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THE DEVELOPMENT AND RESEARCH TREND OF USING DSAS TOOL FOR SHORELINE CHANGE ANALYSIS: A SCIENTOMETRIC ANALYSIS

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Abstract: The sensitivity of research on shoreline monitoring of coastal erosion is justified due to high density population, climate changes impacts, and intensified development, which are squeezing the ecosystem of coastal zones around the world. The budding fields of optical remote sensing such source medium and high-resolution satellite imagery in conjunction with avenue programming of Digital Shoreline Analysis System (DSAS) are widely used extended tools for analyzing the rate of coastal erosion and deposition. Although, there is a geometric growth in the research published documents in the last decades after the start of DSAS in 1990, but its broad insight into global peer groups, its scientometrics, pattern and trends in research activities in monitoring coastal erosion or shoreline change is missing. To breach this gap, 99 bibliographic records published in the Web of Science core collection for the period of 1994–2019 were analyzed using the VOSviewer software. Further, the analysis about global insight of research activities using DSAS in shoreline change analysis focused on (i) general scientometric characteristics of published output, (ii) experts in research themes and their cooperation, (iii) publishable journal list, (iv) institutional distribution and international collaboration, and (v) potential hotspot areas. This systematic analysis of the theme, graphically using rigorous scientmetric tools, will help coastal researchers to visualize the current research trends and prospective guideline for future research. The output of the present study will provide a robust road map to early carrier researchers for their advance inquiry in these fields in coming days.

Keywords: Coastline; DSAS; scientometric; VOSviewer; coastal erosion; coastal accretion

INTRODUCTION

The coastal systems around the world are degrading due to the population growing, global economy and anthropogenic-induced global warming and sea level changes (Nicholls *et al.*, 2016; Luijendijk *et al.*, 2018; Day & Rybczyk, 2019; Livingston *et al.*, 2019; Wright *et al.*, 2019; Le Cozannet *et al.*, 2019). The impact of sea level rise are shoreline retreats (Nicholls & Cazenave, 2010; De Winter & Ruessink, 2017; Le Cozannet *et al.*, 2019) and the result is that two-third of the beaches around the world are facing the brunt of coastal erosion (Appeaning Addo *et al.*, 2008; Bird, 1985; Luijendijk *et al.*, 2018). The dynamic characteristics of shoreline change are attributed due to myriad of coastal process of interface between sea and land, and meteorological and anthropogenic forcing (Oyedotun, 2014; Mishra *et al.*, 2019). Thus, reliable shoreline change rate assessment is needed for perspective coastal planning, sustainable coastal zone management and mitigating sea level rise in high valued coastal system of the world. The digital information about shoreline geometry (position, orientation and shape) is essential for assessment, monitoring, mitigating, and modeling the dynamics and configuration of the coastal area. The quantification of the rate of erosion and accretion, and creation of spatial data of shorelines in spatial and temporal dimension are required for modeling and forecasting (Collins & Sitar, 2008; Katz & Mushkin, 2013; Oyedotun, 2014). The input data about short- and long-term shoreline changes are desirable for overcoming not only coastal problem but also managing coastal zone sustainability. More field-based researches were used to appraise the short-term shoreline change and its resilience to the anthropogenic, astronomical and meteorological forcing (Quinn *et al.*, 2010; Brooks *et al.*, 2012; Thébaudeau *et al.*, 2013). However, longer time period shoreline changes and their response to the coastal forces cannot be accounted by field-based researches (Oyedotun, 2014). Therefore, quantification and data acquisition automation of digital shoreline changes are needed to evaluate the driving forces in coastal zones and their configuration.

The science of historical shoreline change analysis has significantly advanced in terms of use of remote sensed data, tools and techniques, and more advances are done to reduce the uncertainties involved (Moussaid *et al.*, 2015). The Landsat imageries (TM, ETM+ and OLI) are mostly used for quantification to be applied in shoreline analysis around the world (Murali *et al.*, 2015; Bheeroo *et al.*, 2016; Nandi *et al.*, 2016; Nassar *et al.*, 2019; Mishra *et al.*, 2019). The DSAS is an add-in to Environmental System Research Institute (ESRI) ArcGIS for quantifying shoreline change statistics from optical satellite imageries from various chronological positions (Thieler *et al.*, 2009). The automated tool of DSAS developed by United State of Geological Society (USGS) has revolutionized the short- and long-term shoreline change analysis around the world (Brooks & Spencer, 2010). The combination of ESRI ArcGIS and DSAS tool helps in the shoreline extraction, baseline creation, transect generation, calculation of distance between baseline and each transect, a using user-friendly interface to statistically analyze the shoreline changes (Net Shoreline Movement – NSM, Shoreline Change Envelope – SCE, End Point Rate – EPR, Linear Regression Rate – LRR and Weighted Linear Regression Rate – WLR) (Thieler *et al.*, 2009; Nassar *et al.*, 2019; Mishra *et al.*, 2019; Acharyya et al., 2020). This add-in extension allows to create transect, baseline and calculate the rates of erosion and accretion in automated way, using a user-friendly interface (Thieler *et al.*, 2009). The DSAS versions 1 to 5 are effectual tools used by researchers around the world for shoreline change analysis, evaluation and monitoring of shoreline positions and geometry. Although, application of DSAS technique is mainly applied for shoreline or coastline rate analysis but has wider utilization in studies about construction of coastal infrastructure, coastal risk, vulnerability, coastal tourism, coastal morphology, shore area management, predictive analyses and coastal groundwater quality mapping. Further, wider application of DSAS in spatial and temporal scale around the world is shown in **Table 1**. Despite the budding importance of application of DSAS in historical shoreline change analysis around the world, analysis of spatial temporal variation of the status of application of DSAS in Historical Trend Analysis (HTA) by bibliometric/scientometric analysis in this topic is scarce. The coastal scientists are yet to establish the quality of research done in this area. Thus, automated application of DSAS and improvement of shoreline analysis justifies our present study for scientometric analysis. The bibliometric/scientometrics are meta-analysis of scientific research and science policy product indexed and also tool to map the scientific citation, trend of publication, impact of research articles, institutions, productive journals and identifying the domain of research (Leydesdorff & Milojević, 2015). The purpose of the study is to conduct scientometric analysis with help of Web of Science database to highlight the year in which DSAS application has started, the characterization of the outputs, the journal that published the most, trend of research hotspots using key words and the most relevant authors in this thematic area. The output of the present research will help to orient policymakers in coastal research in the use of DSAS, and journals and authors to be consulted for evaluating HTA for shoreline studies.

