LATEST EXTENDED CURRICULUM VITAE FOR PROF. (DR.) B. S. DAYA SAGAR

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Summary of Credentials of Prof. B. S. Daya Sagar

- Head, Indian Statistical Institute – Bangalore Centre, 2023-2027
- Professor (Higher Administrative Grade), Systems Science and Informatics Unit (SSIU), Indian Statistical Institute, 2022- (Basic INR 224100/-)
- Professor, Systems Science and Informatics Unit (SSIU), Indian Statistical Institute, 2013-2021
- Elected a **Fellow of the International Artificial Intelligence Industry Alliance** (FAIIA) (w.e.f April 2024)
- Elected a **Fellow of the Indian National Science Academy** (FNA) in under the Earth & Environmental Sciences Section (w.e.f Jan 2024)
- Elected a **Fellow of the Indian Academy of Sciences** (FASc) in 2022 under the Earth & Planetary Sciences (EPS) Section
- **Member of American Geophysical Union (AGU) Honors & Recognition Committee** (2022-2023)
- Author of **FOURTEEN Books or Monographs**
- Author, **Over 140 Technical Papers (90 papers in International Journals)**
- **Recipient of "IEEE GRSS Certificate of Appreciation - 2021". From the President of the IEEE GRSS**
- **Recipient of "IEEE Geoscience and Remote Sensing Society (GRSS) Distinguished lectureship Award (2020-2023)" Only Indian to Receive this prestigious Award.**
- **Recipient of "Georges Matheron Award (with Lecturership)-2011 of International Association for Mathematical Geosciences (IAMG)" Only Asian to Receive this prestigious Award.**
- **Recipient of "IAMG Certificate of Appreciation - 2018". Only Asian to receive this prestigious Award.**
- **Delivered "Frank Harary Endowment Lecture – 2019" at the ICDM-2019**
- B. S. Daya Sagar, "Mathematical Morphology in Geomorphology and GISci" (2013, ISBN-10: 1439872007, ISBN-13: 9781439872000. Pages: 546, Publisher: Chapman & Hall (Taylor & Francis Group)).
- B. S. Daya Sagar, Qiuming Cheng, and Frits Agterberg, "Handbook of Mathematical Geosciences: Fifty Years of IAMG", Springer Publishers: Cham, Switzerland, p. 942, 2018. This Handbook is officially launched on 8th September 2018 at the IAMG Golden Anniversary, Prague. Openly Accessible at https://link.springer.com/book/10.1007%2F978-3-319-78999-6, the number of downloads of this book crossed ONE Million.
- Visiting Professor, University of Trento, May 2017
- Head, Systems Science and Informatics Unit, Indian Statistical Institute
- Associate Professor, Systems Science and Informatics Unit (SSIU), Indian Statistical Institute, 2007-2013
- Associate Professor, Faculty of Engineering and Technology (FET), Multimedia (Telekom) University, Malaysia, during 2001-2007
- Grade-A Research Scientist, Centre for Remote Imaging, Sensing and Processing (CRISP), Faculty of Science, The National University of Singapore during 1998-2001
- Various Research positions at Department of Geoengineering, Centre for Remote Sensing and Information Systems, Faculty of Engineering, Andhra University during 1991-1998
- Doctor of Philosophy (PhD) from Faculty of Engineering of Andhra University, India in 1994 for a thesis entitled "Applications of mathematical morphology, remote sensing and fractal geometry to study surface water body systems".
- Life Member, IAMG
- Elected Senior Member, IEEE (Affiliated to GRSS and Computer Society)
- Founding Chairman, Bangalore Section IEEE GRSS Chapter (since 2012)
- Elected Fellow, Royal Geographical Society
- Elected Fellow, Indian Geophysical Union
- Editor-In-Chief, Springer's Encyclopedia of Mathematical Geosciences
- Editor-In-Chief, Springer's Handbook of Mathematical Geosciences: Fifty Years of IAMG
- Editorial Board Member, Mathematical Geoscience (Springer)
- Editorial Board Member, Computers & Geosciences (Elsevier)
- Editor, Discrete Dynamics in Nature and Society (Hindawi Publishers, USA)
- Associate Editor, Image Analysis & Stereology (International Stereological Society)
- Editor, Environmental Informatics-Frontiers
- Editor, ICTACT Journal of Image and Video Processing
- Associate Editor, Springer Indian Statistical Institute Series
- Guest Editor for EIGHT Special Issues of Journals: Guest Editor, Journal Mathematical Geosciences (Springer)-2001; Guest Editor, International Journal of Pattern Recognition and Artificial Intelligence (World Scientific Publishers)-2003; Guest Editor, Chaos Solitons & Fractals (Elsevier Publishers)-2004; Guest Editor for IEEE Geosciences and Remote Sensing Letters-2004; Guest Editor, International Journal of Remote Sensing (Taylor & Francis Publishers, UK)-2010; Guest Editor, IEEE Journal on Special Topics in Signal Processing-2012; Guest Editor, IEEE Journal on Selected Topics in Applied Earth Observation and Remote Sensing-2017; Guest Editor, IEEE Journal on Selected Topics in Applied Earth Observation and Remote Sensing-2020; Editor-In-Chief, Springer's Encyclopedia of Mathematical Geosciences-2018-2022.
- Technical Program Committee Member for IGARSS 2006, 2008-2021
- Advisor, 16 Doctoral (16 awarded) and over 25 Masters Thesis Students Graduated
- Presenter, Over 500 Invited Talks (for more than 1000 hours) Internationally and Nationally
- Funding, Over INR 100 Million in Research Grants
- Instructor, Over 10 Different Undergraduate and Graduate Courses
- Recipient of Krishnan Gold Medal-2002 from Indian Geophysical Union
- Recipient of Dr. S. Balakrishna Memorial Award-1995 from Andhra Pradesh Akademi of Science
- Convener for a Two-Day Conference on the theme of 'Spatial Information Retrieval Analysis, Reasoning and Modelling-2009'; a Four-Day course on "Mathematical Morphology in Image Analysis, GISci, Geomorphology-2010"; a Two-Day "Workshop Honouring Prof. Jean Serra-2010"; a Workshop on "Advanced Methods for Spatial Data Processing and Analysis-2012"; a Five-Day Course on "Spatial Statistical Tools in Data Processing and Analysis-2012"; Workshop on "Mathematical Morphology and Pattern Recognition: Theory and Applications (26-28 March 2013)"; Workshop on "Image Pattern Analysis and Applications (09-10 Nov 2013); a Two-Day Workshop on 'Spatial Data Sciences -2021 (25-26 June 2021)".

Extended Curriculum Vitae for Prof. (Dr.) B. S. Daya Sagar

Updated on 02 July 2025

1 Personal Background

1.1 Personal Data

Name	**B. S. Daya Sagar**
Preferred Name	**B. S. Daya Sagar**
Birth Date	February 24, 1967
Birth Place	Eluru, Andhra Pradesh, India
Citizenship	Indian
Permanent Resident	Canada (2009-14) (but stayed only for a month during 2009-14)
Family	married to Latha, Children: Saketh (2000), Sriniketh (2008)
Home Address	#1704, Tower – 9, Salarpuria Sattva Divinity, Pantarapalya, Nayandahalli, Bangalore – 560036, Karnataka, INDIA
Home Telephone	+91-(080)-26985505; Mobile: +91-9880893291
Home Email	bsdsagar@yahoo.co.uk
ResearcherID	http://www.researcherid.com/rid/A-2654-2012
ORCiD	http://orcid.org/0000-0002-6140-8742
Amazon Author Page	http://www.amazon.com/B.-S.-Daya-Sagar/e/B00AFD8L6M
Wikipedia Page	http://en.wikipedia.org/wiki/B._S._Daya_Sagar
IEEE - GRSS	Senior Member since 2003
IAMG Affiliation	Life Member
AGU - ESSI	Member since 2004
RGS-IGB (London)	Fellow of the Royal Geographical Society (FRGS) since 2000
IGU	Fellow of the Indian Geophysical Union (FIGU) since 2011
IASc	Fellow of the Indian Academy of Sciences (FASc) since 2022
INSA	Fellow of the Indian National Science Academy (FNA) since 2024
AIIA	Fellow of the International Artificial Intelligence Industry Alliance (FAIIA) 2024

1.2 Business Affiliation

Professor (Higher Administrative Grade, HAG)
Founding Head, Systems Science and Informatics Unit (SSIU), and
Head, Indian Statistical Institute-Bangalore Centre
8th Mile, Mysore Road, RVCE PO
Bangalore-560059, Karnataka, India
T/F: +91-(080)-26985540
Email: bsdsagar@isibang.ac.in, URL: http://www.isibang.ac.in/~bsdsagar

1.3 Education

1994 Ph.D. in Remote Sensing and Geoengineering
Thesis: *Applications of Remote Sensing, Mathematical Morphology and Fractals to Study Certain Surface Water Bodies*. Thesis Advisors: SVLN Rao and BS Prakasa Rao
Andhra University, College of Engineering, Department of Geoengineering, India,
1990 M.Sc (Tech). in Resources Development Technology, Distinction, First Class, First rank
Thesis: *Identification of Groundwater Potential Zones by Using LANDAST TM Data*
Thesis Advisor: VV Rao
Andhra University, College of Engineering, Department of Geoengineering, India,
1987 B.Sc. in Earth Science, Distinction, First Class, Third rank
Andhra University, Faculty of Science, SDS College of Arts and Applied Sciences, India

1.4 Professional Expertise

Prof. Daya Sagar's two-decade long research contributions span both basic and applied fields in mathematical morphology with emphasis in complex terrestrial geomorphologic phenomena and processes. His works provided unique contributions for the theory of mathematical morphology applied in retrieval, analysis, reasoning and modeling the spatial and/or temporal phenomena of terrestrial and GISci relevance. The key links that Prof. Sagar has shown between the following aspects–(i) pattern retrieval, (ii) pattern analysis, (iii) simulation and modeling, and (iv) spatial reasoning and their importance in understanding spatiotemporal behaviors of several terrestrial phenomena and processes–was a significant success. Recently, he developed novel methods for spatial interpolation and spatial reasoning to visualize spatiotemporal behavior, generate contiguous maps, and to identify strategically significant set(s). His work that has spurred interdisciplinary activity has implications and has yielded insights for quantitative geomorphology and spatiotemporal GISci. Sagar has made pioneering contributions to the field of geosciences, with special emphasis on development of spatial algorithms meant for geo-pattern retrieval, analysis, reasoning, modeling and visualization by using concepts of mathematical morphology and fractal geometry. These significant contributions have provided quantitative basis with insights for better understanding of spatiotemporal behavior of terrestrial phenomena and processes, and geospatial computations. These path breaking works have collectively provided an impetus to the understanding of spatio-temporal behavior of terrestrial geomorphic features and processes, and have had significant impact across remote sensing, terrestrial data analysis, quantitative geomorphology, and GISci. His work that has spurred interdisciplinary activity has implications and has yielded several insights for quantitative geomorphology and spatiotemporal GISci. His accomplishments have already been recognized (i) internationally evidenced through his selection for Georges Matheron Award-2011 (with Lectureship) of International Association for Mathematical Geosciences (IAMG), and (ii) IAMG Certificate of Appreciation Award - 2018, (iii) IEEE Geoscience and Remote Sensing Society (GRSS) Distinguished Lectureship (DL) for 2020-2024, and (iv) nationally evidenced through his selection for Krishnan Medal-2002 of Indian Geophysical Union, Dr. Balakrishna Memorial Award-1995 of A.P. Akademi of Sciences, Member of the Honors and Recognition Committee (HRC) of the American Geophysical Union (AGU) for 2022-25. He is an elected Fellow of Royal Geographical Society, Indian Academy of Sciences, Indian National Science Academy, Indian Geophysical Union. and several Fellowships.

2.1. Two-Page Brief CV of Prof. Daya Sagar, MSc, PhD, FRGS (London), SMIEEE (USA), FIGU (India), FASc, FNA, FAIIA

2.1.1. Education: B. S. Daya Sagar was educated in St Anthony School, Visakhapatnam, Government Arts College, and the Andhra University, India where he studied Earth Sciences (Shree Durga Prasad Saraf College of Arts and Applied Sciences, BSc, 1987, College of Engineering, MSc, 1991). He obtained PhD degree in 1994 from Andhra University for the thesis on *Applications of Remote Sensing, Mathematical Morphology, and Fractals to Study Certain Surface Water Bodies*.

2.1.2. Career: From 1991-2, he was a project assistant in a project 'PC-Based Image Processing System' at the Department of Geoengineering, Andhra University College of Engineering; from 1992-4, a Senior Research Fellow of the Council of Scientific and Industrial Research (CSIR); from 1994-5, a Research Associate of CSIR; from 1997-7, a Research Scientist/Principal Investigator in a Scheme for Extramural Research for Young Scientists funded by Ministry of Science and Technology; from 1998-8, a Senior Research Associate of CSIR; from 1998-2001, Gr-A Research Scientist in Centre for Remote Imaging Sensing and Processing (CRISP) in the National University of Singapore. He was appointed Associate Professor of the Faculty of Engineering and Technology at the Multimedia University, Malaysia in 2001; Deputy Chairman of the Centre for Applied Electromagnetics in 2003, serving until 2007. During 2007-13, he was an Associate Professor at the Indian Statistical Institute-Bangalore centre, and during 2009-13, he was overseeing as the Founding Head of the Systems Science and Informatics Unit at the Indian Statistical Institute-Bangalore Centre. Since 2013, he has been a Full Professor at the Indian Statistical Institute-Bangalore Centre. Since 2017, he has been a Visiting Professor at the University of Trento, Trento, Italy. In 2022, he is promoted to the Professor (HAG) position.

2.1.3. Management experience: He is actively contributing his services for managing various administrative, academic, and professional activities.

2.1.3.1. Administration: While he was working at Andhra University, he (with Prof. SVLN Rao) set-up remote sensing and digital image processing laboratories at Centre for Remote Sensing, Andhra University. As a Deputy Chairman of Centre for Applied Electromagnetics, at Multimedia University-Malaysia, he developed a group of young researchers dealing with developing algorithms for surficial mapping and terrestrial characterization. As a Founding Head of Systems Science and Informatics Unit (SSIU) that was set up in 2009 at Indian Statistical Institute, he has set up Spatial Informatics Research Group that provides a forum for researchers, engineers, and practitioners in all applications that involve spatial information. He is a member of various examination, administrative, recruitment, promotional committees and Board of Studies, and has been a course coordinator for various subjects that he taught to undergraduate students. Apart from this, he served as a member of committee on board marks normalization in India - A significant education reform to improve the inclusiveness of education in India.

2.1.3.2. Academic: He was on adjudicating panels for over fifty PhD students, and numerous Master students. He secured funding from Govt. of India, French Govt., and Malaysian Govt during 1995-2018. He designed syllabus for elective subjects. On an average he reviews 10 papers a year for scientific and technical periodicals. He has organized over 10 international conferences, workshops, tutorials, summer/winter schools on the topics related to mathematical morphology and spatial informatics. Earth Science academic associations and societies received important contributions from Sagar, and has founded Bangalore Section IEEE Geoscience and Remote Sensing Chapter in India, under which several Lectures by Distinguished Lecturers are organized. He has been actively collaborating with foreign academics and scientists, not only for nurturing young students, but also for popularizing the subjects of mathematical earth sciences and the geospatial data sciences. Ten students under his supervision have been awarded PhD degrees. He has been involved in regular teaching subjects like remote sensing, digital image processing, mathematical morphology, and Geographical Information Science–at graduate and PhD levels from 1995. He delivered lectures both in India and abroad.

2.1.3.3. Professional: He guest edited seven important special issues of journals by collaborating with eminent academics from across the globe. He has edited or co-edited seven theme issues–"*Mathematical Geosciences*", "*Quantitative Image Morphology*", "*Fractals in Geophysics*", "*Surficial Mapping*", "*Spatial Information Retrieval, Analysis, Reasoning and Modelling*", "*Filtering and Segmentation with Mathematical Morphology*", and " *Applied Earth Observation and Remote Sensing in India*"–for *Journal of Mathematical Geosciences*, *International Journal of Pattern Recognition and Artificial Intelligence*, *Chaos Solitons & Fractals*, *IEEE Geoscience and Remote Sensing Letters*, *International Journal of Remote Sensing*, *IEEE Journal on Selected Topics of Signal Processing*, and *IEEE Journal on Selected Topics of Applied Earth Observation and Remote Sensing*. He is serving as editor, associate editor, and editorial board member for reputed journals including *Discrete Dynamics in Nature and Society: Multidisciplinary Research and Review Journal*, *Computers & Geosciences*, *Image Analysis and Stereology*, *Frontiers in Environmental Informatics*, and *Journal of Mathematical Geosciences*

2.1.4. Research: Sagar has authored and / or edited eleven books, and over 110 papers, out of which 85 papers appeared in International Journals. Spatial algorithms that Prof. Daya Sagar developed based on mathematical morphology, and fractals to handle the intertwined topics–(i) pattern retrieval, (ii) pattern analysis, (iii) simulation and modelling of terrestrial phenomena and processes, (iv) spatial reasoning, and (v) visualization–to address a range of questions of importance to mathematical geosciences, remote sensing, and geographical information science were a significant success–summarized in his recent monograph "Mathematical Morphology in Geomorphology and GISci". Most salient features of his contributions on the aforementioned five intertwined topics and beyond include the following:

2.1.4.1. Terrestrial Pattern Retrieval: Prof. Sagar has developed algorithms based on nonlinear morphological transformations (a) to extract valley and ridge connectivity networks from spatial data (e.g. Digital Elevation Model (DEM)), and the distinguishing feature of these methods is that they can be generalized to heterogeneous (e.g. highly complex terrain like fluvial landscapes) and homogeneous (less complex terrain like tidal flats) data, (b) to segment spatial data into zones of influence such as watersheds, physiographic features including mountains, basins, and piedmont slopes from Digital Elevation Models (DEMs), and (c) to quantify the degree of similarity between two spatial fields, which is useful for automatically rank the possible pairs of large spatial data sets into best-pair to worst-pair, and for the spatial data classification and clustering.

2.1.4.2. Terrestrial Pattern Analysis: Applications of spatial algorithms that he developed have highlighted the (a) evidence of self-organization via scaling laws which provide excellent agreement with geomorphologic laws such as Horton's laws, Hurst exponents,

Hack's exponent, and other power-laws originally developed in a non-geoscientific context, (b) validity of his heuristically true arguments that the power-laws, which are scale-invariant, provide limited utility in understanding the geomorphologic processes, and these arguments further lead him to propose granulometric and morphologic shape decomposition based algorithms that yield scale-invariant but shape-dependent indices–which are more appropriate as what matters most in understanding spatial processes is shape–that could capture basic distinctions between topologically invariant geomorphologic basins, and (d) importance of a novel geomorphologic indicator, computed via a geodesic spectrum that provides unique one-dimensional geometric support, over the conventional width-function.

2.1.4.3. Simulation and Modelling: Algorithms to mimic the realistic spatio-temporal processes that Sagar developed by employing the bifurcation theory, fractal geometry, and nonlinear morphological transformations include (a) Fractal-Skeletal Based Channel Networks (F-SCNs) Model, as an alternate to the classic random models, generated for different shapes of fractal basins and their generalized Hortonian laws have been found to be in good accord with other established network models such as Optimal Channel Networks (OCNs) and real-world rivers, (b) modelling the geomorphologic process via morphological dilation and erosion, and their cascades through which he proposed the concept of discrete force and five laws of geomorphologic structures, (c) simulation of fractal landscapes that are geomorphologically realistic, and (d) discrete simulations based on the interplay between numeric and graphic analyses, he has shown various behavioural phases that geomorphologic systems – such as water bodies, folds, dunes, landscapes – traverse.

2.1.4.4. Spatial Reasoning: Using tools from mathematical morphology, Sagar developed efficient algorithms to (a) find 'strategically significant' spatial object(s) from a cluster of nonoverlapping spatial objects, (b) to compute origin-specific morphological dilation distances between spatial objects, which in turn can be used to determine directional spatial relationships between the spatial objects, and (c) develop modified gravity models to study the variable-specific interactions between the spatial zones for further classification in a hierarchical manner.

2.1.4.5. Visualization: The spatial algorithms that are of immense value in geographical information science, and in particular for spatiotemporal geo-visualization that he developed for (a) categorization of spatial-temporal maps via non-Euclidean metrics, (b) spatiotemporal modelling via hierarchical generation of median maps via morphological interpolations, (c) morphing a source-spatial field into a target-spatial field via hierarchical median map computations, (d) convert point-specific non-contiguous data into zonal maps through the weighted skeletonization by zones of influence (WSKIZ) transformation, and (e) generating contiguous variable-specific cartograms via WSKIZ thus solving a decade-long problem of preservation of global and local shapes of cartograms.

Prof. John Harbaugh of Stanford University in his Letter to the Editor of IAMG Newsletter highlighted the aforementioned work of Prof. Sagar– *"Today in the hinterlands, there are some mathematical geoscientists doing very original work involving applications that we'd barely thought about earlier. I'll mention one of today's pioneers, whose focus is on mathematical morphology of geological features, Daya Sagar of the Indian Statistical Institute at the Bangalore Centre. Notably he's been at it for two decades and has published a lot, including a seminal 546-page book in 2013 entitled "Mathematical Morphology in Geomorphology and GISci" that spans much of the field. Let's face it, the shapes or forms of geological objects are tantalizing, and some can be astoundingly complex. Landscapes, for example, often exhibit complex forms. Trying to describe their shapes alone can be challenging, but the greater challenge is to explain the processes and morphological forms that affect each other. Everyday features, such as stream meanders on broad floodplains, or lakes on floodplains with short lives, may be common, but they are not simple to categorize or analyze. All the while we're dealing with interdependencies between features and processes. Interdependencies are invariably accompanied by complex cyclic and chaotic behavior. So do you still want to make predictions? Take heart, though, because there are some new tools to help you, and that's where Daya's work is relevant".*

His most recent monograph on "Handbook of Mathematical Geosciences", by Springer in July 2018 has crossed the downloads of 1.13 Million. In summary, his contributions in mathematical morphology and spatial geodata sciences evidenced through his research, teaching, educational, publishing, and editorial activities, and the ways in which his expertise has been applied to a range of questions of importance to mathematical geosciences and geoinformation science has offered a unique contribution.

2.1.5. Honours and Awards: For the accomplishments evidenced through his teaching wide across the globe, internationally acclaimed books, and research contributions published in international journals related to mathematical geosciences and spatial informatics, Prof. Sagar has already received several honours and awards. He was elected as a member of the New York Academy of Sciences in 1995, a Fellow of the Royal Geographical Society in 2000, a Senior Member of IEEE Geoscience and Remote Sensing Society in 2003, a Fellow of the Indian Geophysical Union in 2011, a Fellow of the Indian Academy of Sciences (FASc) effective 2022, a Fellow of the Indian National Science Academy (FNA) effective 2024, and a Fellow of the International Artificial Intelligence Industry Alliance (FAIIA) since 2024. He is also a member of the American Geophysical Union since 2004, and a life member of the International Association for Mathematical Geosciences (IAMG) since 2006. Andhra Pradesh Academy of Sciences awarded him 'Dr. Balakrishna Memorial award in 1995 for his 'Attempt to Establish an Integrated Mathematical Approach to Study Certain Geoscientific Aspects'. He delivered the "Curzon & Co - Seshachalam Lecture - 2009" at Sarada Ranganathan Endowment Lectures (SRELS), Bangalore, and the "Frank Harary Endowment Lecture - 2019" at International Conference on Discrete Mathematics - 2019 (ICDM - 2019), held at the Christ University, Bangalore, India. He was awarded the Krishnan Medal of the Indian Geophysical Union in 2002 'for his Significant Studies in the Field of Applications of Remote Sensing, Mathematical Morphology, and Fractals to Study Certain Surface Water Bodies'. He was the only Asian conferred 'Georges Matheron Award - 2011 with Lectureship' of the IAMG for Outstanding Research Ability in the Field of Spatial Statistics or Mathematical Morphology, the Award of IAMG Certificate of Appreciation - 2018 for exceptional work on behalf of the IAMG, and the IEEE Geoscience and Remote Sensing Society (GRSS) Distinguished Lectureship (DL) for the period 2020-2024. He is also a Member of the Honors & Recognition Committee (HRC) of the American Geophysical Union (AGU) for 2022-2025.

