communities that inhabit coastal areas. The main adaptation correlation occurs with the risk and strategy. These observations suggest a tendency to design strategies for climate change adaptation and to prevent or to be prepared for the possible risks that this entails.

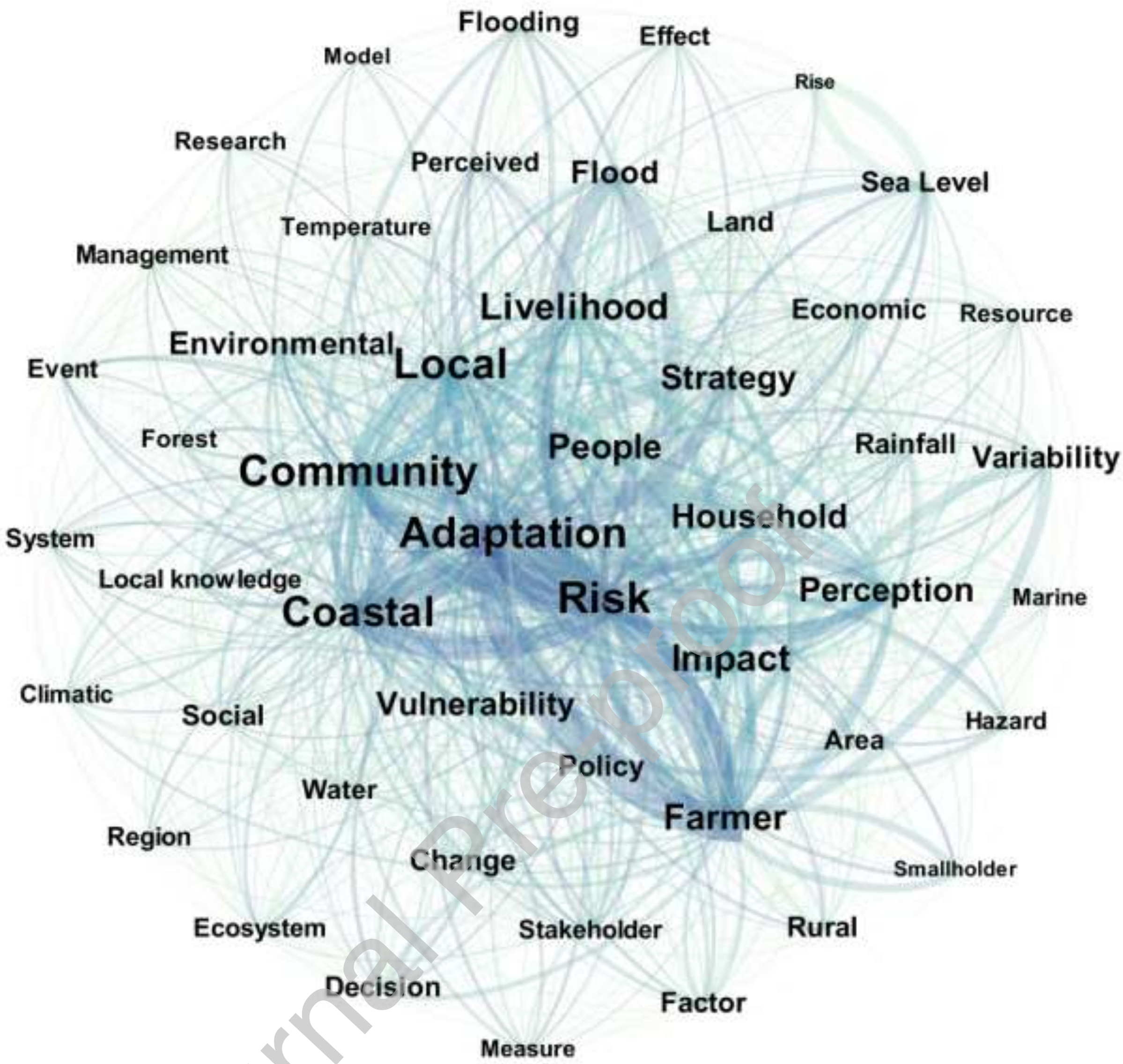

Figure. 8. Network of research nodes and hotspots on climate change perceptions in coastal regions.

In this setting, the word “perception” is associated with the risk perception, such as people and communities who perceive risks where they live, and the farmers’ climatic perceptions about diversifying their crops so that they are more resistant to climate change. The key for strategy design and understanding is to consider the people, their livelihoods, and local opinions.