Table 1 History of shore line mapping using DSAS technique

Author	Country	Purpose of DSAS application	Period
Stavrou *et al.* (2011)	England	To assess the coastal cliff recession and associated risk	1952–2005
Alberico *et al.* (2012)	Italy	To analyze the coastline change for the purpose of helping the policy makers in forming a proper management plan	1870–2009
Ahmad & Lakhan (2012)	Guyana	To analyze the coastline change and present a model for future prediction	1987–1992
Roig-Munar *et al.* (2012)	Spain	To study the impact of beach dune erosion on tourism	1956–2007
Kusimi & Dika (2012)	Ghana	To assess the extent of shoreline recession and its impact on population	1926–2008
Perez-Alberti *et al.* (2013)	Spain	Shoreline change and cliff recession for community infrastructure management and future planning	1956–2008
Halouani *et al.* (2013)	Tunisia	Identification of suitable areas for establishing recreational infrastructure and beach nourishment projects	1963–2001
Epifanio *et al.* (2013)	Portugal	To assess the rate of cliff retreat and identification of landslide prone zones for future hazard preparedness	1947–2007
Brooks & Spencer (2014)	UK	To measure the variability of erosion rate of soft rock cliffs	1883–2010
Kuenzer *et al.* (2014)	China	To find out the coastal changes in the region and address the impact of oil industry on the study area	1976–2013
Castedo *et al.* (2015)	UK	To predict the shoreline Change in response to environmental and climatic changes	1852–2011
Ali *et al.* (2017)	Egypt	To study the sedimentation pattern and the effectiveness of detached breakwater systems	2000–2015
Baral *et al.* (2018)	India	Study of the shoreline change for effective shoreline management planning	1975–2016
Stanchev *et al.* (2018)	Bulgaria	To analyze shoreline change and cliff retreat for coastal management	1975–2011
Nassar *et al.* (2018)	Indonesi	To assess the shoreline changes along the coastline and its effect on tourism	2006–2015
Ariffin *et al.* (2018)	Malaysia	To study the alteration of shoreline due to construction of artificial structures	2005–2014
Duarte *et al.* (2018)	Brazil	To study and predict the effect of sedimentation on the functionality of the port terminal	2011–2014
Garrote *et al.* (2018)	Spain	To analyze the effect of the winter marine storm on the historical evolution of the beach dune structure	1956–2017
Sreekesh *et al.* (2018)	India	To assess the rate of shoreline change and its effect on ground water quality	1971–2007
Ataol *et al.* (2019)	Turkey	To determine the rate of change before and after the construction of large-scale dams through rate of erosion and shoreline change	1953–2017
Ciritci & Türk (2019)	Turkey	To calculate the rate of landward and seaward movement of shoreline along the delta region	1984–201[illegible]

MATERIALS AND METHODS

A scientometric analysis was conducted by using statistical tool to map the quantitative and qualitative changes in distribution features and intellectual structures of the scientific research on the application of DSAS in shoreline change analysis. The distribution features were recognized as characteristics of shoreline change analysis research, including annual research output, document type, active journals, and institutions, countries and authors' performance and their collaborations patterns. However, intellectual structure analysis usually provides research hotspots and research frontiers (De Bakker *et al.*, 2005; Sudarsana & Baba, 2019). These kinds of in-depth analysis will help coastal researchers to evaluate the uses of DSAS in shoreline change analysis and also reducing uncertainty.

The Web of Science (WoS) database was the only bibliometric/scientometric analysis tool until the development of Scopus and Google Scholar in 2004 (Gavel & Iselid, 2008; Mongeon & Paul-Hus, 2016). The WoS and Scopus databases are the main source for citation analysis more than the low data quality of Google scholar databases (Archambault *et al.*, 2009). The WoS database was selected for this study because of its interdisciplinary and systematic distribution of available databases. To retrieve articles related to shoreline change and digital shoreline analysis system, we applied the following search strategy as depicted in **Fig. 1**.

It was found that the first article about shoreline analysis system was published by Thieler & Danforth (1994). Therefore, the time between 1994 and 2019 were fixed for the literature search. The sample of the search result found 99 bibliographic records. The extraction of the bibliographic records was done in May 19, 2019. These records were exported to VOSviewer (Eck & Waltman, 2009) for the further analysis. The VOSviewer is a scientometric analysis tool, which is useful for constructing and displaying large scientific maps in an easy to understand way. VOSviewer has been mainly used for analyzing and visualizing co-citation networks, co-authorships networks and co-occurrence networks. In this study, the following aspects were analyzed: (i) general characteristics of research output, (ii) authors and their collaboration patterns, (iii) involved sources, (iv) profile institutions and country contributions, and (v) keywords.