2.2. Brief CV of Prof. Daya Sagar

Prof. B. S. Daya Sagar obtained B.Sc (majoring in Earth Sciences), M.Sc (Geoengineering), and PhD degrees from Andhra University, India respectively in the years 1987, 1990, and 1994. His PhD thesis is on Applications of remote sensing, mathematical morphology, and fractals to study certain surface water bodies. **B. S. Daya Sagar** is a full Professor of the Systems Science and Informatics Unit (SSIU) at the Indian Statistical Institute. Sagar received the M.Sc and Ph.D degrees from the Faculty of Engineering, Andhra University, Visakhapatnam, India, in 1991 and 1994 respectively. He is also the first Head of the SSIU. Earlier, he worked in College of Engineering, Andhra University, and Centre for Remote Imaging Sensing and Processing (CRISP), The National University of Singapore in various positions during 1992-2001. He served as Associate Professor and Researcher in the Faculty of Engineering & Technology (FET), Multimedia University, Malaysia during 2001-07. His research interests include mathematical morphology, GISci, digital image pro-cessing, fractals and multifractals their applications in extraction, analyses, and modeling of geophysical patterns. He has published over 85 papers in journals, and has authored and/or guest edited 14 books and/or special theme issues for journals. He recently authored a book entitled "Mathematical Morphology in Geomorphology and GISci," CRC Press: Boca Raton, 2013, p. 546. He co-edited a special issue on "Filtering and Segmentation with Mathematical Morphology" for IEEE Journal on Selected Topics in Signal Processing (v. 6, no. 7, p. 737-886, 2012). His recent book on "Handbook of Mathematical Geosciences: Fifty Years of IAMG", Springer Publishers, p. 942, 2018 crossed the downloads of 1.3 Millions. He is an elected Fellow of Royal Geographical Society (1999), Indian Geophysical Union (2011), Indian Academy of Sciences (2022), Indian National Science Academy (2024), International Artificial Intelligence Industry Alliance (2024), and was a member of New York Academy of Science during 1995-96. He received Dr. Balakrishna Memorial Award from Andhra Pradesh Akademi of Sciences in 1995, Krishnan Gold Medal from Indian Geophysical Union in 2002, and ‘Georges Matheron Award-2011 (with Lecturership)” of International Association for Mathematical Geosciences (IAMG), IAMG Certificate of Appreciation – 2018, and the IEEE Geoscience and Remote Sensing Society (GRSS) Distinguished Lectureship (DL) for the period 2020-2024. He is the Founding Chairman of Bangalore Section IEEE GRSS Chapter. He is on the Editorial Boards of Computers & Geosciences, and Frontiers: Environmental Informatics. More details about him can be seen at http://www.isibang.ac.in/~bsdsagar.

3 Publications of Prof. B. S. Daya Sagar

3.1 Books / Edited Special Issues of Journals

1. 

B. S. Daya Sagar (Ed.): For a special issue of *Journal of Mathematical Geosciences*, In memory of the Late Professor SVLN Rao. v. 33, no.3, p.245-396, 2001. (Publisher: Kluwer Academic Publishers)

2. 

B. S. Daya Sagar and C. Babu Rao (Eds.) For a special issue of *International Journal Pattern Recognition and Artificial Intelligence*. Quantitative Image Morphology. v. 17, no. 2 p. 163-330, 2003). (Publisher: World Scientific Publishers).

3. 
B. S. Daya Sagar, G. Rangarajan and Daniele Veneziano (Eds.) For a special issue of *Chaos Solitons & Fractals*, Fractals in Geophysics, v. 19, no. 2, p. 237-462, 2004 January). (Publisher: Elsevier Science).

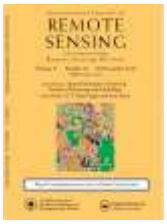
4. 

B. S. Daya Sagar (Monograph), 2005, *Qualitative models of certain discrete natural features of drainage environment*, Allied Publishers Limited , ISBN: 81-7764-446-7, p. 232.

5. 

B. S. Daya Sagar and Lori Mann Bruce (Eds.), Surficial Mapping for *IEEE Geoscience and Remote Sensing Letters* (ISSN 1545-598X). v. 2, no. 4, p. 375-408, October 2005. (Publisher: IEEE Society).

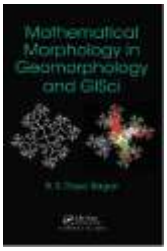
6. 
B. S. Daya Sagar (Ed.), Proceedings on "*Spatial Information Retrieval, Analysis, Reasoning and Modelling*" Seminar held during 18-20 March 2009, p. 231.

7. 

B. S. Daya Sagar and Jean Serra (Eds.), Special Issue of *International Journal of Remote Sensing*, "Spatial Information Retrieval, Analysis, Reasoning and Modelling", v. 31, no. 22, Nov, 2010, p. 5747-6032. (Publisher: Taylor & Francis).

8. 

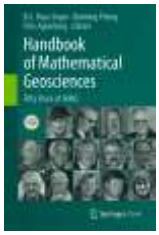
Laurent Najman, Junior Barrera, **B. S. Daya Sagar**, Petros Maragos, and Dan Schonfeld (Guest Editors). Special Issue of *IEEE Journal of Selected Topics in Signal Processing*, Filtering and Segmentation in Mathematical Morphology, v. 6, no. 7, p. 736-886, 2012. (Publisher: IEEE Society).

9. 

B. S. Daya Sagar (Monograph), "*Mathematical Morphology in Geomorphology and GISci*" 2013, (ISBN-10: 1439872007, ISBN-13: 9781439872000. Pages: 546, Publisher: Chapman & Hall (Taylor & Francis Group). Foreword and Afterword on this monograph are respectively written by Jean Serra (Founder of Mathematical Morphology) and Arthur P Cracknell (Co-Editor-In-Chief of International Journal of Remote Sensing). Several other pioneering scientists and academicians have written quotes (see the Appendix in page. 31) on this book.

10. 

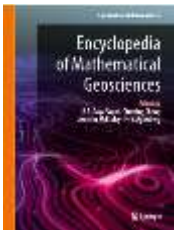
Avik Bhattacharya, Lorenzo Bruzzone, **B. S. Daya Sagar**, and Paul Rosen (Guest Editors). Special Issue on *Applied Earth Observation and Remote Sensing in India*, *IEEE Journal of Selected Topics in Applied Earth Observation and Remote Sensing*, v. 10, no. 12, p. 5150, 2017. (Publisher: IEEE Society).

11. 

B. S. Daya Sagar, Qiuming Cheng, and Frits Agterberg (Editors), *Handbook of Mathematical Geosciences: Fifty Years of IAMG*, Springer Publishers, Cham, Switzerland, P. 942, 2018

12. **IEEE JSTARS SPI**

B. S. Daya Sagar, Jon Atli Benediktsson, Lorenzo Bruzzone, and Jocelyn Chanussotand (Guest Editors). Special Issue on *Mathematical Morphology in Geoscience and Remote Sensing*, *IEEE Journal of Selected Topics in Applied Earth Observation and Remote Sensing*, (scheduled for release in 2021. (Publisher: IEEE Society).

13. 

B. S. Daya Sagar, Qiuming Cheng, Jennifer McKinley, Frits Agterberg (Editors), Encyclopedia of Mathematical Geosciences, Springer International Publishers, Cham. Print Version is Published in Two Volumes on 21 June 2023, pages 1756.

14. **CRC Press Book**

B. S. Daya Sagar, 2023, Mathematical Morphology in Digital Elevation Models, CRC Press (Taylor & Francis Group), A Chapman & Hall Book, Boca Raton, Florida, USA.

3.2. Refereed Journal Papers (in Reverse Chronological Order)

1. **B. S. Daya Sagar** and Frits Agterberg, 2025, Two Decades of Georges Matheron Award Lecture of the IAMG, Historical Note, *Mathematical Geosciences*, v. 57, no. 5, p. 1-11. https://doi.org/10.1007/s11004-025-10199-0
2. Geetika Barman and **B. S. Daya Sagar**, 2025, A New Approach to Compute Pixel Vector Based Morphological Profile for Classification of Hyperspectral Image, *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, (In Press), DOI: 10.1109/JSTARS.2025.3561007
3. Lim Sin Liang, Jaya Sreevalsan-Nair, **B. S. Daya Sagar**, 2024, "Multispectral Data Mining: A Focus on Remote Sensing Satellite Images", *WIREs Data Mining and Knowledge Discovery*, e1522, http://doi.org/10.1002/widm.1522
4. Geetika Barman and **B.S Daya Sagar**, Generation of High Spatial Resolution Terrestrial Surface from Low Spatial Resolution Elevation Contour Maps via Hierarchical Computation of Median Elevation Regions, *IEEE Transactions on Geoscience and Remote Sensing*, v. 61, p. 1-11, 2023. doi: 10.1109/TGRS.2023.3335120
5. S. Soor and **B. S. Daya Sagar,** 2022. Segmentation of Multi-Band Images Using Watershed Arcs, *IEEE Signal Processing Letters*. v. 29, p. 2407-2411. DOI: 10.1109/LSP.2022.3223625
6. K. Nagajothi, Sravan Danda, Aditya Challa, and **B. S. Daya Sagar,** A Theoretical Analysis of Granulometry-based Roughness Measures on Cartosat DEMs, *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing.* vol. 15, pp. 2836-2844, 2022. doi: 10.1109/JSTARS.2022.3161667.
7. Aditya Challa, Sravan Danda, **B.S.Daya Sagar**, and Laurent Najman, 2022, Triplet-Watershed for Hyperspectral Image Classification, *IEEE Transactions on Geoscience and Remote Sensing*, v. 60, pp. 1-14, 2022, Art no. 5515014, doi: 10.1109/TGRS.2021.3113721.
8. Aditya Challa, Geetika Barman, Sravan Danda and **B. S. Daya Sagar**, 2022, Band Selection Using Dilation Distances, *IEEE Geoscience and Remote Sensing Letters*, v. 19, pp. 1-5, 2022, Art no. 5503705, doi: 10.1109/LGRS.2021.3057117.
9. Sravan Danda, Aditya Challa, **B.S.Daya Sagar**, and Laurent Najman, 2022, A Tutorial on Applications of Power Watershed Optimization to Image Processing, *European Physical Journal Special Topics*, v. 230, p.2337–2361 (2021). DOI: 10.1140/epjs/s11734-021-00264-0
10. Rajesh Gogineni, Ashvini Chaturvedi, and **B. S. Daya Sagar**, 2021, A Variational Pan-sharpening Algorithm to Enhance the Spectral and Spatial Details, *International Journal of Image and Data Fusion*, v. 12, no.3, pp. 242-264, 10.1080/19479832.2020.1838629.
11. K. Nagajothi, H. M. Rajasekhara, and **B. S. Daya Sagar**, 2021, Universal Fractal Scaling Laws for Surface Water Bodies and Their Zones of Influence, *IEEE Geoscience and Remote Sensing Letters*, v. 18, no. 5, 2021, pp. 781-785. 10.1109/LGRS.2020.2988119
12. Sampriti Soor, Aditya Challa, Sravan Danda, **B. S. Daya Sagar**, and Laurent Najman, 2021, Iterated Watershed : Connected Variation of K-Means for Clustering GIS Data, *IEEE Transactions on Emerging Topics in Computing*, v. 9, no. 2, pp. 2020 DOI: 10.1109/TETC.2019.2910147.
13. **B. S. Daya Sagar**, DEM an Important Source of Data for Geoscientists, *IEEE Geoscience and Remote Sensing Magazine*, v. 8, no. 4, pp. 138-142, 2020.
14. Aditya Challa, Sravan Danda, **B. S. Daya Sagar**, and Laurent Najman, Power Spectral Clustering, *Journal of Mathematical Imaging and Vision*, v. 62, no. 9, p. 1195–1213, 2020.
15. K. Nagajothi and **B. S. Daya Sagar**, Classification of Geophysical Basins Derived From SRTM and Cartosat DEMs via Directional Granulometries, *IEEE Journal on Selected Topics on Applied Earth Observation and Remote Sensing*, v. 12, no. 12, p. 5259-5267, 2019.
16. Aditya Challa, Sravan Danda, **B. S. Daya Sagar** and Laurent Najman, Watersheds for Supervised Classification, *IEEE Signal Processing Letters*, v. 26, no. 5, p. 720-724, 2019.
17. Sravan Danda, Aditya Challa, **B. S. Daya Sagar**, and Laurent Najman, Revisiting the Isoperimetric Graph Partitioning Problem, *IEEE Access*, v. 7, no. 1, p. 50636-50649, 2019.
18. **B. S. Daya Sagar,** Variable-Specific classification of zones, pairs of zones, and clusters of a spatial system via modified gravity model, *IEEE Transactions on Emerging Topics in Computing*, v.7, no. 2, p. 230-241, 2019.
19. Sravan Danda, Aditya Challa, **B. S. Daya Sagar**, and Laurent Najman, 2019, Some Theoretical Links Between Shortest Path Filters and Minimum Spanning Tree Filters, *Journal of Mathematical Imaging and Vision*, v. 61, p.745-762, 2019.

20. Challa, A., Danda, S., **B. S. Daya Sagar** and Najman, L.: Some Properties of Interpolations Using Mathematical Morphology, *IEEE Transactions on Image Processing*, v. 27, no. 4, 2038-2048, 2018.
21. Ranjeet Kumar Rout, Pabitra Pal Choudhury, Santi Prasad Maity, **B. S. Daya Sagar** and Sk. Sarif Hassan, Fractal and mathematical morphology in intricate comparison between tertiary protein structures, *Computer Methods in Biomechanics and Biomedical Engineering: Imaging & Visualization*, v. 6, no. 2, 12 pages, 2018. DOI: 10.1080/21681163.2016.1214850
22. Ginde, G., Saha, Mathur, A. S., Venkatagiri, S., Vadakkepat, S., Narasimhamurthy, A., and **B. S. Daya Sagar**, ScientoBASE: a framework and model for computing scholastic indicators of nonlocal influence of journals via native data acquisition algorithm, *Scientometrics*, 108, **3**, 1479–1529, 2016. DOI: 10.1007/s11192-016-2006-2.
23. **B. S. Daya Sagar** and Lim, S. L.: Morphing of grayscale DEMs via morphological interpolations, *IEEE Journal on Selected Topics on Applied Earth Observation and Remote Sensing*, 8, **11**, 5190-5198, 2015.
24. **B. S. Daya Sagar** and Lim, S. L.: Ranks for pairs of spatial fields via metric based on grayscale morphological distances, *IEEE Transactions on Image Processing*, 24, **3**, 908-918, 2015.
25. Hassan, S.S., Choudhury, P. P., **B. S. Daya Sagar**, Chakraborty, S., Guha, R., and Goswami, A.: Quantitative description of genomic evolution of olfactory receptors, *Asian-European Journal of Mathematics*, 8, **3**, 1550043 (14 pages), 2015.
26. Sharma, R., and **B. S. Daya Sagar**, Mathematical morphology based characterization of binary image, *Image Analysis & Stereology*, 34, 2, 111-123, 2015.
27. **B. S. Daya Sagar**, Cartograms via mathematical morphology, *Information Visualization*, 13, **1**, 42-48, 2014.
28. **B. S. Daya Sagar**, Erratum to "Visualization of Spatiotemporal Behavior of Discrete Maps via Generation of Recursive Median Elements", *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 36, **3**, 2014.
29. Vardhan, S. A., **B. S. Daya Sagar**, Rajesh, N., and Rajashekara, H. M., Automatic detection of orientation of mapped units via directional granulometric analysis, *IEEE Geoscience and Remote Sensing Letters*, 10, **6**, 1449-1453, 2013.
30. **B. S. Daya Sagar**, Rajesh, N., Vardhan, S. A., and Vardhan, P.: Metric based on morphological dilation for the detection of spatially significant zones, *IEEE Geoscience and Remote Sensing Letters*, 10, **3**, 500-504, 2013.
31. Najman, L., Barrera, J., **B. S. Daya Sagar**, Maragos, P., and Schonfeld, D.: Introduction to the issue on filtering and segmentation with mathematical morphology, *IEEE Journal of Selected Topics in Signal Processing*, 6, **7**, 737-738, 2012.
32. Rajashekara, H. M., `Vardhan, P.,` and **B. S. Daya Sagar**, Generation of zonal map from point data via weighted skeletonization by influence zone, *IEEE Geoscience and Remote Sensing Letters*, 9, **3**, 403-407, 2012.
33. **B. S. Daya Sagar**, 2010, Visualization of spatiotemporal behavior of discrete maps via generation of recursive median elements, *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 32, no. 2, p. 378-384.
34. Lim Sin Liang, Voon Chet Koo, and **B. S. Daya Sagar**, 2009, Computation of complexity measures of morphologically significant zones decomposed from binary fractal sets via multiscale convexity analysis, Chaos, Solitons & Fractals, 10.1016/j.chaos.2008.05.006.
35. Lim Sin Liang, and **B. S. Daya Sagar**, 2008, Derivation of geodesic flow fields and spectrum in digital topographic basins, Discrete Dynamics in Nature and Society. Volume 2008 (2008), Article ID 312870, 26 pages, doi:10.1155/2008/312870.
36. Lim Sin Liang and **B. S. Daya Sagar**, 2008, Cloud field segmentation via multiscale convexity analysis, Journal Geophysical Research-Atmospheres, 113, D13208, doi:10.1029/2007JD009369.
37. **B. S. Daya Sagar**, 2007, Universal scaling laws in surface water bodies and their zones of influence, Water Resources Research., v. 43, no. 2, W02416, 2007.
38. Lea Tien Tay, **B. S. Daya Sagar** and Hean Teik Chuah, 2007, Granulometric analysis of basin-wise DEMs: a comparative study, International Journal of Remote Sensing, 28, 15.
39. Sathymoorthy. D., P. Radhakrishnan, and **B. S. Daya Sagar**, 2007, Morphological segmentation of physiographic features from DEM, International Journal of Remote Sensing, v. 28, no. 15.
40. Alan W. C. Tan, M. V. C. Rao, and **B. S. Daya Sagar**, 2007, A signal subspace approach for speech modeling and classification, Signal Processing, v. 87, p. 500-508.
41. Alan W. C. Tan, M. V. C. Rao and **B. S. Daya Sagar**, 2007, A discriminative signal subspace speech classifier, IEEE Signal Processing Letters, v. 14, no. 2, p. 133-136.
42. Alan W. C. Tan, M. V. C. Rao and **B. S. Daya Sagar**, 2007, Robust signal subspace speech classifier, IEEE Signal Processing Letters, DOI:10.1109/LSP.2007.900036, v. 14, no. 11, p. 844-847.

43. Alan W. C. Tan, M. V. C. Rao and **B. S. Daya Sagar**, 2007, A composite signal subspace speech classifier, Signal Processing, v. 87, no. 11, p. 2600-2606.
44. Lea Tien Tay, **B. S. Daya Sagar** and Hean Teik Chuah, Allometric relationships between travel-time channel networks, convex hulls, and convexity measures, Water Resources Research, v. 46, no.2, W06502,10.1029/2005WR004092.
45. Teo Lay Lian and **B. S. Daya Sagar**, Modeling, Characterization of Pore-channel, throat and body, Discrete Dynamics in Nature and Society, v. 2006, Article ID 89280, p. 1-24.
46. **B. S. Daya Sagar**, 2005, Discrete simulations of spatio-temporal dynamics of small water bodies under varied streamflow discharges, (invited paper), Nonlinear Processes in Geophysics, v. 12, 31-40.
47. Lea Tien Tay, **B. S. Daya Sagar** and Chuah Hein Teik, 2005, Analysis of geophysical networks derived from multiscale digital elevation models: a morphological approach, I.E.E.E Geoscience and Remote Sensing Letters. v. 2, no. 4, p. 399-403.
48. Lea Tien Tay, **B. S. Daya Sagar** and Chuah Hein Teik, 2005, Derivation of terrain roughness indicators via Granulometries, International Journal of Remote Sensing, v. 26, no. 18, p. 3901-3910.
49. L. Chockalingam and **B. S. Daya Sagar**, 2005, Morphometry of networks and non-network spaces, Journal of Geophysical Research-Solid Earth, v. 110, B08203, doi:10.1029/2005JB003641.
50. Teo Lay Lian and **B. S. Daya Sagar**, 2005, Reconstruction of pore space from pore connectivity network via morphological transformations, Journal of Microscopy (Oxford), v. 219, Pt 2, p. 76-85.
51. P. Radhakrishnan, **B. S. Daya Sagar** and B. Venkatesh, 2005, Morphological image analysis of transmission systems, IEEE Transactions of Power Delivery, v. 20, no. 1, p. 219-223.
52. **B. S. Daya Sagar** and Tay Lea Tien, 2004, Allometric power-law relationships in a Hortonian Fractal DEM, Geophysical Research Letters, v. 31, no. 6, L06501.
53. **B. S. Daya Sagar** and L. Chockalingam, 2004, Fractal dimension of non-network space of a catchment basin Geophysical Research Letters, v.31, no.12, L12502.
54. P. Radhakrishnan, Teo Lay Lian and **B. S. Daya Sagar**, 2004, Estimation of fractal dimension through morphological decomposition, Chaos Solitons & Fractals, v 21, no. 3, p. 563-572.
55. Lay Lian Teo, P. Radhakrishnan and **B. S. Daya Sagar**, 2004, Morphological Decomposition of Sandstone Pore-Space: Fractal Power-Laws, Chaos Solitons & Fractals.
56. S Gunasekaran, B Venkatesh and **B. S. Daya Sagar**, 2004, Fractal Characterization of BPN Weights Evolution, International Journal of Neural Systems, v. 14, no. 2 (2004).
57. **B. S. Daya Sagar**, M. B. R. Murthy, C. Babu Rao and Baldev Raj, 2003, Morphological approach to extract ridge-valley connectivity networks from Digital Elevation Models (DEMs), International Journal of Remote Sensing, V. 24, No. 3, 573 – 581.
58. L. Chockalingam and **B. S. Daya Sagar**, 2003, Automatic generation of sub-watershed map from Digital Elevation Model: a morphological approach, International Journal of Pattern Recognition and Artificial Intelligence, v. 17, no. 2. p. 269-274.
59. **B. S. Daya Sagar**, M. B. R. Murthy, and P. Radhakrishnan, 2003, Avalanches in numerically simulated sand dune dynamics, Fractals, v. 11, no. 2, p. 183-193.
60. S. Gunasekaran, B. Venkatesh, and **B. S. Daya Sagar**, 2003, Convergence index for BPN training, Neurocomputing, v. 55, p. 711-719.
61. **B. S. Daya Sagar**, C. Babu Rao and Baldev Raj, 2002, Is the spatial organization of larger water bodies heterogeneous?, International Journal of Remote Sensing, v. 23, no. 3, p. 503-509.
62. **B. S. Daya Sagar**, 2001, Generation of self organized critical connectivity network map (SOCCNM) of randomly situated surface water bodies, Letters to Editor, Discrete Dynamics in Nature and Society, v. 6, no. 3, p. 225-228.
63. **B. S. Daya Sagar**, 2001, Quantitative spatial analysis of randomly situated surface water bodies through f-□ spectra, Discrete Dynamics in Nature and Society, v. 6, no. 3, p. 213-217.
64. **B. S. Daya Sagar**, D. Srinivas, B. S. Parakasa Rao, 2001, Fractal skeletal based channel networks in a triangular initiator basin, Fractals, v. 9, no. 4. p. 429-437.
65. **B. S. Daya Sagar** and M. Venu, 2001, Phase space maps of a simulated sand dune: a scope, Discrete Dynamics in Nature and Society, v. 6, no.1. p. 63-65.
66. **B. S. Daya Sagar**, 2001, Hypothetical laws while dealing with effect by cause in discrete space, Letter to the Editor, Discrete Dynamics in Nature and Society, v. 6, no.1. p. 67-68.