4. Discussion

Climate change is altering weather patterns by increasing the frequency and intensity of extreme events. These events are severely impacting coastal areas, their natural resources, and the people who live there. Stimulated by the IPCC, the scientific community has highlighted the need to understand the natural phenomena, its impacts, and people. This has generated almost 27,000 publications on the perception of climate change through 2019 year and it continues to increase. Traditional methods of synthesizing scientific information are reaching their limits due to the exponentially increasing volume of research on the topic (Callaghan et al., 2020). For this study, machine learning was used to analyze geospatiality, keywords, and hotspots from big data to obtain an overview of climate change perceptions.

4.1. Trend analysis of scientific publications

According to different language trend publication, the milestone of the publications was 2009, as shown in Fig. 3. The main reason is that international societies have paid more attention to this issue in the last decade. Since late 1980s, with the creation of the Intergovernmental Panel on Climate Change (IPCC), a number of reports have been made presenting scientific information, technical and socio-economic relevant reports based on scientific research about risk of human-induced climate change, potential impacts, adaptation and mitigation strategy. Thus, beginning in the 2000s, climate change studies have been increasing in number as well as becoming more diverse incorporating new conceptualizations allowing the topic to be addressed from a range of different disciplines (Callaghan et al., 2020). The IPCC Fifth Assessment Report (AR5) was a critical scientific contribution that worked as an indicator of climate change research in the Paris Climate Agreement achieved in 2015, leading to more research attention on this topic (Wu et al., 2018).

The reviewed documents reflect a clear tendency to study local adaptation capacities in the face of extreme events. The most common objective in the articles is to determine how people cope with climate change based on their location (Gurran et al., 2013; Hagedoorn et al., 2019).

4.2. Geographical view on the perception of climate change

Globally, a mechanism has been established to help small islands developing states (SIDS) that share challenges related to sustainable development of small, but growing populations with limited resources, isolation, fragile natural environments and susceptibility to natural disasters (Briguglio, 1995). For instance, Europe, despite its high capacity to adapt to climate change, recognizes that they must be prepared for more complex challenges such as greater vulnerability of their coasts, adopting new methods, implementing technical measures and adjusting their objectives to broader management of coastal areas (Nicholls and Klein, 2005). National and international entities have shown different forms of coastal governance by applying risk mitigation and adaptation strategies that are incorporated into municipal and local spatial planning processes (Flannery et al., 2015). Local perceptions are linked to knowledge: environmental knowledge; environmental awareness, attitudes, and beliefs; and risk perceptions (Altschuler and Brownlee, 2015). In Latin America, a significant increase in research has occurred (Altschuler and Brownlee, 2015; Camacho Guerreiro et al., 2016; Villamizar et al., 2017), recognizing that local knowledge and cultural practices can complement scientific information in the design of adequate and effective climate change policies (Buckley et al. 2017).

4.3. Public policies and local perceptions on sustainable coastal regions

The sustainability of coastal communities depends on the resources associated with the coasts, such as food and energy production that maintains the local economy (Lillebø et al., 2019). We find two risks associated with livelihoods. First, sea levels are increasing at an alarming rate (Antonioli et al., 2017). Second, flooding often occurs where the most vulnerable populations live which can be dramatically impacted by extreme weather events such as Hurricane Sandy in the USA (Burger and Gochfeld, 2017). Unfortunately when Burger and Gochfeld (2017) examined the relationship between perceptions regarding severe storms, sea-level rise, climate change and ecological barriers and the impacts on coastal populations, they found that people do not recognize the role of dunes and swamps as structures that can provide coastal protection.

Many studies have shown the impacts at the local level and the substantive effects of climate change in coastal areas (Stojanov et al., 2017), reflecting the spatial vulnerability and how political practices influence risk perceptions (McGuire, 2017). The more that is known about climate change perceptions and people's reflections on it, the greater the understanding and support will be to make intelligent decisions (Lee et al., 2016). There will also be more motivation to act in both mitigating the causes of climate change and adapting to it (Singh et al., 2019) thus, reducing the coastal area vulnerability (Limuwa et al. 2018; Linnekamp et al., 2011). However, this research is not progressing at the same rate globally (Bunce et al., 2010; Ratter et al., 2016). For this reason, public education is needed to encourage people to reflect on the scope, content and advantages of the climate change research in coastal regions, with an emphasis on getting governments to work on the obligations that they face.