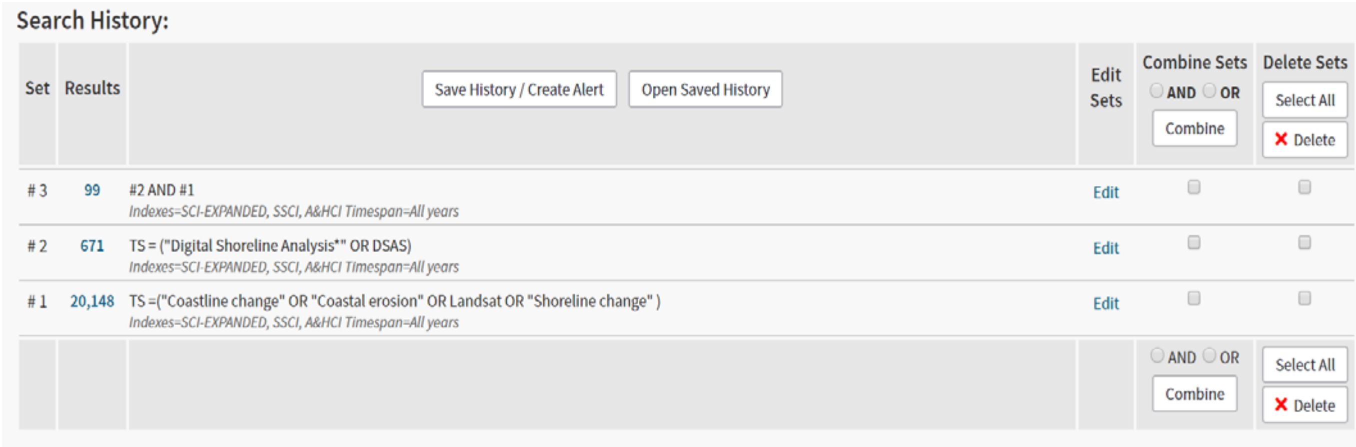

Fig. 1 Search strategy.

RESULT AND DISCUSSION

General characteristics of publication output

The WoS database showed a total of 99 documents from 1994 to 2019. However, 98% of the publications are research article and only 2% were proceedings papers and review papers. The extracted scientific records were analyzed by year-wise (**Fig. 2**). This figure shows that interest on shoreline change analysis has been increased from 1 in 1994 to 99 in 2019 and half (53; 52%) of the publications were published in the last 4 years from 2014 to 2016, and the largest publication happened in 2018 and 2019. Secondly, there was not a single publication from 1995 to 2009. However, academic interest in this topic increased after 2012. The first publication in 1994 was cited for 71 times and the number of citations showed a rising trend at a much higher rate from 2010 to 2015. The possible reason for this increment might be new directions provided by these articles to the researchers. However, a sharp decrease in the number of citations is seen for the period after 2014. The average citation per document is 9.657, whereas annual percentage growth rate of publication on shoreline change analysis is 11.72871.

Authors and their collaboration pattern

The results show that around the world, there are about 99 scientific publication contributed by 331 authors. The largest proportion of authors (91.2%; n = 302/331) is only one publication. Further, 8.7% (n = 29/331) have two publications and 1.5% (n = 5/331) have three or more publications. The ten most productive authors in research on shoreline change analysis are shown in **Table 2**. Amongst 331 authors, the top three publishing authors were found to be Hassan Fath (n = 3), R. S. Kankara (n = 3) and Mehdi Maanan (n = 3). Hassan Fath is a professor of the Environmental Engineering Department, School of Energy and Environmental Engineering, Egypt-Japan University of Science. His areas of interest are shoreline change, DSAS and Desalination, whereas, in term of citations, the top cited authors were Tuncay Kuleli, Abdulaziz Guneroglu, WW Danforth, Mustafa Dihkan and Fevzi Karsli. The number of articles (average) per author is 0.29. The patterns of collaboration of the authors publishing about shoreline analysis system were analyzed with the VOSviewer (**Fig. 3**). The size of the circle depicts the quantity of publications concerning shoreline analysis system. The connected line represents the cooperation. The different color combination shows the collaboration clusters. As for the collaboration network, three author clusters were identified. Prof. Mehdi Maanan, Prof. Hassan Fath, and Prof. Wael Elham Mahmod are the top three strong influenced researchers in the field of shoreline change analysis.

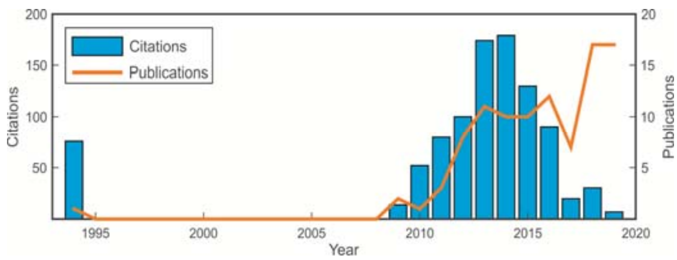

Fig. 2 Trend of publications and citation for years on shoreline change analysis between 1994 and 2019.

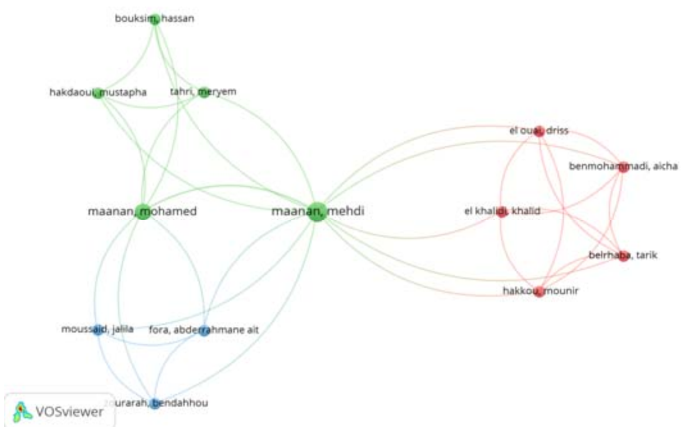

Fig. 3 Author cooperation network in shoreline change analysis.

Table 2. The most productive authors (top ten) publishing in shoreline change analysis research

Author	Organization/ Institution	Country of author	Quant.	Citations
Hassan Fath	Egypt-Japan University of Science and Technology	Egypt	3	5
R. S. Kankara	National Centre for Coastal Research	India	3	8
Mehdi Maanan	Université Hassan II de Casablanca	Moroc co	3	31
Wael Elham Mahmod	Saitama University	Japan	3	5
S Chenthamil Selvan	National Centre for Coastal Research	India	3	8
Appeaning Add Kwasi	University of Ghana	Ghana	2	24
P Balasaraswatl	Institute for ocean management	India	2	0
N Chandraseka:	Manonmaniam Sundaranar University	India	2	36
Laura Del Rio	University of Cadiz	Spain	2	21
S Dhanalakshm	Integrated Coastal and Marine Area Management Project Directorate	India	2	3

Journal publishing researches on shoreline change analysis

It is important to know the quality of the journals publishing research articles on shoreline change analysis. This study identified that 39 trans-disciplinary journals have published 99 scientific articles. Out of the total journals, little more than 51% have one article, 23% have two articles and the rest has either three or more articles.