67. **B. S. Daya Sagar**, 2000, Fractal relation of medial axis length to the water body area, Discrete Dynamics in Nature and Society, v. 4, no.1. p.97.
68. **B. S. Daya Sagar**, M. Venu and D. Srinivas, 2000, Morphological operators to extract channel networks from Digital Elevation Models, International Journal of Remote Sensing. v. 21, no. 1, p. 21-30.
69. **B. S. Daya Sagar** and K S R Murthy, 2000, Generation of fractal landscape using nonlinear mathematical morphological transformations, Fractals, v. 8, no. 3, p.267-272.
70. **B. S. Daya Sagar**, 2000, Multi-fractal-interslipface angle curves of a morphologically simulated sand dune, Discrete Dynamics in Nature and Society, v. 5, no. 2, p. 71-74.
71. **B. S. Daya Sagar**, 1999, Estimation of number-area-frequency dimensions of surface water bodies, International Journal of Remote Sensing, v. 20, no. 13, p.2491-2496.
72. **B. S. Daya Sagar**, M. Venu, and K. S. R. Murthy, 1999, Do skeletal network derived from water bodies follow Horton's laws?, Journal Mathematical Geology, v. 31, no. 2, p.143-154.
73. **B. S. Daya Sagar**, 1999, Morphological evolution of a pyramidal sandpile through bifurcation theory: a qualitative model, Chaos, Solitons & Fractals. v.10 no 9. p. 1559-1566.
74. **B. S. Daya Sagar**, Charles Omoregie, and B. S. Prakasa Rao, 1998, Morphometric relations of fractal-skeletal based channel network model, Discrete Dynamics in Nature and Society, v. 2, no. 2, p. 77-92.
75. **B. S. Daya Sagar**, M. Venu, G. Gandhi, and D. Srinivas, 1998, Morphological description and interrelationship between force and structure: a scope to geomorphic evolution process modelling, International Journal of Remote Sensing, v. 19, no. 7, p. 1341-1358.
76. **B. S. Daya Sagar**, 1998, Numerical simulations through first order nonlinear difference equation to study highly ductile symmetric fold (HDSF) dynamics: a conceptual study, Discrete Dynamics in Nature and Society, v. 2 no. 4, p. 281-298.
77. **B. S. Daya Sagar**, 1996, Fractal relations of a morphological skeleton, Chaos, Solitons & Fractals, v. 7, no. 11, p. 1871-1879.
78. **B. S. Daya Sagar**, G. Gandhi and B S Prakasa Rao, 1995, Applications of mathematical morphology on water body studies, International Journal of Remote Sensing, v 16, no.8. p. 1495-1502.
79. **B. S. Daya Sagar**, M. Venu and B S Prakasa Rao, 1995, Distributions of surface water bodies, International Journal of Remote Sensing, v. 16. no. 16, p.3059-3067.
80. **B. S. Daya Sagar** and B S Prakasa Rao, 1995, Ranking of Lakes: Logistic maps, International Journal of Remote Sensing, v. 16, no. 2, p. 368-371.
81. **B. S. Daya Sagar** and B S Prakasa Rao, 1995, Fractal relation on perimeter to the water body area, Current Science, v. 68, no. 11, p. 1129-1130.
82. **B. S. Daya Sagar** and B S Prakasa Rao, 1995, Possibility on usage of return maps to study dynamics of lakes : Hypothetical approach, Current Science, v. 68, no. 9, p. 950-954.
83. **B. S. Daya Sagar** and B. S. Prakasa Rao, 1995, Computation of strength of nonlinearity in Lakes, letter to the editor, Computers & Geosciences, v. 21, no. 3, p. 445.

3.3. Journal Editorials/Items about Individuals

84. **B. S. Daya Sagar**, 2001, "Introduction on the special issue in memory of Professor SVLN Rao", *Journal Mathematical Geology*, v. 33, no. 3, p. 245-247.
85. **B. S. Daya Sagar**, 2001, "Biographic information of Professor SVLN Rao", *Journal Mathematical Geology*, v. 33, no. 3, p. 249-250.
86. **B. S. Daya Sagar** and C. Babu Rao, 2003, Editorial on "Quantitative Image Morphology", *International Journal of Pattern Recognition and Artificial Intelligence*, v. 17, no. 2, p.163-165.
87. **B. S. Daya Sagar**, G. Rangarajan, and D. Veneziano, 2004, Introduction to "Fractals in Geophysics", *Chaos Solitons & Fractals*, v. 19, no. 2, p. 237-239.
88. **B. S. Daya Sagar**, and J. Serra, 2010, Preface: Spatial Information Retrieval, Analysis, Reasoning and Modelling, *International Journal of Remote Sensing*, v. 31, no. 22, p.5747-5750.
89. Laurent Najman, Junior Barrera, **B. S. Daya Sagar**, Petros Maragos, and Dan Schonfeld, 2012, Introduction to the Issue on Filtering and Segmentation with Mathematical Morphology IEEE Journal of Selected Topics in Signal Processing, v. 6, no. 7, p. 737-738.
90. **B. S. Daya Sagar** and Saroj Kumar Meher, 2013, Bangalore Section Chapter of the GRSS, IEEE Geoscience and Remote Sensing Magazine, v. 1, no. 2, p. 72-73. DOI: 10.1109/MGRS.2013.2260918.

91. Avik Bhattacharya, Lorenzo Bruzzone, **B. S. Daya Sagar**, Paul A. Rosen, 2017, Foreword to the Special Issue on "Applied Earth Observation and Remote Sensing in India", *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, v. 10, no. 12, p. 5151-5154.
92. H. Sarma, A. Frery, N. Rama Rao, **B. S. Daya Sagar**, International Conference on Machine Intelligence for GeoAnalytics and Remote Sensing (MIGARS)2023 – A Brief Report, 2023, *IEEE Geoscience and Remote Sensing Magazine*, (In Press). doi: 10.1109/MGRS.2023.3334554

3.4. Book Reviews

93. **B. S. Daya Sagar**, 2001, (book review) Computer Processing of Remotely-Sensed Images, An Introduction, Second Edition, by Paul M. Mather, John Wiley & Sons, 1999, 292 pp. for Computers & Geoscience, v.27, no. 2, p. 251-251.
94. **B. S. Daya Sagar**, 2001, (book review) Fractals and chaos in geology and geophysics, Second Edition, by Donald L Turcotte, Cambridge University Press, 1997, Mathematical Geology, v. 33, no. 2, p. 239-240.
95. **B. S. Daya Sagar**, 2002, (book review) GIS and Geocomputation, 1st Edition, by Peter M Atkinson and David Martin, Taylor & Francis, 2000, Computers & Geoscience, v. 28, no. 1, p. 87.
96. **B. S. Daya Sagar** and Lea Tien Tay, 2005, (book review) GIS – A computing perspective, Second Edition, by Michael Worboys and Matt Duckhem, 2004. The Photogrammetric Record, 20 (112), p. 397-398.

3.5. Chapters in Books

97. B. S. Daya Sagar, 2018, Mathematical Morphology in Geosciences and GISci: An Illustrative Review. In: Daya Sagar B., Cheng Q., Agterberg F. (eds) Handbook of Mathematical Geosciences. Springer, Cham, p. 703-740, 2018
98. Jain, V., Guha, S., Sagar, B.S.D. (2022). Quantitative Geomorphology. In: Daya Sagar, B.S., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_27-1
99. Daya Sagar, B.S., Kumar, D.A. (2022). Structuring Element. In: Daya Sagar, B.S., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_321-1
100. Sagar, B.S.D., Kumar, D.A. (2022). Thickening. In: Daya Sagar, B.S., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_326-1
101. Sagar, B.S.D., Kumar, D.A. (2022). Thickening. In: Daya Sagar, B.S., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_326-1
102. Sagar, B.S.D. (2022). Korvin, Gabor. In: Daya Sagar, B.S., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_368-2
103. Danda, S., Challa, A., Sagar, B.S.D. (2021). Morphological Opening. In: Daya Sagar, B., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_214-1
104. Challa, A., Danda, S., Sagar, B.S.D. (2022). Morphological Erosion. In: Daya Sagar, B.S., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_213-1
105. Danda, S., Challa, A., Sagar, B.S.D. (2021). Morphological Dilation. In: Daya Sagar, B., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_212-1
106. Panda, R.M., Daya Sagar, B.S. (2022). Decision Tree. In: Daya Sagar, B.S., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_81-2
107. Challa, A., Danda, S., Daya Sagar, B.S. (2022). Morphological Closing. In: Daya Sagar, B.S., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_211-1
108. Sagar, B.S.D. (2022). Goodchild, Michael F.. In: Daya Sagar, B.S., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_386-1

109. Danda, S., Challa, A., Sagar, B.S.D. (2022). Cumulative Probability Plot. In: Daya Sagar, B.S., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_71-1
110. Danda, S., Challa, A., Daya Sagar, B.S. (2021). Binary Partition Tree. In: Daya Sagar, B., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_54-1
111. Quiros-Vargas, J. et al. (2022). Fractal Geometry and the Downscaling of Sun-Induced Chlorophyll Fluorescence Imagery. In: Daya Sagar, B., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_120-1
112. Challa, A., Danda, S., Sagar, B.S.D. (2021). Binary Mathematical Morphology. In: Daya Sagar, B., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_53-1
113. Panda, R.M., Sagar, B.S.D. (2022). Data Acquisition. In: Daya Sagar, B.S., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_73-2
114. Panda, R.M., Daya Sagar, B.S. (2022). Database Management System. In: Daya Sagar, B.S., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_80-1
115. Samiappan, S., Panda, R.M., Sagar, B.S.D. (2022). Z-Transform. In: Daya Sagar, B.S., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_355-1
116. Danda, S., Challa, A., Sagar, B.S.D. (2022). Grayscale Mathematical Morphology. In: Daya Sagar, B.S., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_151-2
117. Sagar, B.S.D. (2021). Rodriguez-Iturbe, Ignacio. In: Daya Sagar, B., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_394-1
118. Lim, S.L., Sagar, B.S.D. (2022). Morphological Pruning. In: Daya Sagar, B., Cheng, Q., McKinley, J., Agterberg, F. (eds) Encyclopedia of Mathematical Geosciences. Encyclopedia of Earth Sciences Series. Springer, Cham. https://doi.org/10.1007/978-3-030-26050-7_215-1

3.6. Conference Proceedings Publications / Book Chapters

119. B. S. Prakasa Rao, P. Mruthyunjaya Rao and B. S. Daya Sagar, Development of methodology for location of percolation tanks – A case study, National Workshop on percolation ponds, held in Madras, December, 1991.
120. S. V. L. N Rao, B. S. Daya Sagar and B. S. Prakasa Rao, 1991. Morphologic changes of Minor river courses of Visakhapatnam district as revealed by topographic and remotely sensed data. Proceedings of National seminar on Applications of Remote Sensing for Agriculture and Rural Development. Organized by IIM, Ahmedabad and Computer Society of India, Ahmadabad, 22nd – 24th February, 1991.
121. B. S. Daya Sagar and B. S. Prakasa Rao, 1992. "Sources of Shape variations in surface water bodies: fractal Analysis", paper communicated to International space year conference on Spectral sensing research", Hawaii, USA, 16th – 20th November, 1992.
122. B. S. Daya Sagar and B. S. Prakasa Rao, 1992. "Applications of Morphological statistical methods in evaluations of sources of water body shape variations in different geological terrains" Published in the proceedings in 6th Australia Asian Remote Sensing Conference, Wellington, New Zealand, 2nd – 6th November, 1992.
123. B. S. Daya Sagar and B. S. Prakasa Rao, 1992. "Study of water body shape analysis using Mathematical Morphological methods", Published in the proceedings of VIII APD congress on Hydraulic research, Pune, 2-th – 23rd October, 1992.
124. B. S. Daya Sagar J. Kiran Kumar and B. S. Prakasa Rao, 1992. "Integrated topographic and Remotely sensed data for effective water potential zone identification. International conference on Remote Sensing and GIS (ICORG), 26th – 28th February, 1992.
125. B. S. Daya Sagar, J. Kiran Kumar and B. S. Prakasa Rao, 1993. "Quantitative hydrogeomorphometric Analysis using remote sensing techniques". International conference on Man and Environment ICOMAN was held on 23rd & 24th October, 1993.

126. B. S. Daya Sagar and B. S. Prakasa Rao, 1997. Characterization of Natural Water bodies through fractals, International Conference on Remote Sensing and GIS, held on 18th to 20th June, 1997 at Hyderabad.
127. B. S. Daya Sagar and B. S. Prakasa Rao, 1997. Fractal structures, Morphological solutions: fractal relations, International Conference on Remote Sensing and GIS held on 18th to 20th June, 1997 at Hyderabad.
128. B. S. Daya Sagar and B. S. Prakasa Rao, 1998. National conference on Nellore Schist Belt, National Conference on Major Bridges, Green Park, Visakhapatnam, January, 1998.
129. B. S. Daya Sagar, and K. S. R. Murthy, Automatic measurement of basin outline forms, presented at VIII APD-IAHR congress organized at the Central Water and Power Research Station, Pune, 1992. Proceeding of CWPRS Conference.
130. B. S. Daya Sagar, and B. S. Prakasa Rao, Basic measure computations of surface water bodies, presented at VIII APD-IAHR congress organized at the Central Water and Power Research Station, Pune, 1992. Proceeding of CWPRS Conference.
131. B. S. Daya Sagar and B. S. Prakasa Rao, Studies on Railway Track Disaster using IRS 1a data, Paper presented at the National conference on the Impact of May 1990 Cyclone. This work has been published subsequently in a book as a chapter.
132. Charles Omoregie and B. S. Daya Sagar, Federal GIS use for resource management (SPIE Proceedings Paper), Proceedings of SPIE Volume: 1943, 1993.
133. M. Venu, T. C. M. Rao, B. S. Prakasa Rao and B. S. D. Sagar, Texture characterization: morphological approach, Proc. SPIE, Vol. 2055, 512 (1993); doi:10.1117/12.150165
134. B. S. Daya Sagar and B. S. Prakasa Rao, Usage of fractals in drainage environment (SPIE Proceedings Paper), DOI: 10.1117/12.157167, 1993.
135. T. L. Lian, and B. S. Daya Sagar, Fractal analysis of multiscale pore connectivity networks, in: Image and Signal Processing and Analysis, 2003. ISPA 2003. Proceedings of the 3rd International Symposium, 2003, Volume: 2, p. 686- 689.
136. N.A.B.A. Aziz, A. W. Mohemmed, B. S. Daya Sagar, 2007, Particle Swarm Optimization and Voronoi diagram for Wireless Sensor Networks coverage optimization, International Conference on Intelligent and Advanced Systems, 2007. ICIAS 2007. 25-28 Nov. 2007, Page(s): 961 - 965. DOI: 10.1109/ICIAS.2007.4658528.
137. Raghvendra Sharma and B. S. Daya Sagar, 2014, Fractal Characterization via Morphological Analysis, IAMG Conference Proceedings, 17-20 October 2014, New Delhi.
138. H. M. Rajashekara, S. Ashok Vardhan, and B. S. Daya Sagar, 2014, Computations of Bi-Variable Spatial Relationships Between the Political Divisions of Karnataka, India via Mahalanobis Distance, IGARSS-2015 Proceedings, 26-31 July 2015, Milan, Italy.
139. Sravan Danda, Aditya Challa, B. S. Daya Sagar, 2016, A morphology-based approach for cloud detection, IEEE International Geoscience and Remote Sensing Symposium (IGARSS) 2016 Pages: 80 -83, DOI: 10.1109/IGARSS.2016.7729011
140. Aditya Challa, Sravan Danda, B. S. Daya Sagar, 2016, Morphological interpolation for temporal changes, IEEE International Geoscience and Remote Sensing Symposium (IGARSS) 2016 Pages: 3358 - 3361, DOI: 10.1109/IGARSS.2016.7729868
141. Sravan Danda, Aditya Challa, B.S. Daya Sagar, Laurent Najman, 2017, Power Tree Filter: A Theoretical Framework Linking Shortest Path Filters and Minimum Spanning Tree Filters, Mathematical Morphology and Its Applications to Signal and Image Processing Pages: 12 pages, DOI: 10.1007/978-3-319-57240-6_16
142. Aditya Challa, Sravan Danda, B.S. Daya Sagar, and Laurent Najman, 2017, An Introduction to Gamma-Convergence for Spectral Clustering, DGCI 2017 Volume: LNCS 10502 Pages: 12 Pages, DOI: 10.1007/978-3-319-66272-5_16
143. G. Barman and B. S. Daya Sagar, "A New Approach to Compute Vector Based Morphological Features for Classification of Hyperspectral Image," 2023 IEEE India Geoscience and Remote Sensing Symposium (InGARSS), Bangalore, India, 2023, pp. 1-4, doi: 10.1109/InGARSS59135.2023.10490362.
144. S. Soor, A. Challa, S. Danda, B. S. Daya Sagar and L. Najman, "Extending K-Means to Preserve Spatial Connectivity," IGARSS 2018 - 2018 IEEE International Geoscience and Remote Sensing Symposium, Valencia, Spain, 2018, pp. 6959-6962, doi: 10.1109/IGARSS.2018.8518643.
145. S. Danda, A. Challa and B. S. Daya Sagar, "A morphology-based approach for cloud detection," 2016 IEEE International Geoscience and Remote Sensing Symposium (IGARSS), Beijing, China, 2016, pp. 80-83, doi: 10.1109/IGARSS.2016.7729011.

146. A. Challa, S. Danda, B. S. D. Sagar and L. Najman, "Power spectral clustering on hyperspectral data," 2017 IEEE International Geoscience and Remote Sensing Symposium (IGARSS), Fort Worth, TX, USA, 2017, pp. 2195-2198, doi: 10.1109/IGARSS.2017.8127423
147. A. Challa, S. Danda and B. S. Daya Sagar, "Morphological interpolation for temporal changes," 2016 IEEE International Geoscience and Remote Sensing Symposium (IGARSS), Beijing, China, 2016, pp. 3358-3361, doi: 10.1109/IGARSS.2016.7729868.
148. P. Kumari, S. Soor, A. Shetty and B. S. Daya Sagar, "Enhancing Martian Mineral Identification Using an Artificial Neural Network With Extracted Spectral Features In CRISM MTRDR Data," IGARSS 2024 - 2024 IEEE International Geoscience and Remote Sensing Symposium, Athens, Greece, 2024, pp. 6168-6171, doi: 10.1109/IGARSS53475.2024.10642888.
149. S. Soor and B. S. Daya Sagar, "Iterative Watershed Partition: An Efficient Method for Hierarchical River-Basin Extraction on Digital Elevation Models," IGARSS 2024 - 2024 IEEE International Geoscience and Remote Sensing Symposium, Athens, Greece, 2024, pp. 5398-5401, doi: 10.1109/IGARSS53475.2024.10640896.
150. S. Soor, P. Kumari, B. S. Daya Sagar and A. Shetty, "Weighted Sum of Segmented Correlation: an Efficient Method for Spectra Matching in Hyperspectral Images," IGARSS 2024 - 2024 IEEE International Geoscience and Remote Sensing Symposium, Athens, Greece, 2024, pp. 8015-8018, doi: 10.1109/IGARSS53475.2024.10642546.
151. K. Nagajothi, H. M. Rajashekara and B. S. Daya Sagar, "Quantitative Analysis of Watersheds Partitioned from Cartosat Dem of Lower Indus Sub-Basin Via Multifractal Spectra," IGARSS 2020 - 2020 IEEE International Geoscience and Remote Sensing Symposium, Waikoloa, HI, USA, 2020, pp. 881-884, doi: 10.1109/IGARSS39084.2020.9323994.
152. G. Barman, A. Kakati, S. L. Lim and B. S. Daya Sagar, "Interpolation of Subsurface Isopach Maps Using Mathematical Morphology," OCEANS 2022 - Chennai, Chennai, India, 2022, pp. 1-5, doi: 10.1109/OCEANSChennai45887.2022.9775480.

4. Research Fields, Areas of Interest, Projects, and Accomplishments

Many space-time models explaining phenomena and processes of terrestrial relevance were of descriptive in nature. Efficient way of understanding the dynamical behavior of many complex systems of nature, society and science is possible through data acquired at multiple spatial and temporal scales. Earlier, several toy models were developed via classical mathematics to explain several possible phases in dynamical behaviors of complex systems. With the advent of computers with powerful graphics facilities, about three decades ago the interplay between numeric (generated via classical equations explaining the behaviors of dynamical systems) and graphics are shown. That progress provided initial impetus to visualize the systems' spatial and/or temporal behaviors that exhibit simple to complex patterns on graphical screens. Understanding the spatiotemporal dynamical behavioral complexity of terrestrial phenomena and processes both across spatial and temporal scales leads to a study of theoretical interest. The main motivation of his work stems out of the curiosity to know whether the terrestrial surfaces traversing the phases from irregular to regular or from regular to irregular? To get proper physically viable answers to such curiosity one requires terrestrial data at various spatial and temporal scales. Since last two decades, we have been seeing significant breakthroughs in data acquisition procedures with precision. Data related to terrestrial (geophysical) phenomena at spatial and temporal intervals are now available in numerous formats facilitating visualization at spatiotemporal intervals. Availability of such data from a wide range of sources in a variety of formats poses challenges to Geosciences community. The utility and application of such data could be substantially enhanced through related technologies developed in the recent past. The varied but coherent phases involve in developing cogent domain-specific models include information retrieval from the source data, information analysis, information reasoning, and simulation and spatiotemporal modeling. These coherent phases that he has been dealing with are basic ingredients required for developing models that provide valuable insights in understanding the complex spatiotemporal dynamical behavioral patterns. His research uses fusion of computer simulations and modeling techniques in order to better understand

certain terrestrial phenomena and processes with the ultimate goal of developing cogent models in discrete space further to gain a significantly good understanding of complex terrestrial systems in a way that is not possible with lab experiments. Effectively attaining these goals presents many computational challenges, which include the development of frameworks. While perceiving the terrestrial surfaces (e.g. geophysical and geomorphic basins (e.g. Digital Elevation Models, Digital Bathymetric Models, cloud fields, microscale rock porous media etc) as functions, planar forms (e.g. topographic depressions, water bodies, and threshold elevation regions, hillslopes) as sets, and abstract structures (e.g. networks and watershed boundaries) as skeletons, he made attempts that unraveled key links between the following aspects, and provided rich clues for understanding spatiotemporal behaviors of several of terrestrial phenomena and processes: (i) terrestrial pattern retrieval, (ii) terrestrial pattern analysis, (iii) simulation and modeling, and (iv) reasoning and visualization of terrestrial phenomena and processes of terrestrial geomorphologic relevance.

4.1. Terrestrial Pattern Retrieval

Availability of spatiotemporal data—for natural, anthropogenic, and socio-economic studies—acquired from a wide range of sources and a variety of formats, opens new horizons to the remote sensing and geosciences communities. Retrieving relevant information from such precisely acquired spatial-temporal data of varied types about a specific complex system is a basic prerequisite to understand the spatial-temporal behavior of a system. He developed original spatial algorithms based on non-linear morphological transformations for retrieval of unique networks, landforms, threshold elevation regions for efficient characterization, and segmentation of various geophysical objects and spatial fields.

4.1.1. Unique Topological Networks: He has taken the advantage that use curvatures in the elevation contours over the terrain for the simultaneous retrieval of both channel and ridge networks. In contrast to other recent works, which have focused on extraction of channel networks via algorithms that fail to precisely extract networks from non-hilly regions (e.g. tidal regions), the algorithms proposed by him can be generalized to both hilly (e.g. fluvial) and non-hilly (e.g. tidal) terrains, and also pore connectivity networks. This work helps solve basic problems that all algorithms meant for extraction of unique terrestrial connectivity networks have faced for over three decades.

4.1.2. Segmentation of Spatial Objects and Spatial Fields: Until recent past, mapping the features has been done through tedious field work and visual interpretation of topographies. He proposed a morphology-based segmentation approach to map physiographic features such as mountains, basins, and piedmont slopes from DEMs. The approach based on computation of complexity measures of morphologically significant zones decomposed from binary fractal sets via multiscale convexity analysis—which can be implemented on several geophysical and geomorphologic fields (e.g. DEMs, clouds, binary fractals etc) to segment them into regions of varied topological significance—has been demonstrated on **DEMs** derived directly from elevation field and cloud fields derived from MODIS data to better segment the regions within the cloud fields that have different compaction properties with varied cloud properties.[17-18] This approach solves a basic problem by preserving the spatial variability which could not be achieved by conventional geomorphometric quantities of topological relevance. planimetric-based measures.

4.1.3. Ranking of Best Pairs of Spatial Fields: A new metric to quantify the degree of similarity between any two given spatial fields is proposed. This metric of morphological significance can be used to derive best pair(s) of spatial fields among a large number of spatial fields available in a database. This metric can be used in the image classification, in particular hyperspectral image classification.

4.2. Terrestrial Pattern Analysis

Multiscale analysis for characterization of terrestrial phenomena and processes is one of his innovative new directions of research. He has developed original approaches that yield measures that are scale invariant but shape-dependant to explain characteristics of terrestrial phenomena and processes.
4.2.1. Scale Invariant Measures: Towards analyzing terrestrial surfaces he has shown unique ways to quantitatively characterize the spatiotemporal terrestrial complexity via scale-invariant measures that explain the commonly sharing physical mechanisms involved in terrestrial phenomena and processes. Other unique contributions by his group also highlighted the evidence of self-organization via scaling laws—in water bodies and their zones of influence. that evidently belong to different universality classes, networks and hierarchically decomposed subwatersheds, and pore connectivity networks and other topological components of relevance to porous medium—which possess excellent agreement with geomorphologic laws such as Horton's Laws, Hurst exponents, Hack's exponent, and other power-laws given in non-geoscientific context.