Livelihoods play an important role in studies on the perceptions of climate change. For example, shrimpers in southwestern Bangladesh reported greater pressures due to environmental and climatic changes (Islam et al., 2019). Although their understanding of climate change diverges from the scientific evidence (in the long term), their knowledge of short term hydroclimatic patterns aligns with the scientific evidence. In relation to local perceptions, some farmers have adjusted their aquaculture practices. However, while climatic disturbances are increasingly stressful, most farmers tend to maintain their cultural practices (Islam et al., 2019). Understanding psychological, sociological, and cultural reasons for variations in climate change perceptions has implications for how the design of educational strategies and policy interventions can be adapted to local conditions (Weber, 2010).

4.4. Research considerations

The perception of climate change in coastal communities should be a fundamental consideration to climate change policies. Scientific evidence suggests that climate change effects in coastal areas will continue to significant environmental, economic, social and cultural impacts (Button and Harvey, 2015; Roy and Sharma, 2015). Public perceptions involve the different stakeholders that influence coastal spaces, while social perceptions refer to society's self-perception of coastal communities including those living on the coasts as well as the livelihoods that support them (Rybråten et al., 2018). The approach to environmental and social components has the characteristics of multi-inter-trans disciplinarily. Climate change effects are perceived by indigenous people (Sangha et al., 2019; Vogt et al., 2016), farmers (Uddin et al., 2017) and coastal communities (Liao et al., 2019) which in turn adopt culturally viable measures due to their interrelations with natural resources (Armah et al., 2017).

5. Conclusions

We conducted a bibliometric identification mainly using Scopus to summarize scientific research progress in the field of climate change perception. Publications have gradually increased due to growing concerns about climate change. USA authors had the most publications followed by the UK, India, and China. The analysis of keywords indicates that the research focuses on adaptation strategies, climate variability, climate perception, climate impact and adaptability. The main research objects include studies on sea levels, climate perception of farmers, extreme weather events and climate impact perceptions. The research methods used in these studies included discussion groups and semi-structured key informant and focus group interviews.

To improve research in this field, it is essential to use an interdisciplinary approach (e.g., hybrid or complementary methods), since no single method can address complicated socio-environmental phenomenon. Coastal communities deserve more attention due to their complexity and because they are most vulnerable to climate change. They have fragile ecosystems and are highly susceptible to sea-level rise, storms, floods, landslides and spread of infectious diseases. The main contribution of this article was to provide an overview of this emerging topic and to identify current and future research trends and methods. The results of qualitative and quantitative analyses provide valuable information and help to inspire researchers to contribute to this field.

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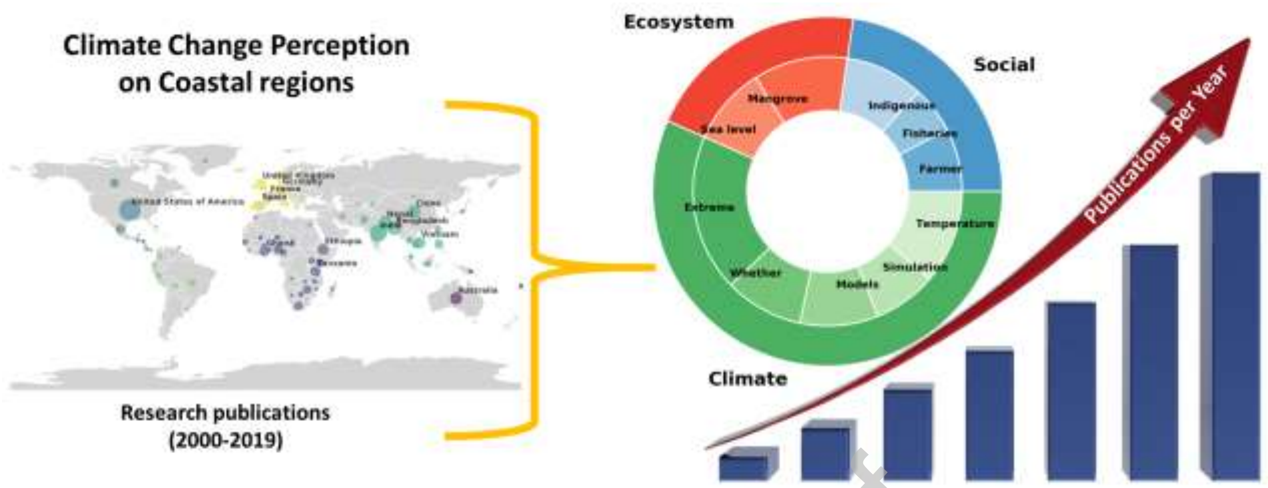
Graphical Abstract



Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.