Table 3 presents the top 10 most active journals with the most publications, as well as the top 10 journals with the most citations. These 10 journals published 61% of all publications (n = 61/99). The top-ranked journals on the basis of the count of the number of articles are Journal of Coastal Research, with a record of 20, followed by Environmental Earth Sciences, and Journal of Coastal Conservation both with 7 articles. These are the three most productive core journals where researches related to shoreline change analysis are published.

Geographical distribution of institutes and cooperation

Countries and their linkage The publications about shoreline change analysis researches are originated from 39 different regions, as shown in **Fig. 4**, 37 countries (90.8%) produced less than eight publications, and two countries (5.1%) have produced between 16 and 19 publications. It was observed that India produced the most publications, whereas, in term of citations, research publications from USA, Turkey, India, Germany and Italy are highly cited. The collaboration networks between different countries are shown in **Fig. 5**. The network analysis highlights the collaboration between countries with one or more publications.

The line linking the circles reflects the collaborations between such countries, while the thickness of the line represents the intensity of such collaboration. According to this analysis, five core groups (clusters) were identified. The first cluster is composed by Italy and Spain (red group), the second cluster is formed by Australia and France (green group), the 3rd and 4th clusters is Canada (blue group) and USA (yellow group), respectively, and the 5th cluster refers to Japan and Egypt. The countries like USA, Spain, Italy, Australia and Canada are having more collaboration when compared to other countries.

Institutions A total of 166 organizations/institutions participated in 99 publications based on author affiliation data. Of all institutions, 82.5% (n = 137) have contributed in only one publication, 12.6% (n = 21) have contributed in two publications, and 4.9% (n = 8) have participated in three or four publications. **Table 4** provides the statistics of the top 10 most productive institutions, from which is noted that the University of Ghana was the most active institution on DSAS research with four publications.

Table 3 Top 10 most active journals with the most publications and citations

Name of the journal	Quant.	Name of the journal	Citations
J. Coastal Research	20	J. Coastal Research	212
Environ. Earth Sci.	7	Ocean Engineering	91
J. Coastal Conservation	7	Estuaries and Coasts	63
Ocean & Coastal Management	6	Applied Geography	57
Environ. Monit. and Assess.	5	Environmental Earth Scienc	56
Natural Hazards	4	Ocean & Coastal Management	56
Arabian J. Geosci.	3	Environ. Monit. and Assessment	55
Estuaries and Coasts	3	J. Coastal Conservation	46
Geomorphology	3	Geomorphology	34
J. Indian Soc. Remote Sensing	3	Biogeosciences	31

Table 4 Top 10 most productive institutions publishing in shoreline change analysis research

Institution	Documents	Country
University of Ghana	4	Ghana
Assiut University	3	Ghana
National Research Council	3	Italy
Mansoura University	3	Egypt
University of Aveiro	3	Portugal
University of Cádiz	3	Spain
University of Cape Coast	3	Ghana
Universidade Federal de Santa Catarina	3	Brazil

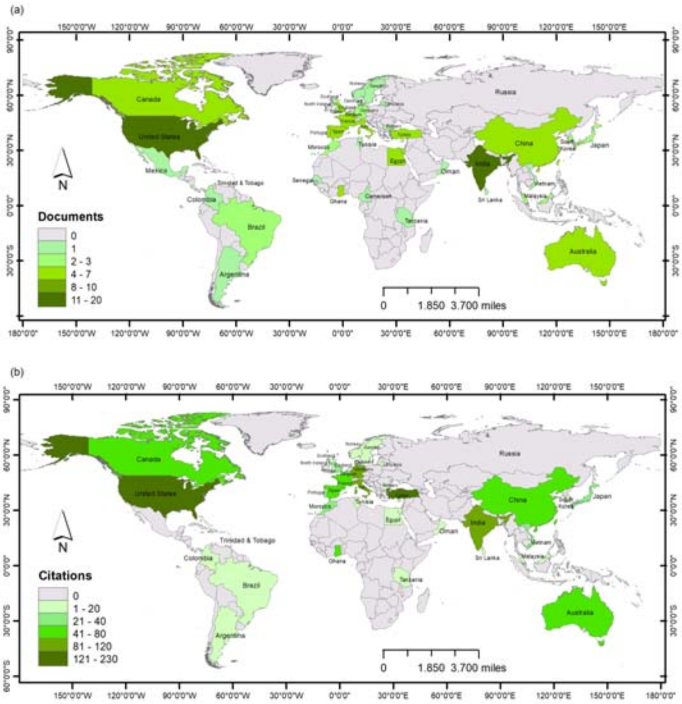

Fig. 4 Global geographic distribution by country or region of (a) documents, and (b) citations.

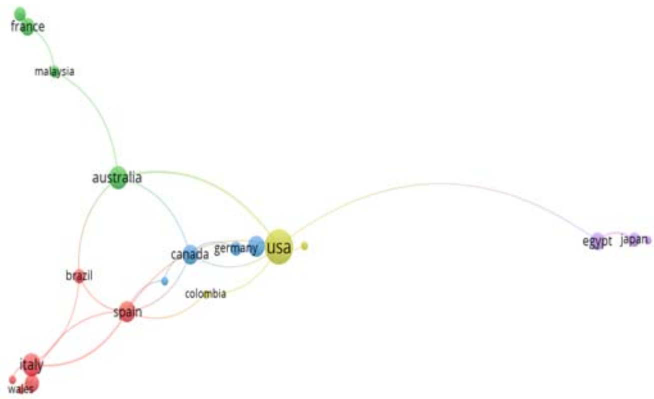

Fig. 5 Collaboration network between countries in shoreline change analysis research.