4.2.2. Scale Invariant but Shape Dependant Measures: In sequel works on terrestrial analysis, he argued that these universal scaling laws possess limited utility in exploring possibilities to relate them with geomorphologic processes. These arguments formed the basis for alternative methods. Shape and scale based indexes provided to analyze and classify non-network space (hillslopes), and terrestrial surfaces received wide attention. These methods that preserve the spatial and morphological variability yield quantitative results that are scale invariant but shape dependent, and are sensitive to terrestrial surface variations. "Fractal dimension of non-network space of a catchment basin", provides an approach to show basic distinction between the topologically invariant geomorphologic basins. It introduced morphological technique for hillslope decomposition that yields a scale invariant, but shape dependent, power-laws. Further granulometric indexes derived for spatial elevation fields also yield scale invariant bust shape-dependent measures.
4.2.3. Geodesic Spectrum: He provided a novel geomorphologic indicator by simulating geodesic flow fields within a basin consisting of spatially distributed elevation regions, further to compute a geodesic spectrum that provides a unique one-dimensional geometric support. This one-dimensional geometric support, in other words geodesic spectrum, outperforms the conventional width function based approach which is usually derived from planar forms of basin and its networks--construction involves basin as a random elevation field (e.g. Digital Elevation Model, DEM) and all threshold elevation regions decomposed from DEM for understanding the shape-function relationship much better than that of width function.

4.3. Modeling and Simulation

Besides providing approaches to simulate fractal-skeletal based channel network model, and fractal landscapes, he has shown via the discrete simulations the varied dynamical behavioral phases of certain geoscientific processes (e.g. water bodies, ductile symmetric folds, sand dunes, landscapes) under nonlinear perturbations caused due to *endogenic* and *exogenic* nature of forces. For these simulations he employed nonlinear first order difference equations, bifurcation theory, fractal geometry, and nonlinear morphological transformations as the bases.
4.3.1. Fractal-Skeletal Based Channel Network Model: His work on channel network modelling represents unique contributions to the literature, which until recently were dominated by the classic random model. Fractal-skeletal based channel network model (F-SCN) was proposed by following certain postulates. He developed this model by employing nonlinear morphological transformations to construct other classes of network models, which can exhibit various empirical features that the random model cannot. In the F-SCN model that gives rise to Horton laws, the generating mechanism plays an

important role. Homogeneous and heterogeneous channel networks can be constructed by symmetric generator with non-random rules, and symmetric or asymmetric generators with random rules. Subsequently, the F-SCNs in different shapes of fractal basins are generated and their generalized Hortonian laws are computed which are found to be in good accord with other established network models such as Optimal Channel Networks (OCNs), and realistic rivers. F-SCN model is extended to generate more realistic dendretic branched networks.

4.3.2. Fractal Landscape via Morphological decomposition: By applying morphological transformations on fractals of varied types are decomposed into topologically prominent regions (TPRs) and each TPR is coded and a fractal landscape organization that is geomorphologically realistic is simulated.

4*.3.3. Geomorphologic Modeling: Concept of Discrete Force*: Concept of discrete force was proposed from theoretical standpoint to model certain geomorphic phenomena, where geomorphologically realistic expansion and contractions, and cascades of these two transformations were proposed, and five laws of geomorphologic structures are proposed. A possibility to derive a discrete rule from a geomorphic feature (e.g. lake) undergoing morphological changes that can be retrieved from temporal satellite data was also proposed in this work, and explained. Laws of geomorphic structures under the perturbations are provided and shown, through interplay between numerical simulations and graphic analysis as to how systems traverse through various behavioral phases.

4.3.4. Water Bodies' Dynamics: He has shown via the discrete simulations the varied dynamical behavioral phases of certain geoscientific processes (e.g. water bodies) under nonlinear perturbations. Spatio-temporal patterns of small water bodies (SWBs) under the influence of temporally varied streamflow discharge behaviors are simulated in discrete space by employing geomorphologically realistic expansion and contraction transformations[47]. Expansions and contractions of SWBs to various degrees, which are obvious due to fluctuations in streamflow discharge pattern, simulate the effects respectively owing to streamflow discharge that is greater or lesser than mean streamflow discharge. The cascades of expansion-contraction are systematically performed by synchronizing the streamflow discharge, which is represented as a template with definite characteristic information, as the basis to model the spatio-temporal organization of randomly situated surface water bodies of various sizes and shapes.

4.3.5. Ductile Symmetrical Fold Dynamics: Under various possible time-dependent and time-independent strength of control parameters, in other words nonlinear perturbations, the two-limb and three-limb symmetrical folds are transformed in a time sequential mode to simulate various possible fold dynamical behaviors mimicking the realistic fold dynamical behaviors. He employed normalized fractal dimension values, and interlimb angles as parameters along with strength of nonlinear parameters in this study. Bifurcation diagrams are constructed for both time-dependent and time-independent fold dynamical behaviors, and the equations to compute metric universality by considering the interlimb angles computed at threshold strengths of nonlinearity parameters are proposed.

4.3.6. Symmetrical Sand Dune Dynamics: Certain possible morphological behaviors with respective critical states represented by inter-slip face angles of a sand dune under the influence of non systematic processes are qualitatively illustrated by considering the first order difference equation that has the physical relevance to model the morphological dynamics of the sand dune evolution as the basis. It is deduced that the critical state of a sand dune under dynamics depends on the regulatory parameter that encompasses exodyanmic processes of random nature and the morphological configuration of sand dune. With the aid of the regulatory parameter, and the specifications of initial state of sand dune, morphological history of the sand dune evolution can be investigated. As an attempt to furnish the

interplay between numerical experiments and theory of morphological evolution, the process of dynamical changes in the sand dune with a change in threshold regulatory parameter is modeled qualitatively for a better understanding. An equation to compute metric universality by considering attracting interslipface angles is also proposed. Avalanche size distribution in such a numerically simulated sand dune dynamics have also been studied.

4.4. Spatial Reasoning

He developed and demonstrated algorithms to (i) identify strategically significant set(s) for spatial reasoning and planning, (ii) determine directional spatial relationship between areal objects (e.g.: lakes, states, sets) via origin-specific dilations, and (iii) spatial interactions via modified gravity model.

*4.4.1. Strategically Significant State (s)***:** Identification of a strategically significant set from a cluster of adjacent and/or non-adjacent sets depends upon the parameters that include size, shape, degrees of adjacency and contextuality, and distance between the sets. An example of cluster of sets includes continents, countries, states, cities, etc. The spatial relationships, deciphered *via* the parameters cited above, between such sets possess varied spatial complexities. Hausdorff dilation distance between such sets is considered to derive automatically the strategic set among the cluster of sets. The (i) dilation distances, (ii) length of boundary being shared, and (iii) degrees of contextuality and adjacency between origin-set and destination sets, which together provide insights to derive strategically significant sets with respect to distance, degree of contextuality, degree of adjacency and length of boundary being shared. Simple mathematical morphologic operators and certain logical operations are employed in this study. Results drawn—by applying the proposed framework on a case study that involves spatial sets (states) decomposed from a spatial map depicting country India—are demonstrated and discussed.

4.4.2. Directional Spatial Relationship: He provided an approach to compute origin-specific morphological dilation distances between planar sets (e.g.: areal objects, spatially represented countries, states, cities, lakes) to further determine the directional spatial relationship between sets. Origin chosen for a structuring element (B) that yields shorter dilation distance than that of the other possible origins of B determines the directional spatial relationship between A_i (origin-set) and A_j (destination set). He demonstrates this approach on a cluster of spatial sets (states) decomposed from a spatial map depicting country India. This approach has potential to extend to any number (type) of sets on Euclidean space.

4.4.3. Spatial Interactions: Hierarchical structures include spatial system (e.g. river basin), clusters of a spatial system (e.g. watersheds of a river basin), zones of a cluster (e.g. subwatersheds of a watershed), and so on. Variable-specific classification of the zones of a cluster of zones within a spatial system is the main focus of this work on spatial interactions. Variable-specific (e.g. resources) classification of zones is done by computing the levels of interaction between the ith and jth zones. Based on a heuristic argument, we proposed a modified gravity model for the computations of levels of interaction between the zones. This argument is based on the following two facts: (i) the level of interaction between the ith and jth zones, with masses m_i and m_j is direction-dependent, and (ii) the level of interactions between the ith and jth zones with corresponding masses, situated at strategically insignificant locations would be much different (lesser) from that of the ith and jth zones with similar masses but situated at strategically highly significant locations. With the support of this argument, we provide a modified gravity model by incorporating the asymmetrical distances, and the product of location significance indexes of the corresponding zones. This modified gravity model yields level of interaction between the two zones that satisfies the realistic characteristic that is level of interaction between the zones is direction-dependent.

4.5. Visualization

His works also include (i) visualization of spatiotemporal behavior of discrete maps via generation of recursive median elements, (ii) point-polygon conversion, and (iii) cartogram generation.

*4.5.1. Spatial (Morphological) interpolation***:** This work concerns the development of frameworks with a goal to understand spatial and/or temporal behaviors of certain evolving and dynamic geomorphic phenomena. We have shown the importance of non-Euclidean metrics for categorization of spatial-temporal maps (e.g. geophysical fields, epidemic spread, etc), and nonlinear morphological interpolation for spatiotemporal modeling of various terrestrial phenomena were shown. (i) how Hausdorff-Dilation and Hausdorff-Erosion metrics could be employed to categorize the time-varying spatial phenomena, and (ii) how thematic maps in time-sequential mode can be used to visualize the spatiotemporal behavior of a phenomenon, by recursive generation of median elements. Spatial interpolation that was earlier seen as a global transform is extended by introducing *bijection* to deal with even connected components. This aspect solves problems of global nature in spatial-temporal GIS.

4.5.2. Morphing: He demonstrates the application of grayscale morphological interpolations, computed hierarchically between the spatial fields, to metamorphose a source-spatial field into a target-spatial field. Grayscale morphological interpolations are computed with respect to both flat and non-flat structuring elements, and found that the morphing, shown for transform source- spatial field into target-spatial field, created with respect to non-flat structuring element is more appropriate as the transition of source- spatial field into the target-spatial field across discrete time steps is smoother than that of the morphing shown with respect to flat structuring element. This morphing shown via nonlinear grayscale morphological interpolations is of immense value in geographical information science, and in particular spatiotemporal geo-visualization.

4.*5.3. Point-to-Polygon Conversion via WSKIZ***:** Data about many variables are available as numerical values at specific geographical locations. He developed a methodology based on mathematical morphology to convert point-specific data into polygonal data. This methodology relies on weighted skeletonization by zone of influence (WSKIZ). This WSKIZ determines the points of contact of multiple frontlines propagating, from various points (gauge stations) spread over the space, at the travelling rates depending upon the variable's strength for a better geographic visualization. He demonstrated this approach for converting rainfall data available at specific rain gauge locations (points) into a polygonal map that shows spatially distributed zones of equal rainfall.

4.5.4. Cartograms: Visualization of geographic variables as spatial objects of size proportional to variable strength is possible via generating cartograms. He developed a methodology based on mathematical morphology to generate contiguous cartograms. This approach determines the points of contact of multiple frontlines propagating, from centroids of various planar sets (states), at the travelling rates depending upon the variable's strength. The contiguous cartogram generated via this algorithm preserves the global shape, and local shapes, and yields minimal area-errors. It is inferred from the comparative error analysis that this approach could be further extended by exploring the applicability of additional characteristics of structuring element, which controls the dilation propagation speed and direction of dilation while generating variable-specific cartograms, to minimize the local shape errors, and area-errors. This algorithm addresses a decade-long problem of preservation of global and local shapes of cartograms.

4.6. Statement regarding collaboration with scientists abroad

Since 1998, Prof. Sagar has been collaborating with scientists abroad. His collaboration activities are fourfold: 4.*6.1. Collaboration on academic research while working at overseas Universities (1998-2006)*: collaboration with overseas scientists while working in the National University of Singapore, and Multimedia University-Malaysia, and collaboration with overseas scientists while working in India. He

served Centre for Remote Imaging Sensing and Processing, The National University of Singapore, as Grade-A Research Scientist during 1998-2001. During this period he worked with other research scientists, whose origins are from China, Taiwan, Germany, Singapore, France, on monitoring a Cambodian Lake (Tonlesap) through remotely sensed data. from Singapore, France, USA, Canada, Brazil, Greece, Iceland, Italy, Denmark, and China.

*4.6.2. Collaboration with scientists abroad on Research Projects (2005-2011)***:** On research projects, Sagar has collaboration with a group coordinated by Prof. Jean Serra (inventor of Mathematical Morphology) on Modelling and Simulations of Natural Disasters (under ICT-Asia Programme funded by French Government). He continues collaboration with his former colleagues from Malaysia on applications of mathematical morphology and fractal geometry in terrestrial analysis. Prof. Sagar is collaborating with Prof. Bala Venkatesh of Ryerson University of Canada on solar radiation mapping in three-dimensions for proper planning of renewable energy sources.

*4.6.3.Collaboration with Co-Guest Editors abroad for special theme issues of Journals (2003-2020)***:** He was a Guest Editor for several special issues of journals, and collaborated with co-guest editors from various parts of the world. Those collaborators include Prof. Daniele Veneziano of Massachusetts Institute of Technology (MIT), Prof. Lori Mann Bruce of Mississippi State University, Prof. Jean Serra of University of Paris-EST, Prof. Laurent Najman of University of Paris-EST, Prof. Petros Maragos of National Technical University of Athens, Prof. Dan Schonfeld of University of Illinois-Chicago, and Prof. Junior Barrera of University of São Paulo, Prof. Lorenzo Bruzzone of University of Trento, Prof. Avik Bhattacharya of Indian Institute of Technology-Bombay, Dr. Paul Rosen of Jet Propulsion Laboratories-NASA, Caltech, Prof. Qiuming Cheng of York University-Canada, Prof. Frits Agterberg of Canada Geological Survey, Prof. Jennifer McKinley of Queen's University-Belfast, Prof. Lorenzo Bruzzone of University of Trento, Prof. Jón Atli Benediktsson of University of Iceland, and Prof. Jocelyn Chanussot of Grenoble Institute of Technology. Success out of these collaborative activities related to releasing special theme issues for various journals of repute is obvious. The details of those special issues edited along with foreign academics are (i) B. S. Daya Sagar, G. Rangarajan and Daniele Veneziano (Eds.) "Fractals in Geophysics" for Chaos Solitons & Fractals, v. 19, no. 2, p. 237-462, 2004, (ii) B. S. Daya Sagar and Lori Mann Bruce (Eds.), "Surficial Mapping" for IEEE Geoscience and Remote Sensing Letters, v. 2, no. 4, p. 375-408, 2005, (iii) B. S. Daya Sagar and Jean Serra (Eds.), "Spatial Information Retrieval, Analysis, Reasoning and Modelling" of International Journal of Remote Sensing, v. 31, no. 22, 2010, p. 5747-6031, (iv) Laurent Najman, Junior Barrera, B. S. Daya Sagar, Petros Maragos, and Dan Schonfeld (Guest Editors), "Filtering and Segmentation with Mathematical Morphology" for IEEE Journal on Special Topics in Signal Processing, v. 6, no. 7, 2012, p. 737-886, (v) Avik Bhattacharya, Lorenzo Bruzzone, B. S. Daya Sagar, and Paul Rosen (Guest Editors), "Applied Earth Observation and Remote Sensing in India " for IEEE Journal on Special Topics in Applied Earth Observation and Remote Sensing, v. 10, no. 12, 2017, p. 5149-5328, (vi) B. S. Daya Sagar, Qiuming Cheng and Frits Agterberg (Editors) Handbook of Mathematical Geosciences: Fifty Years of IAMG, Springer Publishers, 2018, (vii) B. S. Daya Sagar, Qiuming Cheng, Jennifer McKinley and Frits Agterberg (Editors) Encyclopedia of Mathematical Geosciences, Springer Publishers, 2021, and (viii) B. S. Daya Sagar, Lorenzo Bruzzone, Jocelyn Chanussot, and Jon Atli Benedikttsson (Guest Editors), "Mathematical Morphology in Geoscience and Remote Sensing" for IEEE Journal on Special Topics in Applied Earth Observation and Remote Sensing (forthcoming).

*4.6.4. Collaboration with co-organizers abroad for Courses / Workshops (2009-2011)***:** Prof. Sagar also actively collaborates with foreign academics and scientists to organize short-term courses and training programmes, and workshops. Of late, he organized a four-day course and a two-day workshop on

'Mathematical morphology in image analysis, geomorphology, GISci' in collaboration with a group headed by Prof. Jean Serra of University of Paris-EST. The details of these events could be seen at: www.isibang.ac.in/~bsdsagar/cwjs70.

4.7. Special Topics of Lectures Prof. Sagar Delivers Upon Invitation

Lecture 1: Introduction to Mathematical Morphology (120 mins)
Lecture 2: Mathematical Morphology in Terrestrial Pattern Retrieval (120 mins)
Lecture 3: Mathematical Morphology in Terrestrial Pattern Analysis (60 mins)
Lecture 4: Terrestrial Surface Characterization: a Quantitative Perspective (60 mins)
Lecture 5: Size distributions, Spatial Heterogeneity and Scaling Laws (60 mins)
Lecture 6: Morphological Shape Decomposition: Scale Invariant but Shape Dependent Measures (60 mins)
Lecture 7: Granulometries, Convexity Measures and Geodesic Spectrum for DEM Analyses (60 mins)
Lecture 8: Mathematical Morphology in Geomorphologic Modelling and Simulation (60 mins)
Lecture 9: Fractal-Skeletal-Based Channel Network Model (60 mins)
Lecture 10: Synthetic Models to Understand Spatio-Temporal Dynamics of Certain Geo(morpho)logical Processes (60 mins)
Lecture 11: Mathematical Morphology in Quantitative Spatial Reasoning and Visualization (60 mins)
Lecture 12: Mathematical Morphology in Spatial Interpolations (60 mins)
Lecture 13: Conversion of Point-Data into Polygonal Map via WSKIZ (60 mins)
Lecture 14: Visualization of spatiotemporal behavior of discrete maps via generation of recursive median elements (120 mins)
Lecture 15: Quantitative Characterization of Complex Porous Phase via Mathematical Morphology and Fractal Geometry (90 mins)

4.8. Sagar's two most distinctive application of engineering, science, and technology contributions

He authored and/or edited eleven books and/or journal special issues (including special issues of IEEE GRSL, IEEE JSTSP, and IEEE JSTARS on these advanced topics. Original ideas reflected through his ninety high impact journal publications including about 20 in IEEE Transactions / Journals / Letters—with H-index of 17 according to Google Scholar—have spurred interdisciplinary activity, deepened our understanding the spatiotemporal organization of terrestrial phenomena and processes. For his outstanding research ability in spatial statistics and mathematical morphology, he was conferred Georges Matheron Award-2011 of International Association of Mathematical Geosciences (IAMG) *for Outstanding Research Ability in the Field of Spatial Statistics or Mathematical Morphology*. He is only Asian, and the youngest among the recipients so far received this award. His significant contributions have also been recognized by awarding him 'Dr. Balakrishna Memorial Award-1995' by AP Academy of Sciences for his '*Attempt to Establish an Integrated Mathematical Approach to Study Certain Geoscientific Aspects*', 'Krishnan Gold Medal–2002' by Indian Geophysical Union '*for his Significant Studies in the Field of Applications of Remote Sensing, Mathematical Morphology, and Fractals to Study Certain Surface Water Bodies*'. Among many excellent spatial algorithms that he developed and demonstrated, most worthy of awarding the IEEE Fellow, two Achievements in terms of the applications of these algorithms in geosciences, remote sensing and GISci stand out most prominently:

ACHIEVEMENT-1: Daya-Sagar spent over 30 years in developing mathematical morphology based spatial algorithms to treat spatial and spatiotemporal data, most notably Digital Elevation Models (DEMs) to handle the intertwined topics–pattern retrieval, pattern analysis, simulation and modeling of terrestrial phenomena and processes, and spatial reasoning–were a significant success–summarized in his recent sole author 14-chapter monograph "Mathematical Morphology in Geomorphology and GISci, CRC Press, p. 546, 2013". In the first Ten chapters of this unique contribution, applications of the spatial algorithms that he developed are shown (i) to extract valley and ridge connectivity networks from spatial data (e.g. Digital Elevation Model (DEM)), (ii) to segment spatial data into zones of influence such as watersheds, physiographic features including mountains, basins, and piedmont slopes from Digital Elevation Models (DEMs), (iii) evidence of self-organization via scaling laws which provide excellent agreement with geomorphologic laws, (iv) validity of his heuristically true arguments that the power-laws, which are scale-invariant, provide limited utility in understanding the geomorphologic processes, and these arguments further lead him to propose granulometric and morphologic shape decomposition based algorithms that yield scale-invariant but shape-dependent indices–which are more appropriate as what matters most in understanding spatial processes is shape–that could capture basic distinctions between topologically invariant geomorphologic basins, (v) importance of a novel geomorphologic indicator, computed via a geodesic spectrum that provides unique one-dimensional geometric support, over the conventional width-function, (vi) Fractal-Skeletal Based Channel Networks (F-SCNs) Model and has been found to be in good accord with other established network models such as Optimal Channel Networks (OCNs) and real-world rivers, (vii) modelling the geomorphologic process via morphological operations through which he proposed the concept of discrete force and five laws of geomorphologic structures, (viii) simulation of fractal landscapes that are geomorphologically realistic, and (d) discrete simulations based on the interplay between numeric and graphic analyses through which he has shown various behavioural phases that geomorphologic systems–such as water bodies, folds, dunes, landscapes–traverse. In the later four chapters, spatial algorithms are shown to address a range of problems of relevance to Geographical Information Sciences (GISci) that includes (x) to identify ‘strategically significant’ spatial object(s) from a cluster of nonoverlapping spatial objects, (xi) to determine directional spatial relationships between the spatial objects, (xii) spatiotemporal modelling via hierarchical generation of median maps via morphological interpolations, (xiii) convert point-specific non-contiguous data into zonal maps through the weighted skeletonization by zones of influence (WSKIZ) transformation, and (xiv) generating contiguous variable-specific cartograms.

ACHIEVEMENT-2: For the first time, Prof. Sagar employed morphological distances between the spatial fields such as DEMs and between the mapped units, location significance of each mapped unit, and hierarchical computations of median functions between the DEMs to represent them in the forms of variable-specific interaction matrices, and has shown applications in geoinformatics, particularly (i) to designate each and every possible pair of DEMs stored in a database with a rank such that the pair-wise rank indicates the degree of similarity between the DEMs of the pair further to group the spatial field data such as DEMs into pairs ranging from best pair to worst pair through ranks to all possible pairs of spatial data stored in a bigdata bases, (ii) to transform source DEM into target DEM to understand the time-dependent changes in the surficial phenomena as reflected in DEMs, and (iii) to compute the level of interaction, between every mapped geographical unit (e.g. geophysical basin) to every other mapped unit via a modified gravity model that Prof. Sagar proposed, to categorize the mapped units ranging from strongly interacting pair to the weakly interacting pairs. This set of recent achievements of the nominee is very unique and provide solutions (a) to quantify the degree of similarity between two spatial fields, which is useful for automatically rank the possible pairs of large spatial data sets into best-pair to

worst-pair, and for the spatial data classification and clustering, (b) for morphing a source-spatial field into a target-spatial field via hierarchical median map computations, and to categorize mapped units based on the level of interaction between the zones of a cluster of zones. These works have addressed numerous challenges encountered in remotely sensed satellite data processing and analysis, and GIScience.