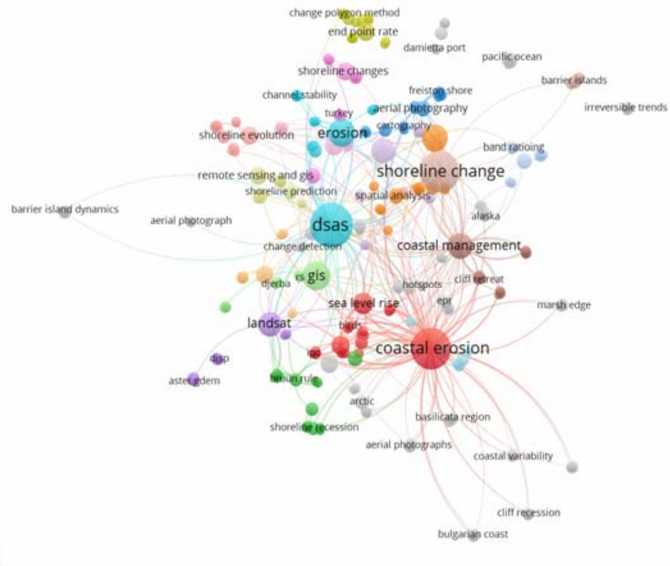

Fig. 6 The keywords co-occurrence network based on occurrences of keywords in articles. The size of node proportional to the frequency of occurrence of the keyword, and the thickness of line represents the intensity of co-occurrence between individual keywords.

Trend of research output and hotspot based on keywords

The keyword can be a single word or phrase having a descriptive idea about the whole research document (Sudarsana *et al.*, 2018). The keyword co-occurrences were analyzed to map the research output and hotspots, which can provide insight to new research frontiers. The visual analysis of the keyword co-occurrences in the domain were conducted by using VOSviewer. Out of 287 keywords found in 99 documents, 44 keywords occurred at least two times, forming 16.1% of the total keywords. The hotspots of the research in the field of shoreline change analysis in the past decades were identified and visualized. It should be observed that (i) the size of the nodes and words in **Fig. 6** denotes the quantity of the co-occurrence of that keyword, and (ii) the distance between the nodes reflects the strength of the relation between them.

A shorter distance generally reveals a stronger relationship, whereas the line between the two keywords represents the co-occurrence of the words and the line thickness denotes the frequency of the co-occurrence of the two keywords. The nodes with the same color indicate that the keywords appeared during the same period. It can be inferred from the map that "DSAS", "coastal erosion", "shoreline change", "GIS", "erosion", "coastal management", "Landsat", "remote sensing", "sea level rise", "accretion", "climate change", "coastline change", and "end point rate" have the highest frequency and these can be represented as hotspots of research domain. However, small nodes without names indicate the fewer occurrences of these subjects in the research papers pertaining to knowledge domain of shoreline change analysis. Finally, the keyword relationships in period are shown in **Fig. 7**. The color combination of the keywords highlights the

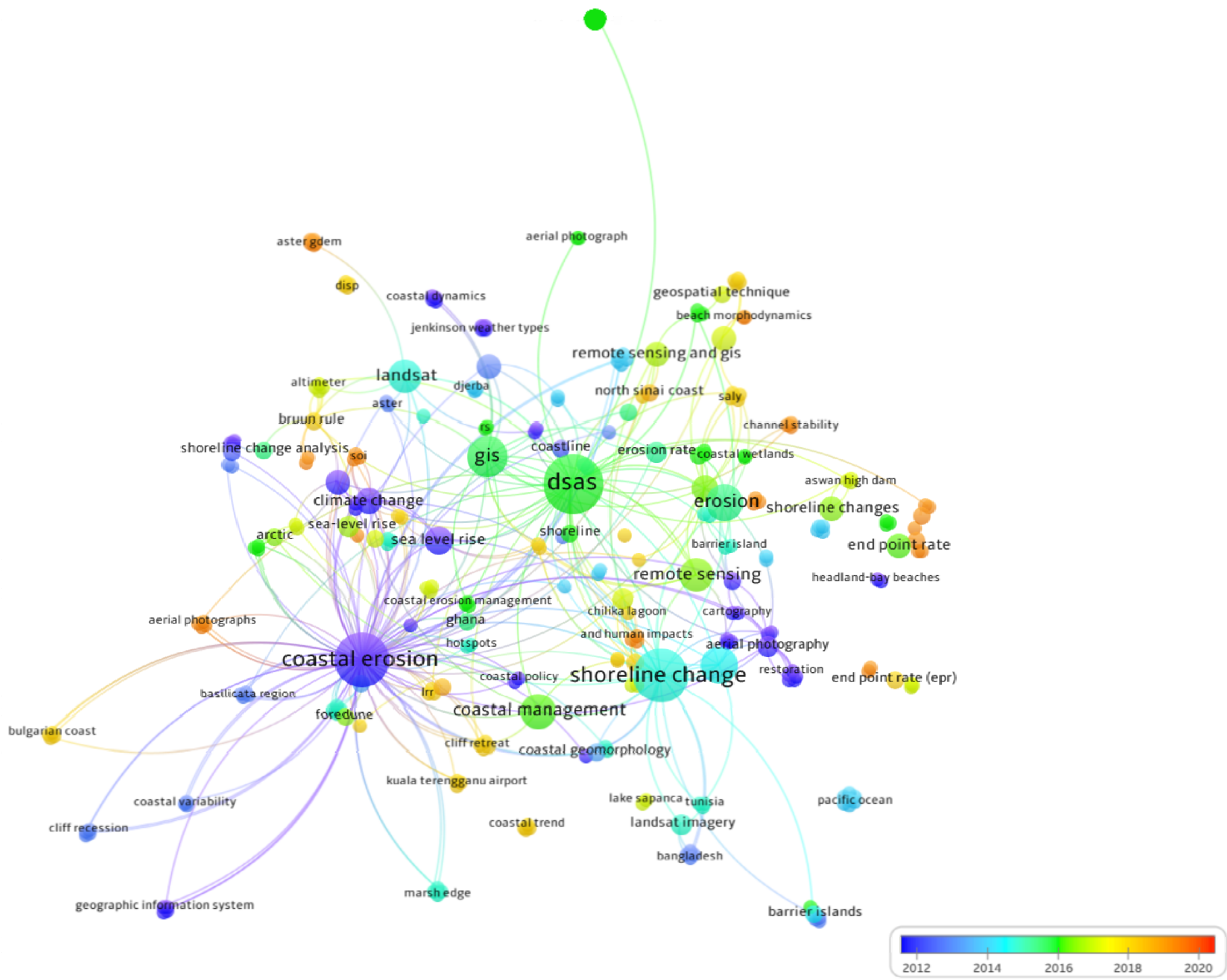

Fig. 7 Term analysis in shoreline change analysis research including publications with time information.

average publication time. The most commonly used keywords were extracted from the period between 2002 and 2020. The blue color highlights the oldest terms and the red one indicates the most contemporary terms. In addition, the research frontiers in the field of shoreline analysis system were identified (**Fig. 7**). These keywords are "channel stability", "landscape change", "reclamation", "aeolian", "coastal hazard", "coastal communities", "disp", "image series", "LRR", "mahanadi delta", "shanghai", "spatiotemporal shoreline change", "bulgarian coast", "land-sea interactions", and "marine spatial planning".

CONCLUSION

This article is a scientometric analysis about the shoreline change analysis using DSAS research published in the WoS between 1994–2019, and highlights the paradigm shift in publishing culture over the last decades. Further, more publications and researches on coastal erosion are seen in underdeveloped and developing countries. It shows potential areas for future coastal research, hotspots of thematic areas, trends of publication and citation, the most reliable important journals for literature search, and the most prolific author and institution working in these subjects. The first work was published in 1994 and a pause between 1995 and 2009 was observed. The most significant publications (53; 52% of publications) were done between 2014 and 2016, while 331 different authors, from 39 different countries and from 166 institutions have published 99 research documents in the WoS. However, 91.2% of the authors have published single publication, and 8.5% and 1.5% published two and three publications, respectively. The Journal of Coastal Research is the leading journal in this field, both in number of research papers and in number of citations. Countries like India have produced the largest number of publications, but countries like the USA, Turkey, Germany and Italy are highly cited countries. The research hot spots in shoreline change analysis are "DSAS", "coastal erosion", "shoreline change", "GIS", "erosion", "coastal management", "Landsat", "remote sensing", "sea level rise", "accretion", "climate change", "coastline change", and "end point rate". Although there is an increasing trend in the number of researches on the application of DSAS in the shoreline analysis, but there are still numerous challenges in transform such researches into action-oriented social products. Adding more keywords would result in a larger set of data, which would require more innovative scientrometric and network analysis. Furthermore, opportunities are there for content analysis of highly cited articles to identify research problems, challenges and future directions.

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REFERENCES

Acharyya, T., Mishra, M., Kar, D. (2020) Rapid impact assessment of extremely severe cyclonic storm Fani on morpho-dynamics & ecology of Chilika Lake, Odisha, India. *J. Coast. Conserv.* **24**, 37. doi: 10.1007/s11852-020-00754-8

Ahmad, S.R. & Lakhan, V.C. (2012) GIS-Based Analysis and Modeling of Coastline Advance and Retreat along the Coast of Guyana. *Mar. Geod.*, **35**(1), 1–15. doi: 10.1080/01490419.2011.637851

Alberico, I., Amato, V., Aucelli, P.P.C., D'Argenio, B., Di Paola, G., Pappone, G. (2012) Historical shoreline change of the Sele Plain (Southern Italy): The 1870-2009 Time Window. *J. Coast. Res.*, **28**(6), 1638–1647. doi: 10.2112/JCOASTRES-D-10-00197.1

Ali, W.A., Kaiser, M.F., Kholief, S., El-Tahan, M. (2017) Assessment of shoreline stability and solidity for future investment plans at Ras El-Bar Resort (Egypt). *Egypt. J. Aquat. Biol. Fish.*, **21**:11–23. doi: 10.21608/ejabf.2017.2377

Appeaning Addo, K., Walkden, M., Mills, J.P. (2008) Detection, measurement and prediction of shoreline recession in Accra, Ghana. ISPRS *J. Photogramm. Remote Sens.*, **63**:543–558. doi: 10.1016/j.isprsjprs.2008.04.001

Archambault, É., Campbell, D., Gingras, Y., Larivière, V. (2009) Comparing bibliometric statistics obtained from the Web of Science and Scopus. *J. Am. Soc. Inf. Sci. Technol.*, **60**:1320–1326. doi: 10.1002/asi.21062

Ariffin, E.H., Sedrati, M., Akhir, M.F., Daud, N.R., Yaacob, R., Husain, M.L. (2018) Beach morphodynamics and evolution of monsoon-dominated coasts in Kuala Terengganu, Malaysia: Perspectives for integrated management. *Ocean Coast Manag.*, **163**:498–514. doi: 10.1016/j.ocecoaman.2018.07.013

Ataol, M, Kale, M.M., Tekkanat, İ.S. (2019) Assessment of the changes in shoreline using digital shoreline analysis system: a case study of Kızılırmak Delta in northern Turkey from 1951 to 2017. *Environ. Earth Sci.*, **78**:579. doi: 10.1007/s12665-019-8591-7

Baral, R., Pradhan, S., Samal, R.N., Mishra, S.K. (2018) Shoreline Change Analysis at Chilika Lagoon Coast, India Using Digital Shoreline Analysis System. *J. Indian Soc Remote Sens.*, **46**:1637–1644. doi: 10.1007/s12524-018-0818-7

Bheeroo, R.A., Chandrasekar, N., Kaliraj, S., Magesh, N.S. (2016) Shoreline change rate and erosion risk assessment along the Trou Aux Biches–Mont Choisy beach on the northwest coast of Mauritius using GIS-DSAS technique. *Environ. Earth Sci.*, **75**. doi: 10.1007/s12665-016-5311-4

Bird, E.C.F. (1985) Coastline changes: a global review. Wiley, Chichester (West Sussex), New York.