4.9. Sagar's three most important items of tangible and verifiable evidence of technical accomplishments

Part-1:

[1]-B.S.D. Sagar "Mathematical Morphology in Geomorphology and GISci", (CRC Press-Taylor & Francis: p.546, 2013). (*18* citations). *Significance*: This sole-author monograph, which included his 70 journal papers (around *500* citations) including 20 in IEEE Transactions / Journals / Letters, that addressed a range of questions of importance to remote sensing, mathematical geosciences, and geographical information science provides a host of original spatial algorithms of fundamental importance to deal with coherent challenges (i) geospatial information retrieval from remotely sensed data, (ii) analysis, (iii) quantitative spatial reasoning, and (iv) modeling and visualization of the terrestrial phenomena and processes. These algorithms not only addressed a challenge of the automatic extraction of complex features of geometric, morphologic and topologic relevance from Digital Elevation Models but also provided methodologies for the quantitative characterizations of processes and morphological forms that affect each other. In the later chapters of the monograph, he has shown the important GIS applications. This path breaking contribution is imminent for developing physics-based models for several terrestrial phenomena and processes. These algorithms are now being implemented on the DEMs derived from (Terrain Mapping Camera) TMC data acquired by the ISRO-Chandrayan 1 & 2 Missions. This book is available in over 200 Libraries across the world, and received wide recognition through excellent reviews by peers that can be seen at https://www.crcpress.com/Mathematical-Morphology-in-Geomorphology-and-GISci/Daya-Sagar/p/book/9781439872000.

[2]- B.S.D. Sagar "Visualization of spatiotemporal behavior of discrete maps via generation of recursive median elements, *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 32(2)378-384, 2010. *Significance*: The main motivation behind this paper was to develop a framework with a goal to understand spatial and/or temporal behaviors of terrestrial phenomena and processes dynamically evolving: Proposes a new nonlinear spatial interpolation technique useful for spatial-temporal GIS, and is of immense value in geographical information science, and in particular spatiotemporal geo-visualization. This single author paper provides an algorithm based on intuition—that deals with the generation of intermediary maps in sequences of thematic maps generated from remotely sensed satellite data. In this paper, shape-based layered information is treated as sets and are made into five categories of spatial-temporal maps (e.g. geophysical fields, epidemic spread) for establishing relationship between pairs of sets. The two well-treated cases—1) Water bodies and 2) Spatial spread of bubonic plague1896 to 1906—considered to demonstrate the robustness of the algorithm served to test the quality of interpolation over the other existing interpolations. This work provides basis for interpolation and predictive analytics to deal with interdependencies, between features and processes that are invariably accompanied by complex cyclic and chaotic behavior.

[3]-B. S. D. Sagar and Lim, S. L., "Ranks for pairs of spatial fields via metric based on grayscale morphological distances, *IEEE Transactions on Image Processing*, 24(3), 908-918, 2015. *Significance*: A new metric to quantify the degree of similarity between any two given spatial fields is proposed, and

demonstrated on the DEMs partitioned hierarchically. This metric of morphological significance can be used to derive best pair(s) of spatial fields among a large number of spatial fields available in a database. This metric can be used in the image classification, in particular hyperspectral image classification.

Part 2:

[1]- Sagar, B.S.D., Venu, M., and Srinivas, D., Morphological operators to extract channel networks from digital elevation models, Int. Jour. Rem. Sen 21(1)21-29, 2000. (*26* citations). *Significance*: Provides an algorithm based on binary morphological transformations that can be used to extract channel and ridge networks from DEMs, and can be generalized to both fluvial and tidal type terrestrial systems. Follow-up work by **Sagar, B.S.D.**, Murthy, M.B.R., Rao, C.B., and Raj, B., Morphological approach to extract ridge-valley connectivity networks from digital elevation models (DEMs), Int. Jour. Rem. Sen 24(573–581), 2003. *Significance*: Provides stable algorithm based on grayscale morphological transformations to retrieve unique networks and landforms from Digital Elevation Models representing terrestrial surfaces, and serve to demonstrate the superiority over other algorithms which cannot be generalized for both fluvial and tidal systems regions.

[2]-Sagar, B.S.D., and Chockalingam, L., Fractal dimension of non-network space of a catchment basin, *Geophysical Research Letters*,31(L12502), 2004. *Significance*: Sagar provides an approach towards explaining basic distinctions between topologically invariant geo–morphologic basins. It introduced morphological techniques for hill–slope decomposition that yield scale–invariant, but shape–dependent power laws. This original algorithm meant for quantitative characterization of dynamically changing terrestrial surfaces provided insights for understanding spatiotemporal behavioral patterns of terrestrial phenomena and processes.

[3]-Sagar, B.S.D. Cartograms via mathematical morphology, *Information Visualization*, 13(1)42-58, 2014. *Significance*: Visualization of geographic variables as spatial objects of size proportional to variable strength is possible via generating cartograms. He developed an algorithm—addressing a decade-long problem of preservation of global and local shapes of cartograms—based on mathematical morphology to generate contiguous cartograms. This algorithm also converts point-data into contiguous zonal map for better visualization - first of its kind.

[4]-Sagar, B.S.D., and Lim, S. L. Morphing of Grayscale DEMs via Morphological Interpolations, *IEEE Journal on Selected Topics on Applied Earth Observation and Remote Sensing*, 8(11), 5190-5198, 2015. *Significance*: He demonstrated the application of grayscale morphological interpolations, computed hierarchically between the source DEM, to metamorphose a source-DEM into a target-DEM, indeed a worthy original solution in the GIScience solves problems of global nature in spatial-temporal GIS. This morphing shown via nonlinear grayscale morphological interpolations is of immense value in geographical information science, and in particular spatiotemporal geo-visualization.

[5] Sagar, B. S. D. Variable-Specific classification of zones, pairs of zones, and clusters of a spatial system via modified gravity model, *IEEE Transactions on Emerging Topics in Computing*, 7(2) 230-241, 2019. *Significance*: Hierarchical structures include spatial system (e.g. river basin), clusters of a spatial system (e.g. watersheds of a river basin), zones of a cluster (e.g. subwatersheds of a watershed), and so on. Based on a heuristic argument, by incorporating the asymmetrical distances, and the product of location significance indexes of the corresponding zones, a modified gravity model for the computations of levels of interaction between the zones is proposed. This modified gravity model yields

level of interaction between the zones of a cluster of zones that satisfies the realistic characteristic that is level of interaction between the zones is direction-dependent. This study provides a new framework to classify the zones.

4.10. Significant Contribution of Sagar

As rich sources of spatial data have become extensively available, it is a necessary condition of making the maximum use of it that effective methods of analysis should be available and this is where Professor Sagar has made a very significant contribution in developing spatial algorithms of immense value in advancing mathematical geosciences and geoinformation sciences through the application of contemporary methods like mathematical morphology and spatial geostatistics, including those of earth observation and mapping. His linking of terrestrial pattern retrieval, pattern analysis, spatial reasoning, and modelling and visualization is innovative and powerful. In summary, his interest in mathematical morphology and spatial geodata sciences evidenced through his research, teaching, educational, publishing, and editorial activities, and the ways in which his expertise has been applied to a range of questions of importance to mathematical geosciences and geoinformation science has offered a unique contribution. He has also been very active in book writing and journal editing and in support for learned societies that promote advances in mathematical geoscience and geoinformation science.

4.11. Impact of the work done by Sagar

What is so appealing about his three decade long work is that he introduced mathematical structure that are rooted in new approaches to geometry, particularly mathematical morphology, fractals and chaos into geosciences and geospatial data sciences. His important work, which should be explored by all those who profess to be interested in spatial morphologies, appeared as over ninety publications in journals of repute and eleven books of fundamental relevance to Geodata Sciences have collectively provided an impetus to the understanding of spatio-temporal behaviour of terrestrial phenomena and processes, and have had significant impact across remote sensing, terrestrial data analysis, quantitative geosciences, and GISci. His work that has led to a deeper understanding of complex terrestrial phenomena across spatiotemporal scales not only helps solve fundamental problems that have plagued algorithms but also provided methodologies for the quantitative characterizations of processes and morphological forms that affect each other, and provides basis for interpolation and predictive analytics to deal with interdependencies, between features and processes that are invariably accompanied by complex cyclic and chaotic behavior further proved robust to handle various challenges such as spatiotemporal modeling, visualization, and quantitative spatial reasoning encountered in geographic information science.

4.12. Sagar's contribution to the Society

Through three decade long research, by bringing the power of mathematics to stand, Professor Sagar exploited the emergence of mathematical models and the enormous data requiring quantitative treatment. He has provided algorithms with mathematical basis to synthesize the data and draw knowledge from them, and contributed immensely to the teaching, academic events, education by lecturing on mathematical geoscience and informatics topics, and publishing through which over 30000 people including undergraduate, postgraduate and Doctoral students, academics and scientists in India and abroad benefitted. His has contributed as the Founding Head, to the establishment of Systems Science and Informatics Unit at Indian Statistical Institute, setup Spatial Informatics Research Group, and IEEE GRSS Bangalore Chapter providing forums for researchers, teachers, engineers and

practitioners in applications involving spatial information. His monograph on Handbook of Mathematical Geosciences, by Springer in July 2018 has crossed the downloads of 2,75,000, testify the importance of his contributions to the global society. He was assisted by sixty pioneering academics from 20 over countries for collaboration, lecturing, education and publishing. In recognition of these contributions to the mathematical geoscience community and scientific societies, he was conferred as the only Asian with the international awards 2011 Georges Matheron Award 2011, and IAMG Certificate of Appreciation Award 2018.

5. Academic, Scientific, Technical and Management Experience

5.1. Employment History including Administrative Positions

2023—2027: Head, Indian Statistical Institute-Bangalore Centre, India

2022—2032: Professor (HAG), Systems Science and Informatics Unit (SSIU), Computer and Communication Sciences Division (CCSD), Indian Statistical Institute-Bangalore Centre, India (Basic Pay @ INR 224100/-)

2013—2021: Professor, Systems Science and Informatics Unit (SSIU), Computer and Communication Sciences Division (CCSD), Indian Statistical Institute-Bangalore Centre, India

2009—Present: Founding Head, Systems Science and Informatics Unit (SSIU), Computer and Communication Sciences Division (CCSD), Indian Statistical Institute-Bangalore Centre, India

2007—2013: Associate Professor, Systems Science and Informatics Unit (SSIU) , Computer and Communication Sciences Division (CCSD), Indian Statistical Institute-Bangalore Centre, India

2001-2007: Associate Professor, Faculty of Engineering and Technology (FET), Telekom University Malaysia (Multimedia University), Melaka Campus, Malaysia.

2003-2007: Deputy Chairman, Centre for applied Electromagnetics (CAEM), Telekom University Malaysia (Multimedia University), Melaka Campus, Malaysia.

1998-2001: Grade-A Research Scientist, Centre for Remote Imaging Sensing and Processing (CRISP), Faculty of Science, The National University of Singapore, Singapore.

1998-1998: Senior Research Associate-CSIR, Department of Geoengineering, College of Engineering, Andhra University, India.

1996-1997: Research Scientist/Principal Investigator -DST, Department of Geoengineering, College of Engineering, Andhra University, India.

1995-1995: Research Associate-CSIR, Department of Geoengineering, College of Engineering, Andhra University, India.

1992-1994: Senior Research Fellow-CSIR, Department of Geoengineering, College of Engineering, Andhra University, India

1991-1992: Project Fellow -MHRD, Department of Geoengineering, College of Engineering, Andhra University, India.

1996: Short Term Visiting Fellow, Tata Institute for Fundamental Research (TIFR), Bangalore, India

1998: Guest Faculty, Centre for Space Science Technology-Asia Pacific (CSSTE-AP), Affiliated to United Nations, Dehradun, India.

2008-2009: Guest Faculty, Department of Geoengineering, College of Engineering, Andhra University, India.

5.2. Memberships, Professional Contributions and Activities, Honors & Awards

5.2.1 Non-IEEE Related: Professional Activities, Awards, Certificates

- Elected a **Fellow of the International Artificial Intelligence Industry Alliance (**FAIIA) effective 2024

- Member of the American Geophysical Union (AGU) '**Honors and Recognition Committee**' (HRC) 2022-2025.
- Elected a **Fellow of the Indian National Science Academy** (FNA) effective 2024
- Elected a **Fellow of the Indian Academy of Sciences** (FASc) effective 2022
- **"Georges Matheron Award-2011 (with Lecturership) of International Association for Mathematical Geosciences (IAMG)". (Only Asian to receive this Awards)**
- **Recipient of "IAMG Certificate of Appreciation - 2018". (Only Asian to receive this Award).** Received at Prague, Czech Republic
- Editorial Board Member for Journal Mathematical Geosciences (Springer Publishers) - 2019-2021
- Associate Editor for Springer Indian Statistical Institute Series- 2018-2023
- Member of Selection Committee for the 2015-Computers & Geosciences Research Scholarships (Co-Sponsored by Elsevier and IAMG)
- Editor In Chief, Springer's Encyclopedia of Mathematical Geosciences – 2019-2022
- Principal Editor, Springer's Handbook of Mathematical Geosciences: Fifty Years of IAMG-2018
- Editorial Board Member, Computers & Geosciences (Elsevier Journal) - 2013-
- Life Member, International Association for Mathematical Geologists (IAMG), since 2006
- Guest Editor, Journal Mathematical Geosciences (Springer)-2001

5.2.2 IEEE Related: Professional Activities, Awards, Certificates

- IEEE GRSS Certificate of Appreciation from the IEEE GRSS President
- Recipient of "IEEE Geoscience and Remote Sensing Society (GRSS) Distinguished lectureship Award (2020-2024)" Only Indian to receive this prestigious Award.
- Speaker at Tutorial on "Morphological Interpolations and Extrapolations" at IGARSS 2020
- Speaker at Tutorial on "Mathematical Morphology in Geosciences and GISci" at IGARSS 2015, 2017, 2020
- Tutorial Co-Chair for InGARSS-2020, 2021
- Organized EIGHT GRSS Distinguished Lecture Talks ever since Bangalore Section IEEE GRSS Chapter was established
- 'Letter of Appreciation' from IEEE-Bangalore-Section
- IEEE-Bangalore-Section ExeCom Member
- Founding Chair of Bangalore Section IEEE GRSS Chapter (since 2012-)
- IEEE Member since 2003 (21 years)
- IEEE Senior Member since 2003 (21-years)
- Member, IEEE Senior Member Applications Review panel on 29-March-2013, Bangalore.
- Member, Technical Program Committee IGARSS-2006, 2008-2020
- Received Felicitation Certificate with Cash Prize from IEEE Bangalore Section-2011, 2013
- Guest Editor (Associate Editor) special section on "Surficial Mapping" for IEEE Geoscience and Remote Sensing Letters (v.2, no.4, 375-408, 2005)
- Guest Editor (Associate Editor) special issue on "Filtering and Segmentation with Mathematical Morphology" for IEEE Journal on Selected Topics in Signal Processing (v.6, no.7, 736-886, 2012).
- Guest Editor (Associate Editor) special issue on "Applied Earth Observation and Remote Sensing in India" for IEEE Journal on Selected Topics in Applied Earth Observation and Remote Sensing (v. 10, no. 12, p. 5149-5328, 2017).

- Guest Editor (Associate Editor) special issue on “Mathematical Morphology in Remote Sensing and Geoscience” for IEEE Journal on Selected Topics in Applied Earth Observation and Remote Sensing (2021).
- Convener/Chairman for IEEE Sponsored workshops on "Spatial Statistical Tools in Data Processing and Analysis (26-30 Nov 2012)", "Mathematical Morphology and Pattern Recognition: Theory and Applications (26-28 March 2013)", "Image Pattern Analysis and Applications (09-10 Nov 2013)", "Mathematical Morphology in Interpolations (Last week of Feb 2014)".
- Provided support letters to over 40 qualified IEEE members to upgrade their status to Senior member.
- Published papers in IEEE Journals/Transactions/Letters namely, IEEE Geoscience and Remote Sensing Letters (GRSL), IEEE Signal Processing Letters (SPL), IEEE Transactions on Power Delivery, IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), and IEEE Journal on Selected Topics in Signal Processing (JSTSP), IEEE Transactions on Emerging Topics in Computing, IEEE GRSS Magazine, and IEEE-GRS-Newsletter.
- Reviewed papers for IEEE GRSL, IEEE TGRS, IEEE SPL, IEEE TKDE, IEEE JSTSP, IEEE TPAMI.
- Organized first ever GRSS DL talk in India on 27 Jan 2014.
- Frank Harary Endowment Lecture - 2019
- Associate Editor, Image Analysis & Stereology (2015-16)
- Review Editor, Frontiers: Environmental Informatics - 2016-
- Editorial Board Member, Computers & Geosciences (Elsevier Journal) - 2013-
- Editor, Discrete Dynamics in Nature and Society (Hindawi Publishers, USA) - 2003-2012
- Editor, ICTACT Journal of Image and Video Processing- 2008-
- Guest Editor, International Journal of Pattern Recognition and Artificial Intelligence (World Scientific Publishers)-2003
- Guest Editor, Chaos Solitons & Fractals-2004
- Guest Editor, International Journal of Remote Sensing-2010
- Member AGU since 2004
- Member ACM SIGSPATIAL - 2008
- Elected Fellow of Royal Geographical Society (London), since 2000
- Elected Fellow of Indian Geophysical Union, since 2011
- Member New York Academy of Sciences, 1995 (In active)
- Life Member International Association for Mathematical Geosciences- since 2006
- Member, Technical Program Committee ISMM-2013, 2015, 2017, 2019
- Member, Scientific Advisory Committee IAMG-2014, 2015, 2018
- Advisor, 16 Doctoral and 10 Masters Thesis Students Graduated
- Presenter, Over 300 Invited Talks Internationally and Nationally
- Funding, Over INR 100 Million in Research Grants
- Instructor, Over 10 Different Undergraduate and Graduate Courses
- Krishnan Gold Medal-2002 from Indian Geophysical Union
- Dr. S. Balakrishna Memorial Award-1995 from Andhra Pradesh Akademi of Science
- NSF Grant Proposal Reviewer 2010 & 2014
- Expert Committee Member, Board of Research in Nuclear Science (BRNS), 2014
- Convener for Two-Day Workshop on "Image Pattern Analysis and Applications", jointly organized by the Systems Science and Informatics Unit (SSIU), Indian Statistical Institute-

Bangalore Centre and the Amrita School of Engineering, Bangalore, 09-10 November, 2013. (Workshop Webpage: http://www.isibang.ac.in/~bsdsagar/Amrita-ISI-Poster.pdf)

- Convener for Three - Day Workshop on "Mathematical Morphology and Pattern Recognition: Theory and Applications", Indian Statistical Institute - Bangalore Centre, India, 26 - 28 March, 2013. (Workshop Webpage: http://www.isibang.ac.in/~mmprta/);
- Convener for Five-Day Course on "Spatial Statistical Tools in Data Processing and Analysis", Indian Statistical Institute, Bangalore, India, 26-30 November, 2012. (Workshop Webpage: http://www.isibang.ac.in/~sstdpa/);
- Convener for Workshop on "Advanced Methods in Spatial Data Analysis and Processing", Indian Statistical Institute, Bangalore, India, 6-7 March 2012. (Webpage: https://sites.google.com/site/advancedmethodsssiu/home);
- Convener for Course on "Mathematical Morphology in Image Analysis, GISci, Geomorphology", Indian Statistical Institute, Bangalore, India, 19-25 October 2010 (Organized jointly by Systems Science and Informatics Unit (SSIU) and ESIEE Engineering, Universit Paris-Est, France). (Webpage: http://www.isibang.ac.in/~cwjs70/);
- Convener for Workshop on "Honouring Professor Jean Serra", Indian Statistical Institute, Bangalore, India, 26-28 October 2010. (Webpage: http://www.isibang.ac.in/~cwjs70/);
- Convener for International Seminar of "Spatial Information Retrieval Analysis, Reasoning and Modelling (SIRARM)", Indian Statistical Institute, Bangalore, India, 18-20 March 2009. (Webpage: http://www.isibang.ac.in/~sirarm/);
- Coordinator for Two-Week DST Summer School on Mathematical Morphology in Geosciences (24 March-08 April 2015) (Webpage: http://www.isibang.ac.in/~dst-ss-mmg/);
- Program Chair for Ninth International Conference on Advances in Pattern Recognition (ICAPR-2017) December 28-30, 2017 (Webpage: http://www.isical.ac.in/~icapr17/index1.php).
- Book entitled “Mathematical Morphology in Geomorphology and GISci” (Scheduled for Release May 2013, ISBN-10: 1439872007, ISBN-13: 9781439872000. Pages: 536, Publisher: Chapman & Hall (Taylor & Francis Group)).
- Reviewer University Press (India) Limited, (an associate of Orient Longman Ltd), Journal Mathematical Geology, International Journal of Remote Sensing, Computers & Geosciences, International Association for Pattern Recognition, International Journal of Pattern Recognition and Artificial Intelligence, Chaos Solitons & Fractals, Tribology International, Discrete Dynamics in Nature and Society, NSF Grant Proposal Reviewer.
- Biography included in Who’s Who in the World (Marquis), 15th Edition, 1997; International Who’s Who of Intellectuals (Marquis) 13th Edition, 1998; 20th Century Outstanding Achievement Award (International Biographical Centre, Cambridge); Dictionary of Who’s Who in the World (International Biographical Centre, Cambridge)27th Edition, 1998; Who’s Who in the Science and Engineering (Marquis)2004; Who’s Who in the Asia (Marquis) 2006;
- Travel grant arranged by Science & Technology Corporation, Virginia, USA To Present paper in the International Space Year Conference on Spectral Sensing Research, Hawaii 1992
- Awards of Senior Research Fellowship, Research Associateships Council of Scientific and Industrial Research, India 1992-1996
- Award of Young Scientist Scheme, Department of Science and Technology, India, 1996-97
- Finalist for INSA Young Scientist Medal, Indian National Science Academy 1996 & 1998
- Finalist for Swarnajayanthi Fellowship Department of Science and Technology, India, 1999

5.2.3 Invited Contributions to Workshops, Courses, Seminars and Conferences

Prof. Sagar has delivered several invited lectures in India and abroad, organized international conferences / workshops, and chaired various technical sessions. These details are given below

- Symposia and a Workshop on "Mathematical Morphology in Geosciences and Geoinformatics", at the 35th IGC, Cape Town, South Africa, 2016.
- Half-Day Tutorial on "Mathematical Morphology in Geosciences and GISci", was organized on 26 July 2015 at the IGARSS-2015, Milan, Italy.
- A Two-Week Long Summer School on "Mathematical Morphology in Geosciences", was organized during 24 March 2015 to 08 April 2015 at the Indian Statistical Institute-Bangalore Centre, India.
- Pre-IAMG Conference Short Course on "Mathematical Morphology in Geosciences and GISci", organized at Jawaharlal Nehru University (JNU), New Delhi, India, during 15-16 October 2014.
- Workshop on "Mathematical Morphology and Pattern Recognition: Theory and Applications" 26 – 28 March, 2013, Indian Statistical Institute - Bangalore Centre. (Website: http://www.isibang.ac.in/~mmprta/)
- Convener, 5-Day course on "Spatial Statistical tools in data processing and analysis, 26-30 Nov 2012, Bangalore, India. (Website: http://www.isibang.ac.in/~sstdpa/)
- Convener, 4-Day course on "Mathematical morphology in image analysis, geomorphology, and GISci', 19-23 Oct 2010, Bangalore, India (Website: http://www.isibang.ac.in/~cwjs70/)
- Co-Convener, Workshop on 'Advanced methods in spatial data processing and analysis', 6-7 March 2012, Bangalore, India. (Website: https://sites.google.com/site/advancedmethodsssiu/home)
- Chair, 'Workshop Honoring Jean Serra' October 25-26, 2010, Bangalore, India, 2009 (Website: http://www.isibang.ac.in/~cwjs70/)
- Chair, International Seminar of Spatial Information Retrieval Analysis, Reasoning and Modelling (SIRARM), Bangalore, India, 2009 (Website: http://www.isibang.ac.in/~sirarm/)
- Chair, M2USIC-2002, Multimedia University, Cyberjaya, Malaysia, 2002
- Convener, A Course on Mathematical Morphology in Image Analysis, GISci, Geomorphology, Bangalore, India, 2010.
- Invited talk on 'Application of mathematical morphology to compute basic measures' Summer School on Application of Mathematical Morphology in Pattern Studies, Centre for Remote Sensing and Information Systems, Department of Geoengineering, Andhra University, Visakhapatnam, 1992
- Invited talk on 'New mathematical tools to study structural dynamics' Andhra University Research Forum, Visakhapatnam, 1995.
- Invited talk on 'Attempts to establish an integrated mathematical approach to study certain geoscientific aspects' A.P. Akademi of Sciences, Visakhapatnam, 1995.
- Invited talk on 'Advanced mathematical tools to study certain geo-scientific aspects' Indian National Science Academy (INSA), New Delhi, 1996.
- Invited talk on 'Mathematical tools to study shapes' Tata Institute of Fundamental Research (TIFR), Bangalore, 1996.
- Invited talk on 'Fractal and mathematical morphological applications to study natural processes' Centre for Space Science Technology and Education-Asia Pacific (CSSTE-AP), Dehra Dun, 1998.
- Invited talk on 'Numerical simulations using first order nonlinear difference equation to study highly ductile symmetrical fold dynamics: a conceptual approach' Indian National Science Academy (INSA), New Delhi, 1998
- Invited talk on 'Extraction of river networks from digital elevation models by applying mathematical morphological transformations' Centre for Remote Imaging Sensing Processing

(CRISP), National University of Singapore, 1999.