Brooks, S.M. & Spencer, T. (2010) Temporal and spatial variations in recession rates and sediment release from soft rock cliffs, Suffolk coast, UK. *Geomorphology*, **124**:26–41. doi: 10.1016/j.geomorph.2010.08.005

Brooks, S.M. & Spencer, T. (2014) Importance of decadal scale variability in shoreline response: examples from soft rock cliffs, East Anglian coast, UK. *J. Coast Conserv.*, **18**:581–593. doi: 10.1007/s11852-013-0279-7

Brooks, S.M., Spencer, T., Boreham, S. (2012) Deriving mechanisms and thresholds for cliff retreat in soft-rock cliffs under changing climates: Rapidly retreating cliffs of the Suffolk coast, UK. *Geomorphology*, **153**–**154**:48–60. doi 10.1016/j.geomorph.2012.02.007

Castedo, R., De la Vega-Panizo, R., Fernandez-Hernandez, M., Paredes, C. (2015) Measurement of historical cliff-top changes and estimation of future trends using GIS data between Bridlington and Hornsea - Holderness Coast (UK). *Geomorphology,* **230**:146–160. doi: 10.1016/j.geomorph.2014.11.013

Ciritci, D. & Türk, T. (2019) Automatic Detection of Shoreline Change by Geographical Information System (GIS) and Remote Sensing in the Göksu Delta, Turkey. *J. Indian Soc. Remote Sens.*, 47:233–243. doi: 10.1007/s12524-019-00947-1

Collins, B.D., Sitar N. (2008) Processes of coastal bluff erosion in weakly lithified sands, Pacifica, California, USA. *Geomorphology*, **97**:483–501. doi: 10.1016/j.geomorph.2007.09.004

Day, J.W. & Rybczyk J.M. (2019) Global Change Impacts on the Future of Coastal Systems: Perverse Interactions Among Climate Change, Ecosystem Degradation, Energy Scarcity, and Population. In: Coasts and Estuaries. Elsevier, 621–639

De Bakker, F.G.A., Groenewegen, P., Den Hond, F. (2005) A Bibliometric Analysis of 30 Years of Research and Theory on Corporate Social Responsibility and Corporate Social Performance. *Buss. Soc.,* **44**:283–317. doi: 10.1177/0007650305278086

De Winter, R.C. & Ruessink, B.G. (2017) Sensitivity analysis of climate change impacts on dune erosion: case study for the Dutch Holland coast. *Clim Change,* **141**:685–701. doi: 10.1007/s10584-017-1922-3

Duarte, C.R., De Miranda, F.P., Landau, L., Souto, MVS. (2018) Short-time analysis of shoreline based on RapidEye satellite images in the terminal area of Pecem Port, Ceara, Brazil. *Int. J. Remote Sens.*, **39**:4376–4389. doi: 10.1080/01431161.2018.1457229

Epifanio, B., Zezere, J.L., Neves, M. (2013) Identification of hazardous zones combining cliff retreat rates with landslide susceptibility assessment. *J. Coast Res.*, **65**(10065): 1681–1686. doi: 10.2112/SI65-284.1

Garrote, J., Díaz-Álvarez, A., Nganhane, H., Garzón Heydt, G. (2018) The Severe 2013–14 Winter Storms in the Historical Evolution of Cantabrian (Northern Spain) Beach-Dune Systems. *Geosciences,* **8**:459. doi: 10.3390/geosciences8120459

Gavel, Y. & Iselid, L. (2008) Web of Science and Scopus: a journal title overlap study. *Online Inf. Rev.,* **32**:8–21. doi: 10.1108/14684520810865958

Halouani, N., Gueddari, M., Frihy, O. (2013) The Northwestern Mediterranean Coast of Tunisia: Wave Processes, Shoreline Stability and Management Implications. *Arab. J. Sci. Eng.,* **38**:1851–1860. doi: 10.1007/s13369-012-0401-4

Katz, O. & Mushkin, A. (2013) Characteristics of sea-cliff erosion induced by a strong winter storm in the eastern Mediterranean. Quat Res 80:20–32. doi: 10.1016/j.yqres.2013.04.004

Kuenzer, C., Ottinger, M., Liu, G., Sun, B., Baumhauer, R., Dech, S. (2014) Earth observation-based coastal zone monitoring of the Yellow River Delta: Dynamics in China's second largest oil producing region over four decades. *Appl. Geogr.* **55**:92–107. doi: 10.1016/j.apgeog.2014.08.015

Kusimi, J.M., Dika, J.L. (2012) Sea erosion at Ada Foah: assessment of impacts and proposed mitigation measures. Nat HAZARDS **64**:983–997. doi: 10.1007/s11069-012-0216-3

Le Cozannet, G., Bulteau, T., Castelle, B., Ranasinghe, R., Wöppelmann, G., Rohmer, J., Bernon, N., Idier, D., Louisor, J., Salas-y-Mélia, D. (2019) Quantifying uncertainties of sandy shoreline change projections as sea level rises. *Sci. Rep.,* **9**:42. doi: 10.1038/s41598-018-37017-4

Leydesdorff, L. & Milojević, S. (2015) *Scientometrics*. In: International Encyclopedia of the Social & Behavioral Sciences: Second Edition. 322–327.

Livingston, J., Woiwode, N., Bortman, M., McAfee, S. McLeod, K., Newkirk, S., Murdock, S. (2019) *Natural Infrastructure to Mitigate Inundation and Coastal Degradation*. In: Wright, L., Nichols, C. (eds). Tomorrow's Coasts: Complex and Impermanent. Coastal Research Library, **27**. Springer, Cham pp 167–189. doi: 10.1007/978-3-319-75453-6_11.