- Invited talk on 'Exploring complex networks', Faculty of Engineering and Technology, Multimedia University, Malaysia, 2003.
- Invited talk on 'Conducting research, and writing papers for Journals and Conferences' Kolej University Technical Kebangsan Malaysia, Melaka, Malaysia, 2003
- Invited talk on 'Geophysical networks in a DEM, and allometric power-law relationships' Multimedia University, Melaka, Malaysia, 2003.
- Invited talk on 'Morphological analysis of Digital Elevation Models (DEMs) and associated features' Centre for Soft Computing Research, Indian Statistical Institute, Kolkata, 2008.
- Invited talk on 'Mathematical morphology in spatial information analysis' Andhra University College of Engineering, Visakhapatnam, 2008.
- Invited talk on A series of eight lectures on 'Mathematical Morphology' , Centre for Remote Sensing Andhra University College of Engineering, Visakhapatnam, 2009.
- Invited talk on 'Techniques for characterization and modeling of spatial phenomena' Curzonco-Seshachalam lecture (5) 2009, Sarada Ranganathan Endowment for Library Science, Bangalore, 2009.
- Invited talk on 'Network extraction from Digital Elevation Models and analyses of networks via mathematical morphology' University Centre for Earth and Space Sciences (UCESS), University of Hyderabad, Hyderabad, 2009.
- Invited talk on 'Visualization of spatiotemporal behavior of discrete maps via recursive generation of median elements', University Centre for Earth and Space Sciences (UCESS), University of Hyderabad, Hyderabad, 2009.
- Invited talk on 'Cellular Automata (CA) model for urban analysis' Workshop on Applying CA Model for Peri-Urbanization of Bangalore-An ISRO Sponsored Major Project work, Bangalore University, Bangalore, 2010.
- Invited talk on 'Cartograms via mathematical morphology' Workshop honouring Jean Serra, Indian Statistical Institute-Bangalore Centre, Bangalore, 2010.
- Invited talk on 'Median Maps and Cartograms via Mathematical Morphology', Indian Statistical Institute-Karnataka Chapter, Bangalore, 2011.
- Invited talk on 'Mathematical Morphology in Terrestrial Surface Characterization', Electronics & Radar Development Establishment (LRDE), DRDO, Bangalore, 2011.
- Invited talk (Georges Matheron Award Lecture of IAMG) on 'Mathematical Morphology in Geomorphology and GISci', IAMG Conference, Salzburg, Austria, 2011.
- Lecture on 'Introduction to Mathematical Morphology and its applications in Visualization', Five-Day Course on Spatial Statistical Tools in Data Processing and Analysis, 26 Nov 2012
- Lecture on 'Binary and Grayscale Granulometries', Five-Day Course on Spatial Statistical Tools in Data Processing and Analysis, 28 Nov 2012.
- Lecture on 'Spatial Interpolation and Extrapolation', Five-Day Course on Spatial Statistical Tools in Data Processing and Analysis, 30 Nov 2012.
- Delivered a series of eight lectures on 'Mathematical Morphology and Applications' at Kongu Engineering College, Tamilnadu, 8th-9th May 2013.
- A series of six lectures on "Image Pattern Analysis and Applications", at the Amrita School of Engineering, Bangalore, 09-10 November, 2013.
- Delivered invited lecture on 'Mathematical Morphology in Earth Systems Science" Contact Programme Workshop on "Earth Surface Dynamics" at Indian Institute of Technology-Gandhinagar, 10th December 2013.

- Delivered Inaugural lecture on 'Overview on Mathematical Morphology in Image Analysis' at a AICTE-Sponsored National Seminar on "Recent Trends and Developments in the Field of Computer Vision", VR Siddhartha Engineering College, Vijayawada, Andhra Pradesh, 20th December 2013.
- Delivered Inaugural lecture on 'Overview on Mathematical Morphology in Intelligent Systems' at BMS College of Engineering, Bangalore, 23 January 2014.
- Delivered three lectures at a workshop on “Spatial Information Analytics” at PESIT, Bangalore, 28 Feb 2014.
- Delivered Inaugural talk on “Mathematical Morphology in Image Processing and Analysis”, at ICICT conference, PESIT, Shimoga, 04 April 2014.
- Delivered three lectures at a workshop on “Mathematical Morphology in Signal Processing” at National Institute of Technology-Surathkal, 10 April 2014.
- Delivered three invited lectures at a training program on “Earth and Space Sciences” at University of Hyderabad, 29 Sep 2014.
- Delivered a series of 8 lectures at a short course on “Mathematical Morphology in Geosciences and GISci”, at Jawaharlal Nehru University (JNU), Delhi, 15-16 Oct 2014.
- Delivered Invited Talk on "Mathematical Morphological Interpolations for Morphing", at Multidisciplinary International Workshop on Artificial Intelligence-2014 (MIWAI-2014), 10 December 2014, Bangalore, India.
- Delivered a series of 15 lectures at a winter school on “Spatial Ecology & Remote Sensing”, at Indian Institute of Technology-Kharagpur, 15-26 December 2014.
- Delivered an invited talk on "Overview on Mathematical Morphology and Applications", Recent Emerging Trends in Computer Science", PESIT, Bangalore, 09 January 2015.
- A series of 26 Lectures (90 minutes each) on "Mathematical Morphology in Geosciences", 24 March - 08 April 2015, during SERB-DST Summer School on "Mathematical Morphology in Geosciences", at Indian Statistical Institute-Bangalore, India.
- Invited lecture on "Spatial Interpolations: Weighted Skeletonization by Influence Zones (WSKIZ) and Morphological Medians", IIT-Bombay, 05 June 2015.
- Three Hours Lectures on "Mathematical Morphology" at the First Workshop on Computing: Theory and Applications, at the Indian Statistical Institute (ISI) North-East Centre at Tezpur, Organized by: Computer and Communication Sciences Division (CCSD), ISI, 14 – 18 March, 2016.
- A Talk on "Applications of Mathematical Morphology in Remote Sensing and Geosciences: An Overview", at ITPAR Phase Three Concluding Workshop, held at IIT-Bombay, 18 April 2016.
- A series of 3 Lectures at the Amrita University-Coimbatore, 20 April 2016.
- A series of 6 lectures during One Week Faculty Development Programme on "Recent Trends in Signal and Image Processing", June 06-12, 2016, PSG College of Technology, Coimbatore, India.
- Keynote Address on "Overview on Mathematical Morphology and its Applications with Emphasis on Morphological Interpolations" at International Multi-Conference on Information Processing–2016, on 21 August 2016, at Capitol Hotel, Raj Bhavan Road, Bangalore, India.
- A series of 4 lectures at the Workshop on 'Mathematical Genomics' jointly organized by the Applied Statistics Unit of Indian Statistical Institute-Kolkata, and the Bioinformatics Centre, Tripura University, Agartala, India, 27 January 2017.

- Delivered 20 Lectures (Three-Credit Hour Course) on "Mathematical Morphology & Applications" during 02-05 May 2017 for Doctoral Students of Information and Communication Technology (ICT), International Doctoral School of the University of Trento, Italy.
- A Series of 4 lectures on "Mathematical Morphology and Image Analysis", 28 June 2017, Nirma University, Ahmadabad.
- A technical Talk on "Mathematical Morphology in Processing and Analyses of Digital Elevation Models (DEMs): An Illustrative Review", at IEEE BOMBAY GRSS CHAPTER, Indian Institute of Technology-Bombay, 19 July 2017.
- Full-Day Tutorial on "Mathematical Morphology in Interpolations and Extrapolations", on 23 July 2017, During IGARSS 2017, Fort Worth, Texas, USA, 23-28 July 2017.
- Keynote Talk on "Is there a single mathematical field that can address retrieval, analysis, reasoning, modeling and simulations, and visualization of information?", 2017 International Workshop on Frontiers in Mathematical Geosciences, held at Beijing, China, 13-16 November 2017.
- Invited Talk on Mathematical Morphology in Geographical Information Science and Geo-computing: An Overview, at Centre for Artificial Intelligence and Robotics (CAIR) Defence Research and Development Organisation, Bangalore, on 22 November 2017.
- Invited Talk on "Mathematical Morphology & Applications in Spatial Data Sciences", 30 November 2019, RV College of Engineering, Bangalore.
- Invited Talk on "Granulometries in Texture Analysis", 12th March 2019, Ramaiah Institute of Technology, Bangalore.
- Keynote talk on "Mathematical Morphology & Applications in Spatial Data Sciences", 21 March 2019, Periyar University, Salem.
- Delivered a talk via VC on "Mathematical Morphology in Spatial Informatics with emphasis on Digital Elevation Models", 20 March 2019, for a Group-6 of Chandrayaan-2 Project Members at Ahmadabad.
- Delivered Invited Lecture: "Mathematical Morphology in Spatial Data Sciences", 9th April, 2019, SMU Student Colloquium, Indian Statistical Institute-Bangalore Centre.
- Delivered Keynote / Inaugural Talks: "Mathematical Morphology & Applications in Spatial Data Sciences", 21 March 2019, Periyar University, Salem.
- Delivered a Talk via VC on "Mathematical Morphology in Spatial Informatics with emphasis on Digital Elevation Models", 20 March 2019, for a Group-6 of Chandrayaan-2 Project Members at Ahmedabad.
- Delivered Frank Harary Endowment Lecture: Delivered 'Frank Harary Endowment Lecture - 2019' on 8th June 2019 at International Conference on Discrete Mathematics - 2019 (ICDM - 2019), held at the Christ University, Bangalore, India.
- Delivered Invited Presentation: Delivered an Invited Talk (as the Leader of Group-6) on "Mathematical Modelling and Feature Extraction" at the Second Lunar Science Meet, during 13-14 June 2019, at the ISRO Head Quarters.
- Delivered Invited Lecture: "Morphological Interpolations", 15th July 2019, at the One-Week Workshop on "Image Fusion and Multimodal Imaging: Foundations to Advances", Ramaiah Institute of Technology, Bangalore.
- Delivered Invited Lecture: "Digital Elevation Models (DEMs) Derived from Remotely Sensed Satellite Data: A Rich Source of Information of Relevance to the Processing and Analysis of Hydrological Phenomena and Processes", 09 August 2019, at a workshop on "Big-Data and

Digital Agriculture", 08-09 August 2019, at University of Agricultural Sciences, GKVK, Bangalore.

- **2019-December: Tutorial Talk:** "Mathematical Morphology in Spatial Reasoning" 10 December 2019, at International Radar Symposium India – 2019, Bangalore, India
- **2019-December: Plenary Talk:** "Mathematical Morphology in Spatial Reasoning" 13 December 2019, at International Radar Symposium India – 2019, Bangalore, India
- **2019-December: Keynote Talk:** "Mathematical Morphology in Processing and Analysis of Digital Elevation Models", IEEE Hyderabad Section/GRSS Joint Chapter Winter School on Advances in Remote Sensing and Applications at Vignan University, 20 December 2019.
- **2019-December: Keynote Talk:** "Mathematical Morphology in Spatial Data Sciences", at National Conference on Data Sciences – A Statistical Perspective (In honor of Prof. C. R. Rao on his 100th Year), 27 & 28 December 2019, held at Osmania University, Hyderabad, India.
- **2020-February: Invited Talks:** "Mathematical Morphology in Quantitative Geomorphology", at National Workshop on Quantitative Geomorphology, 07-21 February 2020, held at IIT Gandhinagar, Ahmedabad, India.
- **2020-June: Keynote on** "Mathematical Morphology in Geospatial Data Science: An Overview", National Seminar (Webinar) on "Remote Sensing and GIS Applications for Earth Surface Processes and Resource Monitoring, ADIKAVI NANNAYA UNIVERSITY, COLLEGE OF SCIENCE AND TECHNOLOGY, RajarajaNarendra Nagar, NH-16, Rajamahendravaram – 533296. (A.P.)
- **2020-September: IGARSS-2020: Full Day Tutorial** on "Mathematical Morphology in Interpolations and Extrapolations" IGARSS-2020, 26-27 September 2020.
- **2020-November: Keynote on** "Mathematical Morphology in Geoscience and Remote Sensing", AICTE ATAL Sponsored programme on "Advanced Geo-Computational Techniques (AI & Computing for Remote Sesing Remote Sensing and GIS", INDIAN INSTITUATE OF SPACE SCIENCE AND TECHNOLOGY (IIST). Thiruvananthapuram – 695 547
- **2020-November: IEEE GRSS DL Talk on** "Mathematical Morphology in Geosciences, Remote Sensing and Geospatial Data Science: An Overview", IEEE Workshop on Geoscience and Remote Sensing 2020 (IWGRS2020), Virtual Conference from Malaysia, 24 November 2020
- **2020-December: Keynote talk** on "Mathematical Morphology in Geospatial Data Science: An Overview", Geospatial Intelligence Symposium, 15 December 2020, V J Technological Institute, Mumbai-400019
- **2020-December: IEEE GRSS DL Talk on** "Topic-1-Mathematical Morphology in Geosciences, Remote Sensing and geospatial data Science: An Overview" Sponsored by IEEE GRSS-Turkey Chapter, Tuesday, December 8, 2020.
- **2020-December: IEEE GRSS DL Talk on "Topic-2-**"Processing and Analysis of Digital Elevation Models (DEMs) via Grayscale Granulometries, Morphological Interpolations, and Morphological Distances**,** " Sponsored by IEEE GRSS-Turkey Chapter, Tuesday, December 8, 2020.
- **2020 December: Keynote talk on "**Mathematical Morphology in Spatial Data Sciences: An Overview**",** Five Days Online Faculty Development Program On Geospatial Technology and Its Application, December 14th–18th, 2020, National Institute of Technology, Manipur
- **2021-March: IEEE GRSS DL Talk on** "Processing and Analysis of Digital Elevation Models (DEMs) via Grayscale Granulometries, Morphological Interpolations, and Morphological Distances" Sponsored by IEEE GRSS-Saudi Arabia Chapter, Sunday, January 24, 2021.
- **2021-March: IEEE GRSS DL Talk on** IEEE.tv on "Mathematical Morphology in Geosciences, Remote Sensing, and Geospatial Data Science: An Overview", hosted by the IEEE GRSS on IEEE.tv Live Streaming, 02 March 2021.
- **2021-March: IEEE GRSS DL Talk** on "Morphological Interpolations in geoscience and Remote Sensing", Virtual Workshop on "Remotely Sensed Data Analysis", Sponsored by IEEE GRSS KOLKATA CHAPTER, Saturday, March 13, 2021.

- **2021-April: Keynote** on "Mathematical Morphology in Spatial data Sciences: An Overview", International Conference on Data Science, Computation and Security, Department of Data Science, CHRIST (Deemed to be University), Pune Lavasa Campus, Saturday, April 17, 2021.
- **2021-July: Invited Talk** on "Mathematical Morphology and image Analysis", at ATAL FDP ON MACHINE LEARNING AND COMPUTER VISION (ADVANCED), Vignan University, Guntur, 7th July 2021.
- **2021-July: Invited Talk** on "Mathematical Morphology in Geosciences, Remote Sensing, and Geospatial Data Science: An Overview", at GRSS-Bangalore Chapter's Two Weeks Online Summer School on MACHINE AND DEEP LEARNING FOR REMOTE SENSING APPLICATIONS, 15th July 2021.
- **2021-July: Invited Talk** on "Mathematical Morphology in Geosciences, Remote Sensing, and Geospatial Data Science: An Overview", at ATAL FDP ON 'Applications on Artificial Intelligence on Geospatial Data', Maulana Abul Kalam Azad University of Science and Technology, West Bengal, 26th July 2021.
- **2021-August: IEEE GRSS DL Talk** on "Mathematical Morphology in Geosciences, Remote Sensing, and Geospatial Data Science: An Overview", hosted by the IEEE CIS/GRSS Joint Chapter Hyderabad Section in Association with Guntur Section, 21 August 2021.
- **2021-November: IEEE GRSS DL Talk** on "Mathematical Morphology in Processing and Analysis of the Digital Elevation Models", hosted by the IEEE Brazil GRSS-ISPRS Chapter, Santa Catarina State University (UDESC), Brazil, 11 November 2021.
- **2021-December: IEEE GRSS DL Talk** on "Geospatial Intelligence and Mathematical Morphology", hosted by the IEEE GRSS Bombay Chapter, Mumbai, 04 December 2021.
- **2021-December: IEEE GRSS DL Talk** on "Processing and Analysis of Digital Elevation Models (DEMs) via Grayscale Granulometries, Morphological Interpolations, and Morphological Distances", hosted by the IEEE GRSS Bombay Chapter, Mumbai, 11 December 2021.
- **2022-June:** Invited Talk on Mathematical morphology IN GEOSPATIAL DATA SCIENCE: an overview, 5-Day- CEP Course on "Geospatial Technology" (20-24 June 2022), Centre for Artificial Intelligence and Robotics (CAIR), Defense Research Development Organisation (DRDO), Tuesday, June 21, 2022, 11.45 (IST)
- **2022-July: IEEE CONNECT – 2022**: Plenary Talk on "Digital Elevation Models: A Rich Source of Data for Earth and Planetary Scientists", Hosted by IEEE Bangalore Section, Bangalore, 13 July 2022.
- **2022-July:** Full-Day Tutorial on Mathematical Morphology in Processing and Analysis of the Digital Elevation Models (DEMs), at IGARSS-2022, Kuala Lumpur, Malaysia, 15 July 2022.
- **2023-January:** Invited Talk on An Important Source of Data for Earth and Planetary Geoscientists: Mathematical Morphological Treatment of DEMs, Center for Applications and Research in Remote Sensing (CARTEL), at the University of Sherbrooke, Quebec, Canada. Midi-MAP (Midi pour apprendre et partager), Thursday, January 19, 2023, 10.30-11.30 PM IST
- **2023-July:** Inaugural Fellow Talk on Mathematical morphology IN digital elevation models, 89th anniversary general Meeting of INDIAN NATIONAL SCIENCE ACADEMY, December 06-08, 2023, 15.05 – 15.20, (IST) Inaugural Fellow Talk on Mathematical morphology IN Geosciences and Geospatial data Sciences, at 89th Mid Year Meeting of the INDIAN ACADEMY OF SCIENCES, Friday & Saturday, July 07-08, 2023, 17.30 (IST)
- **2023-August:** Inaugural Talk on (Geo)spatial data Sciences via Mathematical morphology based spatial algorithms, The IEEE Geoscience and Remote Sensing Society Student Branch Chapter (SBC) at the NIE Mysuru, Tuesday, August 08, 2023, 12.00 Noon (IST)
- **2023-November:** IEEE GRSS Distinguished Lecture (DL) Talk on Mathematical morphology IN digital elevation models, IEEE Workshop on Geoscience and Remote Sensing 2023 (IWGRS2023), 7 November 2023, Melaka, Malaysia, 09.10 hrs (Malaysian Time)
- **2024-April:** Invited Webinar Talk on Mathematical morphology IN digital elevation models, ISPRS WG-iii/9 webinar series theme: environmental hazards and terrain modeling, 12-April-2024, 20.30 – 21.30, (IST)

- **2024-May:** Invited Talk by B. S. Daya Sagar, on Mathematical Morphology, Fractals, and Power-Laws in Geo-Spatial Data)-Sciences: An Overview, at Pre-Conference Workshop on Computational Geosciences for Sustainable Development, Indian Institute of Technology, Bombay. Thursday, May 30, 2024. 09.30 hrs to 11.00 hrs.
- **2024-June:** Keynote Talk on GEOSPATIAL INTELLIGENCE VIA MATHEMATICAL MORPHOLOGY: AN OVERVIEW, IEEE GRSS Workshop, at NMIT, Bangalore, June 8th 2024
- **2024-July:** Keynote Talk on Mathematical Morphology IN GEO(SPATIAL DATA)SCIENCES: An Overview, at Young Professionals in Space 2024, https://buec.com.tr/ypinspace, Hosted By: IEEE Students Chapter, Bogazici University, Bogazici University South Campus, Demir Demirgil Hall, Istanbul, TURKEY, July 14, 2024
- **2024-August:** Keynote Talk on Mathematical Morphology IN GEO(SPATIAL DATA)SCIENCES: An Overview, Workshop on Innovate in Artificial Intelligence: DSE Day, Hosted By: Data Science and Engineering Department Indian Institute of Science, Education and Research (IISER), Bhopal, August 21, 2024
- **2024-August:** Invited Talk on Mathematical Morphology IN GEO(SPATIAL DATA)SCIENCES: An Overview, NPOL-DRDO, Cochin, August 28, 2024.
- **2024-November**: Keynote Talk on “Mathematical Morphology in Spatial Data Sciences”, at the International Conference on Data Science and Communication – 2024, Siliguri Institute of Technology, Siliguiri, India, 21 November 2024.
- **2024-December**: Keynote Talk on “Mathematical Morphology in Retrieval, Analysis, Reasoning, and Modelling and Visualization of Patterns of Geoscience Relevance: An Illustrative Overview, at the 13th International Conference of Association of Pattern Recognition (IAPR) -2024. 01 December 2024. Kolkata, India
- **2024-December**: Keynote Talk on "Mathematical Morphology to Understand Spatial Data", ATAL Faculty Development Program (FDP) on "Geo-AI: Innovations in AI for Improved Spatial Data Processing," 4th December 2024.
- **2024-December**: Keynote Talk on "Mathematical Morphology in Spatial Data Science: An Illustrative Overview", 3rd International Conference on Data, Decision and Systems, December 5-7, 2024, In-person Conference | PES University, Bengaluru, India. 06 December 2024.
- **2025-January**: Keynote Talk on "Mathematical Morphology in Spatial Data Science: An Illustrative Overview", Atal FDP on Artificial Intelligence in Remote Sensing, January 20-25, 2025, Sikkim Manipal University, Gangtak, Sikkim, India. 24 January 2025.

5.2.4 Computer Simulations

- Epidemic spread: http://www.isibang.ac.in/~bsdsagar/AnimationOfEpidemicSpread.avi
- Population Cartogram: http://www.isibang.ac.in/~bsdsagar/AnimationOfPopulationCartogram.wmv
- Perimeter Cartogram: http://www.isibang.ac.in/~bsdsagar/AnimationOfPerimeterCartogram.wmv
- Point-Poly-Conversion: http://www.isibang.ac.in/~bsdsagar/AnimationOfPointPolygonConversion.wmv
- Direction-Relate: http://www.isibang.ac.in/~bsdsagar/AnimationOfDirectionalSpatialRelationship.wmv
- Spatial-Interaction: http://www.isibang.ac.in/~bsdsagar/MGM-Spatial-Interaction.avi
- Morphing-1: http://www.isibang.ac.in/~bsdsagar/Morphing-1.avi
- Morphing-2: http://www.isibang.ac.in/~bsdsagar/Morphing-2.avi
- Morphing-3: http://www.isibang.ac.in/~bsdsagar/Morphing-3.avi

5.3. Supervision of PhD and Master Students and Short-Term Interns

5.3.1 Doctoral Students

1. P. Radhakrishnan, (PhD Thesis on "Discrete simulation, spatial modelling and characterisation of certain geophysical phenomena"), Faculty of Engineering & Technology, Multimedia University, Melaka, Malaysia, 2004, Current Position: Assistant Professor, King Khaled University, Saudi Arabia
2. L. Chockalingam, (PhD Thesis on "Analyses of Complex Topological and Surficial features Retrieved from Contour based Digital Elevation Models (DEMs) and Remotely Sensed Data"), Faculty of Engineering & Technology, Multimedia University, Melaka, Malaysia, 2005, Current Position: Senior Lecturer, Faculty of Information Science & Technology, Multimedia University, Malaysia
3. Teo Lay Lian, (PhD Thesis on "Quantitative Characterisation of Complex Porous Phase via Mathematical Morphology and Fractal Geometry"), Faculty of Engineering & Technology, Multimedia University, Melaka, Malaysia, 2006. Current Position: Senior Lecturer, Faculty of Information Science & Technology, Multimedia University, Malaysia
4. Tay Lea Tien, (PhD Thesis on "Scaling and Morphologic Analyses of TOPSAR DEMs: A Quantitative Characterization Perspective"), Faculty of Engineering, Multimedia University, Cyberjaya, Malaysia, 2008. Current Position: Senior Lecturer, University of Sains Malaysia, Malaysia
5. Alan Tan Wee Chet, (PhD Thesis on "Signal Modelling and characterization"), Faculty of Engineering & Technology, Multimedia University, Melaka, Malaysia, 2008. Current Position: Associate Professor, Faculty of Engineering & Technology, Multimedia University, Malaysia.
6. Lim Sin Liang, (PhD Thesis on "Derivation of novel quantitative characteristics from certain geophysical fields via mathematical morphological analysis"), Faculty of Engineering & Technology, Multimedia University, Melaka, Malaysia, 2011. Current Position: Senior Lecturer, Faculty of Engineering, Multimedia University, Malaysia
7. Rajashekara H. M., (PhD Thesis on "Design and Development of a Computational Framework for Spatio-Temporal Model"), PhD Awarded in 2018, Bharathiar University.
8. Rajendra Mohan Panda, (PhD Thesis on "Environmental Determinants of Plant Richness in Indian Himalaya"), Indian Institute of Technology-Kharagpur, PhD Awarded in 2018
9. Sravan Danda (PhD Thesis on "Some Applications of the Power Watershed Framework to Image Segmentation and Image Filtering", Indian Statistical Institute-Bangalore, PhD Awarded in 2019)
10. Aditya Challa (PhD Thesis on "Some Studies on Mathematical Morphology for Unsupervised and Semi-Supervised Learning" submitted, Indian Statistical Institute-Bangalore, PhD Awarded in 2019)
11. Ashok Vardhan Sanda, (PhD Thesis on "Automatic Feature Based Classification Using Morphological Granulometries, Fractal Analysis, and Metric Based Distance Computations"), Bharathiar University, PhD Awarded in 2021.
12. K. Nagajothi, (PhD Thesis on Geographic terrain evaluation using Digital Elevation Model and Mathematical Morphology), PhD Awarded in 2022, Bharathiar University
13. Sampriti Soor, (PhD Thesis on Some Extensions of Watershed-Based Clustering Methods for Connected Data), PhD Awarded in 2022, Indian Statistical Institute-Bangalore
14. Sudeepa Roy-Dey, (PhD Thesis on Epidemiological Models And Genealogy Tree In Measuring Scholastic Influence: A Linkage Study Via Machine Learning), PhD Awarded in 2022, Visvesvaraya Technological University (VTU)
15. Swati Sampatrao-Ghambhire, (PhD Thesis on Hierarchical and Quantitative Approaches to Influence and Internationality Estimation of Research Institutions - A Study In Machine Learning), PhD Awarded in 2024, Visvesvaraya Technological University (VTU)
16. Geetika Barman, (PhD Thesis on Some Studies on Mathematical Morphology in Remotely Sensed Data Analysis), PhD Awarded in 2024, Indian Statistical Institute-Bangalore

5.3.2 Masters in Engineering Science Thesis Students

- Dinesh Sathyamoorthy, "Extraction of Hydrogeomorphic Features From Digital Elevation models DEMs Using Morphology", Faculty of Engineering & Technology Multimedia University, Melaka, Malaysia, 2006.
- Uma Devi, "DNA Landscape Analysis via Mathematical Morphology", Faculty of Engineering & Technology, Multimedia University, Melaka, Malaysia -

Nihal Alam (currently working for Tata Consultancy Service, New Delhi), "Overview of GIS and GIS Resources", Documentation Research and Training Centre, Indian Statistical Institute, Bangalore, India, 2009
- Shion Guha (currently pursuing PhD at Computer Science Department of Cornell University, US), "Social Network Analysis", Documentation Research and Training Centre, Indian Statistical Institute, Bangalore, India, 2010
- Debayan De (currently working at Facebook, Hyderabad), Documentation Research and Training Centre, Indian Statistical Institute, Bangalore, India, 2011
- Usashi Chatterjee (currently pursuing PhD at Computer Science Department of Dalhousie University, Canada), Documentation Research and Training Centre, Indian Statistical Institute, Bangalore, India, 2012

5.3.3 Visiting Students

- Prakash, Department of Geoengineering, Andhra University, Waltair, Andhra Pradesh, Current Position: Doctoral Candidate, CSRE, IIT-Bombay, Mumbai.
- Sarif Hasan, Applied Statistics Unit, Indian Statistical Institute, Kolkata, Current Position: Doctoral Candidate, Applied Statistics Unit, Indian Statistical Institute-Kolkata, India.
- Shreya Roy Chaudhuri, National Institute of Technology, Surtahkal, Current Position: Software Engineer at HP Labs.
- Pratap Vardhan, National Institute of Technology, Bhopal, Current Position: Research Assistant at Super Computer Education and Research Centre, Indian Institute of Science
- Saransh Singh, Indian Institute of Technology-Bombay, Mumbai, Current Position: PhD student, CMU
- Ranjeet Rout, Applied Statistics Unit, Indian Statistical Institute, Kolkata, Current Position: Doctoral Candidate, Applied Statistics Unit, Indian Statistical Institute-Kolkata, India.

5.3.4 Scientists Visited Prof. Daya Sagar

- Gustav Camps-Valls, University of Valencia, Spain, 2019
- Jennifer McKinley, Queen's University-Belfast, UK, 2018
- Gregoire Mariethoz, University Lusanne, Switzerland, 2018
- Alejandro Frery, Brazil, 2018
- William J Emery (FIEEE), Colorado University-Boulder, USA, 2017
- Paul A. Rosen (FIEEE), Jet Propulsion Labs-NASA, California Institute of Technology, USA, 2015-17
- Akira Hirose (FIEEE), Department of Electrical Engineering and Information Systems, The University of Tokyo, Japan, 2014
- H. K. Ramapriyan (SMIEEE), NASA, USA, 2014.
- Katsuaki Koike, Department of Urban Management, Kyoto University, Japan, 2014.
- Vera Pawlowsky-Glahn, Universitat de Girona, Spain, 2014
- Juan Jos´e Egozcue, Technical University of Catalonia, Spain, 2014
- Qiuming Cheng, President, International Association for Mathematical Geosciences (IAMG-USA), York University, Canada, 201
- Francesca Bovolo, Department of Computer Science, University of Trento, Italy, 2014.
- Lorenzo Bruzzone (FIEEE), Department of Computer Science, University of Trento, Italy, 2014.
- John (Jack) Schuenemeyer (President), Statistical consulting Corporation, Colorado, USA, 2012.
- Peter M. Atkinson (Professor), University of Southampton, 2012
- Robert Marschallinger (Professor), University of Salsburg, 2012
- Wolfgang-Martin Boerner (FIEEE) (Emeritus Professor), University of Illineois-Chicago, 2005, 2011, 2012, 2014
- Sitarama Iyengar (FIEEE) (Professor and Chairman), Lousiana State University, USA, 2009, 2010, 2011
- Eduardo Beira (EDAM Professor), University of Minho, Portugal, 2011
- Pedro Pina (Professor), IST –Instituto Superior Técnico, CERENA –Centro de Recursos Naturais e

Ambiente, Lisboa, Portugal, 2010
- Laurent Najman (Professor), ESIEE, France, University of Paris-EST, 2010
- Jean Cousty (Professor), ESIEE, France, University of Paris-EST, 2010
- Christer Kiselman (Emeritus Professor), Department of Mathematics, Uppsala University, Sweden, 2010
- John Stell (Senior Lecturer), Department of Computer Science, University of Leeds, Leeds, London, 2009
- Jean Serra (Director), Centre for Mathematical Morphology, Paris School of Mines, Fontainbleau, France, 2005 & 2007, 2010.
- B. L. Deekshatulu (FIEEE), (Visiting Professor), School of Computers and Information Systems, University of Hyderabad, India, 2007-2014.

5.3.5 Administrative Positions & Activities

2023—2027 : Head of the Indian Statistical Institute, Bangalore Centre
2012—2013 : Member of National-Level Committee for Validating Normalization formula of Class XII Board Marks
2009—2013 : Head of the Systems Science and Informatics Unit (SSIU), Indian Statistical Institute, Bangalore Centre
2004—2007 : Deputy Chairman, Centre for Applied Electromagnetics (CAEM), Multimedia University, Malaysia
2009—2015 : Ex-Officio Member of Work Advisory Committee, Indian Statistical Institute-Bangalore Centre
2009—2014 : Purchase Order Committee, Indian Statistical Institute-Bangalore Centre
2009—2010 : Central Computer Committee (CCC), Indian Statistical Institute-Bangalore Centre
2005-2007 : Research and Development Committee, Faculty of Engineering and Technology, Multimedia University, Malaysia
2002—2003 : Member of Advisory Committee for Bachelors Program in Bioengineering, Faculty of Engineering and Technology, Multimedia University, Malaysia

5.3.6 External Funding Procured for Projects

2019-2022 B. S. Daya Sagar (PI), ITPAR-Phase-IV / Department of Space (INR 136.00 lakhs)
2016-2019: B. S. Daya Sagar (PI), Department of Space (INR 28.00 lakhs)
2016-2019: B. S. Daya Sagar (Co-PI: Department of Science & Technology (INR 140.09 lakhs)
2016-2019: B. S. Daya Sagar (PI), Project from Science and Engineering Research Board (SERB), Department of Science and Technology (DST), Government of India, INR 60 lakhs
2013-2014: B. S. Daya Sagar (PI), Science and Engineering Research Board (SERB), Department of Science and Technology (DST), Government of India, provided grant to organize a Summer School during 24 March-08 April 2014, INR 6 lakhs.
2013-2016: B. S. Daya Sagar (PI), Project from Internal Grants of Indian Statistical Institute, INR 10 lakhs
2010-2013: B. S. Daya Sagar (PI), Project from Internal Grants of Indian Statistical Institute, INR 7 lakhs
2010-2010: B. S. Daya Sagar (PI), Board of Research in Nuclear Sciences (BRNS), provided grant to organize a Course and a Workshop held in succession during 19-27 October 2010, INR 3 lakhs.
2007-2010: B. S. Daya Sagar (PI), MOSTI (Malaysian Govt fund), MYR1,10,000
2006-2008: Jean Serra (PI) and B. S. Daya Sagar (Leader Representing Malaysia), "Modeling and Simulations of Disasters", ICT-ASIA Project, French Government
1998-2000: B. S. Daya Sagar (PI), EMCAB Project from Indira Gandhi Institute for Development Research (IGIDR), World Bank Project, INR 10 lakhs
1998-1998: B. S. Daya Sagar (PI-Research Associate), Council of Scientific and Industrial Research, India
1996-1997: B. S. Daya Sagar (PI-Research Scientist), "Studies on structure Behaviour Relationship of 2-D Discrete Natural Features", Department of Science and Technology (Govt. of India), INR 5.5 lakhs
1995-1995: B. S. Daya Sagar (PI-Research Associate), "Studies on Morphometry and Discrete Simulation of

Channel networks", Council of Scientific and Industrial Research, India

1992-1994: B. S. Daya Sagar (PI-Senior Research Fellow), "Applications of Remote Sensing, Mathematical Morphology and Fractals to study certain surface water bodies" Council of Scientific and Industrial Research, India

5.3.7 Online Lectures by Prof. B. S. Daya Sagar

- Talk on "Mathematical Morphology in Spatial Data Sciences", given at the National Conference on Data Sciences: A Statistical Perspective", held on 27th December 2019, Osmania University, Hyderabad, India. YouTube Link: https://www.youtube.com/watch?v=nrYPjouiI00
- Lecture-1: International Summer / Winter Term at IIT-Kharagpur, India, (15-27 December 2014) YouTube Link: https://www.youtube.com/watch?v=S3dTzGANFXE
- Lecture-2: International Summer / Winter Term at IIT-Kharagpur, India, (15-27 December 2014) YouTube Link: https://www.youtube.com/watch?v=c85xwTxLIqE
- Lecture-3: International Summer / Winter Term at IIT-Kharagpur, India, (15-27 December 2014) YouTube Link: https://www.youtube.com/watch?v=o_clIpiKVbY
- Lecture-4: International Summer / Winter Term at IIT-Kharagpur, India, (15-27 December 2014) YouTube Link: https://www.youtube.com/watch?v=tmJ4_eTpsvo
- Lecture-5: International Summer / Winter Term at IIT-Kharagpur, India, (15-27 December 2014) YouTube Link: https://www.youtube.com/watch?v=srcxWGooKIs
- Lecture-6: International Summer / Winter Term at IIT-Kharagpur, India, (15-27 December 2014) YouTube Link: https://www.youtube.com/watch?v=Ux4GDXBrjqs
- Lecture-7: International Summer / Winter Term at IIT-Kharagpur, India, (15-27 December 2014) YouTube Link: https://www.youtube.com/watch?v=MOsIcIlYCeU
- Lecture-8: International Summer / Winter Term at IIT-Kharagpur, India, (15-27 December 2014) YouTube Link: https://www.youtube.com/watch?v=k0TYI7gjkw0
- Lecture-9: International Summer / Winter Term at IIT-Kharagpur, India, (15-27 December 2014) YouTube Link: https://www.youtube.com/watch?v=b4D7JtGAoUE
- Lecture-10: International Summer / Winter Term at IIT-Kharagpur, India, (15-27 December 2014) YouTube Link: https://www.youtube.com/watch?v=-XLQ4Rz2UTw

5.4. Examiner for PhD Theses

- Adjudicator/Supervisor in Doctoral Committee for 7 candidates, Faculty of Engineering and Technology, Multimedia University, Malaysia, 2003—2007
- Adjudicator in Doctoral Committee, Manonimanian Sundarnar University, India, 2005
- Adjudicator in Doctoral Committee, Alagappa University, India, 2006.
- Adjudicator in Doctoral Committee, Jawaharlal Technological University (JNTU), India, 2008 - Adjudicator in Master in Engineering Science (by Research) Doctoral Committee for 5 Candidates, Faculty of Engineering and Technology, Multimedia University, Malaysia (2002—2007).
- Adjudicator in Doctoral Committee, University of Hyderabad, India, 2011, 2012, 2017, 2018.
- Adjudicator in Doctoral Committee, Indian Institute of Science (IISc), India, 2011.
- Adjudicator in Doctoral Committee, Andhra University College of Engineering, India, 2012, 2013, 2014.
- Member Doctoral Committee, Indian Institute of Space Science and Technology, Trivandrum, 2011-2014, 2017, 2018
- Member, Board of Studies of Computer Science and Systems Engineering, RV College of Engineering, Visweswariah University of Technology, Bangalore, 2008-2012
- Member Doctoral Committee, Indian Institute of Technology, Bombay, 2015, 2017, 2018, 2019
- Member Doctoral Committee, Bharathiar University, Coimbatore, 2017
- Member Doctoral Committee, Multimedia University, Malaysia, 2017, 2019
- Member Doctoral Committee, Anna University, Chennai, 2018-19
- Member Doctoral Committee, Indian Institute of Technology, Gandhinagar, 2019-20
- Member Doctoral Committee, Indian Institute of Information Technology, Guwahati, 2022
- Member Doctoral Committee, Visvabharathi University, Calcutta, 2022

5.5. Teaching Expertise

5.5.1. At The Andhra University
M.Tech Subject, Mathematical Morphology, 2008-2009
M.Tech Subject, Digital Image Processing, 1992-1996
M.Tech Subject, Remote Sensing & GIS, 1992-1996
M.Tech Subject, Quantitative Geomorphology, 1992-1996

5.5.2. At The National University of Singapore
Fortnightly Seminar, Remote Sensing Data Analysis, 1999

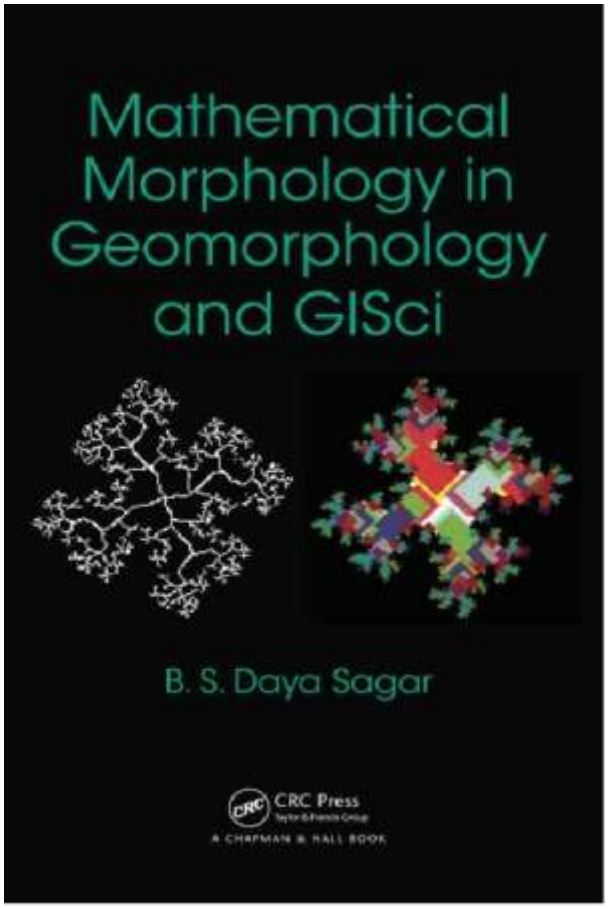
5.5.3. At The Telekom University Malaysia (Multimedia University)
PEM1016, Engineering Mathematics-1, Trimesters 1 & 2: 2001-07
PEM2036, Engineering Mathematics-3, Trimester 3: 2001-07
ECP3056, Digital Image Processing, Trimester 3: 2002
EMM4076, Computer Graphics and Virtual Reality, Trimester 3: 2003-06
ECT1026, Field Theory, Trimester 1: 2002

4.5.4. At The Indian Statistical Institute
Paper 6, Elements of Mathematics-1, Semester 1: 2008-09
Paper 12, Elements of Mathematics -2, Semester 2: 2009, 2011
Paper 8, Elements of Statistics and Research Methodology (Part 2), Semester 2: 2009
Paper 10, Data Structures and Computer Programming (Part 2), Semester 2: 2009
Paper 13, Information Storage, Retrieval and DBMS, Semester 3: 2009-2015
Paper 21, Geographic Information Systems, Semester 4: 2010-2016
Elective, Mathematical Morphology and Applications, Semester 5: 2015
Special Topics on Mathematical Morphology in Geomorphology and GISci, 2010, 2011, 2012

5.5.5. At following Institutes, Dr. Sagar introduced a subject "Mathematical Morphology and Applications"
The Indian Statistical Institute, BMath, MTech-Computer Science, JRF-Computer Science
The National Institute of Technology-Karnataka, BE (Electrical and Electronics Engineering)
ICT Doctoral School, University Trento, Italy (Doctoral Students)

6. Appendix-I: Details of Two Recent Monographs of Prof. B. S. Daya Sagar

B. S. Daya Sagar (2013) ***Mathematical Morphology in Geomorphology and GISci****, CRC Press, Boca Raton, FL, p. 546.*



What is so appealing about this book is that the author introduces geomorphology using models of mathematical structure that are rooted in new approaches to geometry, particularly fractals and chaos. He adopts a basic model of a fractal river basin from which he extracts skeletal structures, thereby introducing ideas about networks in the landscape in an entirely natural way. He uses this as a basis for developing many other aspects of mathematical morphology – the use of sets to generate partitions of areas, the use of interpolation to produce surface representations and the identification of spatial clusters. Towards the end of the book, he generalises many of these ideas to more human spatial systems using the regionalisation of India as his exemplar and in so doing, he has produced as comprehensive a treatment of morphology in geographic information science as you will find anywhere. This is an important book that should be explored by all those who profess to be interested in spatial morphologies.

—**Michael Batty**, FRS, University College London

Since the initial birthing of computational geography and GIS over fifty years ago, the field of Geography has been evolving with many contributions from both the academic and research side as well as the application world. I am happy to see the emergence of the book "Mathematical Morphology in Geomorphology and GISci". This text further extends our understanding of GIScience how fundamental quantitative approaches can extend how we understand geography and our world.

—**Jack Dangermond**, President, Esri

This is a unique book on the analysis of various Geomorphology problems using mathematical morphology. The author is an acknowledged expert on the subject and this specialized book is the outcome of over fifteen years of continued research by him. Spreading over more than 500 pages in fourteen chapters, the book elaborately deals with feature extraction, analysis, reasoning, and modelling of spatio-temporal terrestrial data. The topics are described in a lucid manner with many examples and figures, making them easy to

understand. Though primarily aimed for geo-morphologists, this book will be helpful for researchers working in problems of geography, cartography, geology, remote sensing and pattern recognition.
—**Bidyut B Chaudhuri**, FIEEE, Indian Statistical Institute
The monograph provides, in a consolidated manner, an application of mathematical morphology to structural geology, particularly addressing the issues like quantitative, morphologic and scaling analyses to terrestrial phenomena and processes. Texts on retrieval, modelling and reasoning, for example, are also useful to other application domains related to machine learning and pattern analysis.
—**Sankar K Pal**, FIEEE, Indian Statistical Institute

"... book on "Mathematical Morphology in Geomorphology and GISci" by Daya Sagar considers various topics—like pattern retrieval, pattern analysis, spatial reasoning, and simulation and modelling—of geoscientific interest. ... these intertwined topics which are useful for understanding the spatiotemporal behaviour of many terrestrial phenomena and processes, various original algorithms and modelling techniques that are mainly based on mathematical morphology, fractal geometry, and chaos theory have been presented in this book of 14 chapters. ... the journey through this book should provide geomorphologists and GISci specialists a new experience and exposition, and a host of new ideas to explore further in the contexts of quantitative geomorphology and spatial reasoning. ... book should be of immense value to the postgraduates, doctoral and post-doctoral students who would like to venture into applications of mathematical morphology in geomorphology and GISci."
—From the Afterword by **Arthur P Cracknell**, FRSE, University of Dundee

Prof Daya Sagar is a leading authority who has made major research contributions in most aspects of the applications of mathematical morphology and fractal geometry in terrestrial geomorphology and spatial informatics. This unique book on "Mathematical Morphology in Geomorphology and GISci"—highlighted numerous cases, imminent for those interested in venturing into developing physics-based models useful in geocomputation, and spatial informatics—takes an algorithmic approach to efficiently handle with topics related to (i) retrieval of complex terrestrial phenomena, (ii) analysis and reasoning of such retrieved phenomena, (iii) modeling and visualization of various terrestrial processes, and (iv) spatial informatics. The choice of the author, in this book, to combine mathematical morphology and fractal geometry, being the most powerful ideas in geometric sense, is perfectly right and appropriate for quantitative characterization of terrestrial phenomena and processes that exhibit plethora of geometric features and processes ranging from 'simple' to 'strange'.
—**B. L. Deekshatulu**, FIEEE, Institute for Development and Research in Banking Technology

This enticing book introduces mathematical morphology to GI scientists in way that is persuasive and accessible using ideas that the author himself has pioneered in the last 20 years. It should be read by all those with an interest in how we represent surfaces in the environmental and urban domain.
—**Michael Batty**, FRS, University College London

"…great care is taken in introducing the morphological notions in a pedagogical way. … the numerous examples will allow engineers and researchers in structural geology to exercise their creative faculties and to find new formulations of their own problems."
—From the Foreword by **Jean Serra**, Co-Founder of Mathematical Morphology, Université Paris-Est

"A wide-ranging treatise by an erudite scholar"
—**Jayanth Banavar**, Dean, College of Computer, Mathematical, and Natural Sciences, University of Maryland

"This book attacks the deep problem of analyzing mathematically the form of landscapes by mathematical tools, in particular by involving the discipline founded by geoscientists Matheron and Serra, Mathematical Morphology. The approach is original and pedagogic. It combines systematically experiments on numerical synthetic landscape models with experiments on real digital elevation models. Some chapters are very original, as they aim at the explanation of complex geomorphological phenomena. For example the formation of dunes is explored by its underlying bifurcation theory."
—**Jean-Michel Morel**, Editor-In-Chief of *SIAM Imaging Science*, Ecole Normale Supérieure de Cachan, Department of Mathematics, CMLA, France