Luijendijk, A., Hagenaars, G., Ranasinghe, R., Baart, F., Donchyts, G., Aarninkhof, S. (2018) The State of the World's Beaches. *Sci. Rep.,* **8**:6641. doi: 10.1038/s41598-018-24630-6

Mishra, M., Chand, P., Pattnaik, N., Kattel, D.B., Panda, G.K., Mohanti, M., Baruah U.D., Chandniha, S.K., Achary, S., Mohanty, T. (2019) Response of long- to short-term changes of the Puri coastline of Odisha (India) to natural and anthropogenic factors: a remote sensing and statistical assessment. *Environ. Earth Sci.,* **78**:338. doi: 10.1007/s12665-019-8336-7

Mongeon, P. & Paul-Hus, A. (2016) The journal coverage of Web of Science and Scopus: a comparative analysis. *Scientometrics,* **106**:213–228. doi: 10.1007/s11192-015-1765-5

Moussaid, J., For a, A.A., Zourarah, B, Maanan, M., Maanan, M. (2015) Using automatic computation to analyze the rate of shoreline change on the Kenitra coast, Morocco. *Ocean Eng.,* **102**:71–77. doi: 10.1016/j.oceaneng.2015.04.044

Murali, R.M., Dhiman, R., Choudhary, R., Seelam, J.K., Ilangovan, D., Vethamony, P. (2015) Decadal shoreline assessment using remote sensing along the central Odisha coast, India. *Environ. Earth Sci.,* **74**:7201–7213. doi: 10.1007/s12665-015-4698-7

Nandi, S., Ghosh, M., Kundu, A., Dutta, D., Baksi, M. (2016) Shoreline shifting and its prediction using remote sensing and GIS techniques: a case study of Sagar Island, West Bengal (India). *J. Coast Conserv.,* **20**:61–80. doi: 10.1007/s11852-015-0418-4

Nassar, K., Fath, H., Mahmod, W.E., Masria, A., Nadaoka, K., Negm, A. (2018) Automatic detection of shoreline change: case of North Sinai coast, Egypt. *J. Coast Conserv.* **22**:1057–1083. doi: 10.1007/s11852-018-0613-1

Nassar, K., Mahmod, W.E., Fath, H., Masria, A., Nadaoka, K., Negm, A. (2019) Shoreline change detection using DSAS technique: Case of North Sinai coast, Egypt. *Marine Georesour. Geotechnol.,* **37**:81–95. doi: 10.1080/1064119X.2018.1448912

Nicholls, R.J, Woodroffe, C., Burkett, V. (2016) *Coastline degradation as an indicator of global change*. In: Climate Change. Elsevier, 309–324.

Nicholls, R.J. & Cazenave, A. (2010) Sea-level rise and its impact on coastal zones. *Science*. **328**(5985), 1517–1520. doi: 10.1126/science.1185782

Oyedotun, T.D.T. (2014) Shoreline Geometry: DSAS as a Tool for Historical Trend Analysis. *Geomorpho.l Tech.,* **2**:1–12.

Perez-Alberti, A., Pires, A., Freitas, L., Chamine, H. (2013) Shoreline change mapping along the coast of Galicia, Spain. *Proc. Inst. Civ. Eng.* **166**:125–144. doi: 10.1680/maen.2012.23

Quinn, J.D., Rosser, N.J., Murphy, W., Lawrence, J.A. (2010) Identifying the behavioral characteristics of clay cliffs using intensive monitoring and geotechnical numerical modelling. *Geomorphology*, **120**:107–122. doi: 10.1016/j.geomorph.2010.03.004

Roig-Munar, F.X., Martin-Prieto, J.A., Rodriguez-Perea, A., Pons, G.X., Gelabert, B., Mir-Gual, M. (2012) Risk Assessment of Beach-Dune System Erosion: Beach Management Impacts on the Balearic Islands. *J. Coast Res.,* **28**:1488–1499. doi: 10.2112/JCOASTRES-D-11-00187.1

Sreekesh, S., Sreerama Naik, S.R., Rani, S. (2018) Effect of Sea Level Changes on the Groundwater Quality along the Coast of Ernakulam District, Kerala. *J. Climate Change,* **4**:51–65. doi: 10.3233/JCC-1800013

Stanchev, H., Stancheva, M., Young, R., Palazov, A. (2018) Analysis of shoreline changes and cliff retreat to support Marine Spatial Planning in Shabla Municipality, Northeast Bulgaria. *Ocean Coast Manag.*, **156**:127–140. doi: 10.1016/j.ocecoaman.2017.06.011

Stavrou, A., Lawrence, J.A., Mortimore, R.N., Murphy, W. (2011) A geotechnical and GIS based method for evaluating risk exposition along coastal cliff environments: a case study of the chalk cliffs of southern England. *Nat. Hazards Earth Syst. Sci.*, **11**:2997–3011. doi: 10.5194/nhess-11-2997-2011

Sudarsana, D. & Baba, M.S. (2019) Global nuclear fuel research during 2000 to 2017: A scientometric analysis. *Ann. Libr. Inf. Stud*., **66**:85–93.

Sudarsana, D., Meenachi, N.M., Venkatesh, T. Gunta, V., Gowtham R., Sai Baba, M. (2018) Method for automatic key concepts extraction: Application to documents in the domain of nuclear reactors. *Electron. Libr.* **37**:2–15. doi: 10.1108/EL-01-2018-0012

Thébaudeau, B., Trenhaile, A.S., Edwards, R.J. (2013) Modelling the development of rocky shoreline profiles along the northern coast of Ireland. *Geomorph.* **203**:66–78. doi: 10.1016/j.geomorph.2013.03.027

Thieler, E.R., Danforth, W.W. (1994) Historical shoreline mapping. 2. Application of the digital shoreline mapping and analysis systems (DSMS DSAS) to shoreline change mapping in Puerto-Rico. *J. Coast. Res.* **10**:600–620.

Thieler, E.R., Himmelstoss, E.A., Zichichi J.L., Ergul, A. (2009) The Digital Shoreline Analysis System (DSAS) Version 4.0 – An ArcGIS extension for calculating shoreline change.

Van Eck, N.J. & Waltman, L. (2009) VOSviewer: A Computer Program for Bibliometric Mappin.

Wright, L.D., Syvitski J.P.M., Nichols, C.R., Zinnert, J. (2019) Coastal Morphodynamics and Ecosystem Dynamics. In: Wright, L., Nichols, C. (eds) Tomorrow's Coasts: Complex and Impermanent. Coastal Research Library, **27**. Springer, Cham.