"The book describes several techniques of mathematical morphology to address problems of image processing and data analysis with applications in geophysical information retrieval, analysis, reasoning, and modeling. Some of the specific topics presented include functions, sets, and skeletons as terrestrial surfaces; threshold-decomposed features; and geophysical networks. The aims of the methods described in the book are to extract information about the geometrical structure of an object, such as a water body, basin, channel network, and section of a water body, using concepts of mathematical morphology. The book provides not only details of various techniques of mathematical morphology, but also several illustrations of application. In some of the interesting illustrations in the book, specific geomorphological features are subjected to transformations by using various of structuring elements to achieve multiple effects and different results. Examples are provided to demonstrate how the main characteristics of a structuring template, such as shape, size, origin, and orientation, affect the results in different ways. It is shown how the topological characteristics of a water body, such as spatial distribution, morphology, connectivity, convexity, smoothness, and orientation, can be characterized by different structuring templates. One of the several novel aspects of the book is the integration of mathematical morphology and fractal analysis. Various examples are provided on the generation of fractal landscapes and fractal digital elevation models as well as the extraction of flow direction networks. Illustrations are provided to demonstrate the derivation of simulated fractal digital elevation models through morphological decomposition procedures. The book shows how physiographic and geomorphologic processes can be analyzed by quantitative representations of

concavities and convexities. Valley and ridge connectivity networks are shown as abstract structures of concave and convex zones of terrestrial surfaces. Applications of the methods to extract features of terrestrial significance are provided. The features include unique ridge and channel networks, physiographic features such as mountains, hierarchically decomposed subwatersheds, and topologically significant regions of cloud fields. Methods are presented for the extraction of valley connectivity, ridge connectivity, and drainage networks from digital elevation models. Grayscale skeletonization methods are described to derive ridge and valley connectivity networks. Particularly interesting illustrations are provided of automatically extracted channel networks, ridge networks, and subwatershed maps. The book contains extensive discussion and illustration of many more applications of image and data analysis in geomorphology and geographic information science. Coming from a different background in biomedical signal and image analysis, I find the illustrations and examples provided in the book to be not only interesting but also attractive and intriguing. The detailed procedures described in the book along with the large number of illustrations of application should assist researchers and practitioners in geographic information science and other areas of application of image processing and data analysis."
—**Rangaraj M Rangayyan**, FIEEE, University of Calgary

"This book represents an interesting application of approaches of mathematical morphology to digital terrain modelling."
—**Igor Florinsky**, Russian Academy of Sciences

"Professor Daya Sagar's book is a tour-de-force. He approaches mathematical morphology in depth from a variety of perspectives and practitioners and researchers from many fields will find much to learn. His linking of pattern retrieval, pattern analysis and modelling is innovative and powerful."
—**Sir Alan Wilson**, FRS, University College London

"The 546-page book "Mathematical Morphology in Geomorphology and GISci" by B. S. Daya Sagar published by Chapman and Hall/CRC is a welcome addition to the literature. It fills a gap that has existed for some time in the field of image analysis by providing a comprehensive mathematically-based overview of methods to systematically analyze the great variety of features observed at the surface of the Earth. The study of shapes and sizes of objects and their mutual interrelationships is paramount in Geoinformation Science (GISci) which has become a new flourishing field of scientific endeavor. The author has included numerous instructive examples of application with a substantial number of them related to the analysis of fractal patterns. Overall, the treatment of the subjects is thorough and the book can be regarded as a follow-up to the original approach to mathematical morphology commenced by Georges Matheron in the 1970s and 1980s. These fathers of the field had introduced the use of Minkowski operations such as dilation, erosion and the opening or closing of sets by means of iterative processes. Since then, there has been significant progress both from an observational and a theoretical point of view. Important new high-precision products that have become available include digital elevation models (DEMs). With respect to underwater topography, there now are the digital bathymetric maps (DBMs). Many of the examples in the book use DEMs or DBMs. During the past 25 years we also have witnessed important new developments in the fields of fractal modeling and chaos theory. The author offers excellent explanations and examples of application of non-linear process modelling; for example, he uses the logistic equation to study fold dynamics and applies spatiotemporal dynamical modeling to understand geomorphological processes. At the annual conference of the International Association for Mathematical Geosciences held in Salzburg, Austria, September 5-9, 2011, Professor Sagar delivered the Georges Matheron Lecture providing the audience in this plenary session with an overview of his contributions to mathematical morphology. I am happy to see that this material now has been expanded in book-form, so that it can be studied by scientists working in the field all over the world. I also highly recommend the new book to all teachers engaged in presenting courses on geomorphology and GISci to university students."
—**Frits Agterberg**, Emeritus Scientist, Geological Survey of Canada

Geomorphology is practiced in many earth science disciplines in the study of shape and form and their changes over time. Increasingly the challenges of climate change, population growth and shifts, and conflicting uses of resources have brought geomorphology to the forefront of scientific investigation. The new book addressing the application of mathematical morphology to problems in geomorphology by Dr. B.S. Daya Sagar is timely and fills a needed gap. Dr. Sagar is one of the worlds's leading experts on mathematical morphology. This book is large (515 pages) but well organized and clearly written. It is accessible to those with no knowledge of mathematical morphology, as early chapters introduce the basic structuring elements and provides numerous examples. There are practical examples throughout the book and the theoretical underpinnings are tied to examples. As a statistician, I found the quantitative spatial relationships and reasoning especially interesting. Many of us educated in North America perhaps may have had limited exposure to this subject but it merits serious consideration, given the importance of spatial-temporal relationships and clustering.
—**John H.(Jack) Schuenemeyer**, President, Southwest Statistical Consulting, LLC, USA. Professor Emeritus, Mathematical Sciences, University of Delaware. Fellow, American Statistical Association

"Professor Daya Sagar's book is a triumph in the literature on morphology. It provides rich, comprehensive insight into the mathematics of morphology, using problems and examples from the geographic sciences. In addition, scholars of image processing, computer vision, and medical imagery will also find useful material in shape analysis and recognition."
—**Kentaro Toyama**, Visiting Scientists, School of Information Science, University California Berkeley

"This work was written by a well-known geomorphology expert, Daya Sagar, for other geomorphology experts. Therefore, if you are not a part of that group, then this book is probably not for you. Knowledge in geomorphology and geographic information systems (GIS) is required to be able to follow the material. Chapter 1 summarizes the content of the book. Chapter 2 introduces all the formulas for the

mathematical morphology. The author describes every operator in detail, with many examples. Some readers might find the structure of this chapter confusing, but the explanations and descriptions are of very high quality. A general description of the datasets used in the book is given in chapter 3, and several different real-world geographic environments are discussed in detail. In the following chapters, the author shows how mathematical morphological operators can be used to obtain several different geomorphologic and geographic features, such as mountains, basins, and ridges. The author assumes that the reader is an experienced geomorphologist, familiar with this subject (GIS), who might want to learn more about using mathematical morphology for related tasks. However, I found these chapters very dense and hard to follow. Furthermore, the structure of these chapters is not always clear and sometimes the author seems to go back and forth between concepts, which can make the reading somewhat uncomfortable for any reader. The book does include extensive documentation and numerous references for further reading. I note that many of the references are by the author of this book and his colleagues. While this provides evidence that Sagar is really an expert in the field, it seems that including references from other researchers might broaden the scope for further reading to resources with different points of view. Unfortunately, the book has been published in grayscale. In this type of book, color images are almost mandatory. Color illustrations would have helped me better comprehend the material. The geographic images introduced in chapter 3 and used throughout the book should have appeared in color for improved understanding. Overall, this book provides solid information about using mathematical morphology for geographic imaging from a real expert in the field. Because of the level of expertise required, the book is suitable only for proficient geomorphologists. Novices in this field should not start with this book."
—**Jose Manuel Palomares Munoz**, ACM Computing Reviews

Jean Serra in the Foreword to this book states that it is intended for an audience of "geomorphologists" while Arthur Cracknell in the Afterword suggests that it will be of "immense value" to postgraduates, doctoral and postdoctoral students. But if this is so, the intended readers will have to be exceptionally, mathematically erudite and adept at programming as well, for although Sagar provides an introduction to his version of mathematical morphology, no computer code, pseudo or otherwise, is included in the text. Sagar's audience may well be geomorphologists but he frequently cites the work of human geographers. Consequently, this text will be of great interest to all scientists who believe that space can be utilized as a powerful explanatory variable. Chapter 1 describes the general organization of the book and includes a synopsis of each of the 13 remaining chapters. Chapter 2 explains the various concepts behind mathematical morphology, both binary and mulitiscale operations, that were originally introduced by Georges Matheron in 1975 and then further developed by Jean Serra and others. The third chapter describes the diverse data sets amenable to investigation using the techniques of mathematical morphology. These include simulated and actual Digital Elevation Models, Digital Bathymetric Maps, fractal basins that exhibit self-similarity and indeed any remotely sensed image displayed as a numerical array. Fractal basins can be decomposed into topologically prominent regions but, as usual, William Warntz' seminal contributions to the determination of the critical points, lines and areas of a surface are overlooked (Waters, 2009). Feature extraction, covered in Chapter 4, is a topic of interest to physical and human geographers, for the feature concerned might be a watershed or a commuting district, a river or a road. The segmentation algorithm described on p.80 does reference Warntz' concept of peaks and pits but not the passes and pales and other critical features that are equally useful in surface segmentation. Sagar's primary focus on geomorphological applications is asserted in Chapter 5 where he demonstrates the use of the techniques of mathematical morphology for terrestrial surface characterization. Here he builds upon the pioneering research of Horton and Strahler. The stream order models developed by Horton and revised by Strahler are shown to have a fractal structure and therefore to be scale invariant. In addition, Sagar references Shreve's 1967 paper but Shreve's iconoclastic article (Shreve, 1966) from a year earlier demonstrated that "the law of stream numbers is indeed largely a consequence of random development of channel networks according to the laws of chance". Thus, by and of themselves, these "laws" yield little geomorphological insight. Scaling Laws are the focus of Chapter 6 (and also Chapter 7) but these too have been shown to have little explanatory power unless they are supported by other lines of evidence (see the literature reviewed in Waters, 2013). Sagar does an excellent job of reviewing research from the early days right up until the most recent contributions including his own extensive oeuvre and thus it was pleasant to see both Mike Kirkby and Adrian Scheidegger's work being cited (even if the Scheidegger reference has a few errors). References to the work of Mark Melton and Richard Chorley on morphological systems are, unfortunately, conspicuous by their absence. Particularly, innovative is the discussion of spatial-temporal dynamics in Chapter 9, where Sagar has made extensive and seminal contributions. It would have been reassuring to see an in depth account of the limitations of these approaches, especially the concepts of equifinality, or convergence, where different system trajectories may result in the same end state or the converse of this, multifinality or divergence, where the same initial conditions can result in a variety of end states (Skyttner, 2005, p.54). The methodologies introduced here are illustrated with applications to sand dune avalanches and flood water dynamics. The final chapters of the book discuss Spatial Relationships and Spatial Reasoning (Chapter 10), Derivation of Spatially Significant Zones from a Cluster (Chapter 11), Directional Spatial Relationships (Chapter 12), the intriguing concept of Between Space (Chapter 13) and Spatial Interpolation (Chapter 14). As these chapters cite the work of Mike Batty, Mike Goodchild, Bob McMaster and Alan Wilson, among others, they are likely to be of considerable interest to the community of human geographers. A small quibble: Sagar provides a list of symbols and notations, three pages long, but no such summary of the acronyms used in the book. My overall assessment is that this book is a truly remarkable contribution that is likely to make a significant impact in the GISci community far beyond its primary target audience of geomorphologists. Mathematical Morphology in Geomorphology and GISci is also a celebration of the remarkably innovative contributions of Daya Sagar over the last two decades.

References

Shreve, R. L. 1966. Statistical Law of Stream Numbers. The Journal of Geology, 74 (1), 17-37.

Skyttner, L. 2005. General Systems Theory: Ideas and Applications (Second Edition). World Scientific Publishing, Singapore.

Waters, N.M. 2009. Representing Surfaces in the Natural Environment: Implications for Research and Geographical Education. Ch. 3, pp. 21-39, in Mount, N. J., Harvey, G. L., Aplin, P. and Priestnall, G., Eds., Representing, Modeling and Visualizing the Natural Environment: Innovations in GIS 13, CRC Press, Florida.

Waters, N. 2013. Social Network Analysis. In Fischer M.M., Nijkamp P. (Eds) Handbook of Regional Science, Ch. 38, pp. 725-740. Springer: Heidelberg, New York, Dordrecht, London.
—Nigel Waters, Geomatica, v. 67, no. 4, p. 283-284, 2013

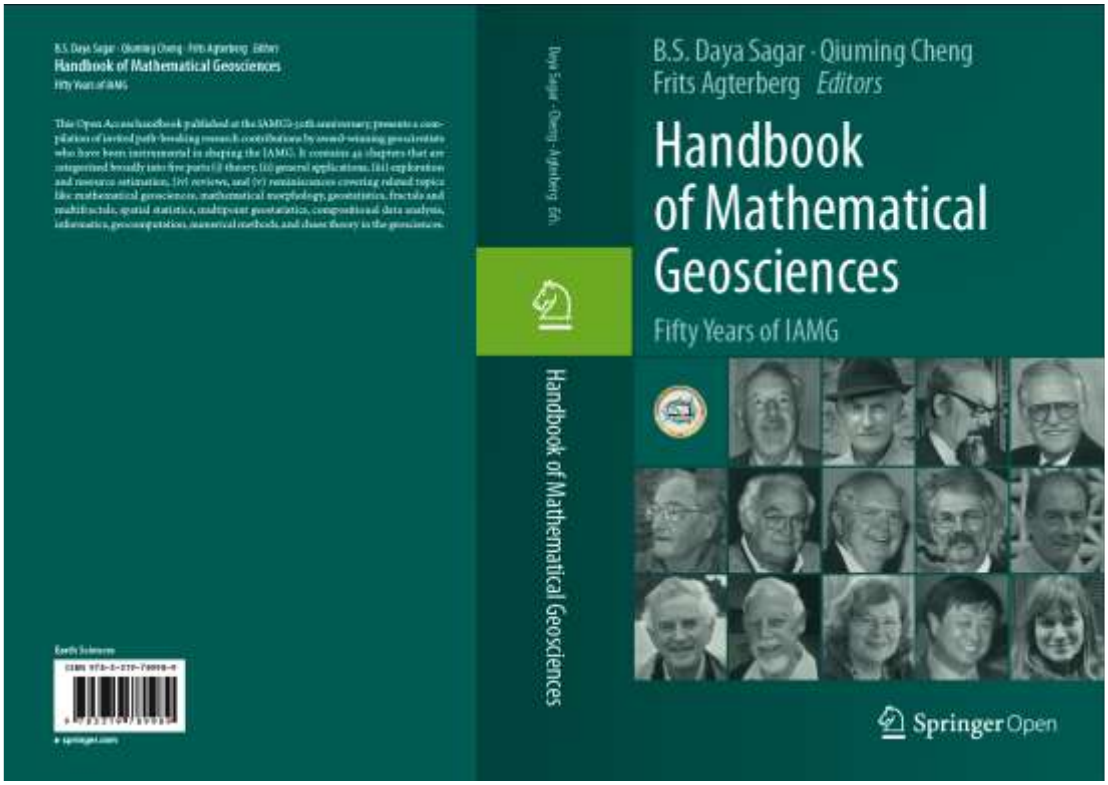
"As hydrologists, we are permanently confronted with problems where the geometrical vision of realty is of paramount importance for quantifying the flow. This is the case, for instance, of river networks, when their geometry is characterised by a fractal dimension, as well as in the case where the estimates of the contaminant concentration in a river water has to be made using Random Functions on a non-Euclidian graph with successive branching. Mathematical morphology tools are required to describe these graphs and to explain why, for instance, the spreading of infectious diseases, like cholera, differs between two different river systems, due to their geometrical properties. The automatic extraction of these river networks from Digital Elevation Models, or those of other surface-water bodies, is also a great challenge. Similarly, for porous media, when the flow is analysed at the pore scale, the governing equations are those of Navier-Stokes, and not Darcy's law, which only applies at the macroscopic scale. With modern tools, e.g. X-ray tomography, 3-D images of the pore space can be obtained, which need to be described by morphological tools to extract from these images the relevant microscopic properties that govern the flow, at both the pore scale and the macroscopic scale. For all these problems, the book Mathematical Morphology in Geomorphology and GISci by Professor Daya Sagar is invaluable. All the basic concepts of mathematical morphology, as originally defined by Matheron and Serra in the 1970s and later extended by many authors, are clearly presented with many practical examples of how to use them. As Professor Sagar has himself largely contributed to the modern theory of geomorphology, his book is rich in new concepts and methods. Hydrologists will be happy to find that many of the examples given in the book deal with rivers, water bodies, and the morphology of drainage basins."
—**Ghislain de Marsily**, Membre French Académie des Sciences, Université Paris 6, France.

I am sure that this very dense and useful work will appeal to geomorphologists, structural geologists and geographers open to new research ideas and approaches. They will find in this book a rich source of inspiration for their own research that, I expect, will foster their desire to deepen their knowledge of mathematical morphology. As a mathematical morphologist myself, I found themany case studies presented stimulating; they have aroused my thinking on morphological tools and approaches that would further refine the solutions proposed. As such, this book can also be considered as an efficient instrument of dialogue, a bridge between image processing and geosciences, giving rise to fruitful discussions and exchanges about emerging issues and possible solutions, thereby contributing to disseminate mathematical morphology. Thanks to Daya Sagar!
—**Serge Beucher**, Center for Mathematical Morphology, Mines ParisTech, Paris, France, Mathematical Geosciences, 2014

Today in the hinterlands, there are some mathematical geoscientists doing very original work involving applications that we'd barely thought about earlier. I'll mention one of today's pioneers, whose focus is on mathematical morphology of geological features, Daya Sagar of the Indian Statistical Institute at the Bangalore Centre. Notably he's been at it for two decades and has published a lot, including a seminal 546-page book in 2013 entitled "Mathematical Morphology in Geomorphology and GISci" that spans much of the field. Let's face it, the shapes or forms of geological objects are tantalizing, and some can be astoundingly complex. Landscapes, for example, often exhibit complex forms. Trying to describe their shapes alone can be challenging , but the greater challenge is to explain the processes and morphological forms that affect each other. Everyday features, such as stream meanders on broad floodplains, or lakes on floodplains with short lives, may be common, but they are not simple to categorize or analyze. All the while we're dealing with interdependencies between features and processes. Interdependencies are invariably accompanied by complex cyclic and chaotic behavior. So do you still want to make predictions? Take heart, though, because there are some new tools to help you, and that's where Daya's work is relevant.
—John W. Harbaugh, Stanford University, USA, IAMG Newsletter, No. 89, p. 5.

B. S. Daya Sagar, Mathematical morphology in geomorphology and GISci. Boca Raton, FL: CRC Press (ISBN 978-1-4398-7200-0/hbk; 978-1-4398-7202-4/ebook). xxix, 516 p. (2013).
The book consists of fourteen chapters: Introduction. Mathematical Morphology: An Introduction. Simulated, Realistic Digital Elevation Models, Digital Bathymetric Maps, Remotely Sensed Data and Thematic Maps. Feature Extraction. Terrestrial Surface Characterization: A Quantitative Perspective Characterize Surficial Phenomena. Size Distributions, Spatial Heterogeneity and Scaling Laws. Morphological Shape Decomposition: Scale-Invariant but Shape-Dependent Measures. Granulometries, Convexity Measures and Geodesic Spectrum for DEM Analyses. \item{9.} Synthetic Examples to Understand Spatiotemporal Dynamics of Certain Geo(morpho)logical Processes. Quantitative Spatial Relationships and Spatial Reasoning. Derivation of Spatially Significant Zones from a Cluster. Directional Spatial Relationship. "Between" Space. Spatial Interpolations. In Chapter 2, a brief introduction of mathematical morphology, which is crucial to understand the techniques employed in subsequent chapters, is given in an easy-to-understand manner. In Chapters 4 through 8, several data sets are used to demonstrate numerous techniques. The specifications of those data sets are provided in Chapter 3. In Chapter 4 original algorithms for the retrieval of unique morphological networks, landforms, and threshold elevation regions for efficient characterization are detailed. The techniques and methodology developed for geomorphology pattern analysis provided are demonstrated through Chapter 5 to 8. Computer simulations and modelling techniques demonstrated in the Chapter 9 provide insights to better understand certain morphological and geophysical systems with the ultimate goal of

developing cogent models in discrete space. The basic inputs required to understand the spatiodynamical behaviour of certain terrestrial phenomena will be drawn from multiscale / multitemporal satellite remotely sensed date. The three complex systems that are explained include the channelization process, surface water bodies, and elevation structures. Methods developed for spatial interpolation, visualization, and quantitative spatial reasoning are demonstrated in the Chapters from 10 to 14. In an approach for spatial interpolation, Hausdorff dilation and Hausdorff erosion distances are employed for the categorization of time-varying thematic maps depicting geomorphological phenomenon and for the visualization of spatiotemporal behaviour of such phenomenon by recursive generation of media elements.
—**Ilia V. Boikov** (Penza) (Reviewer) (English) Zbl 1290.86001, Reviewer:



B. S. Daya Sagar, Qiuming Cheng, and Frits Agterberg (Editors), *Handbook of Mathematical Geosciences: Fifty Years of IAMG*, Springer Publishers, Cham, Switzerland, P. 942, 2018

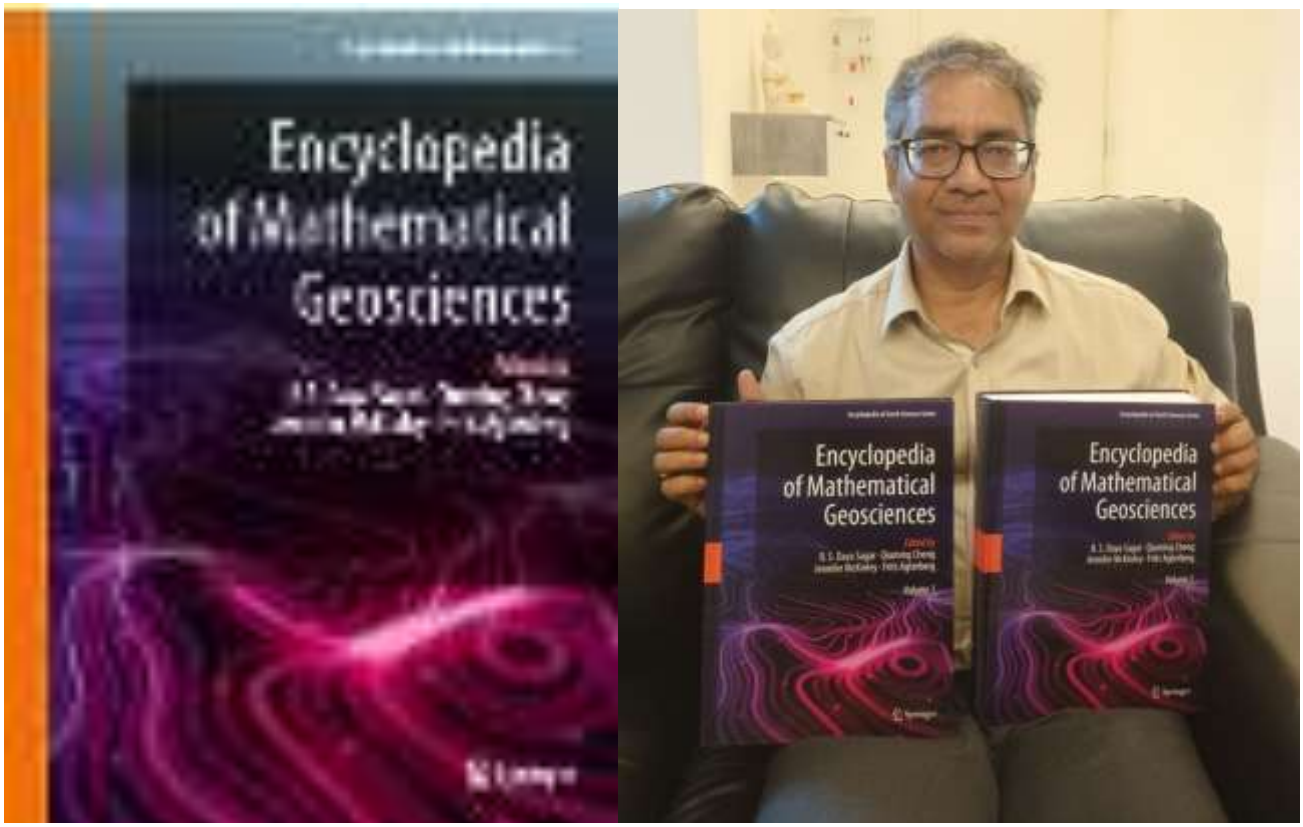
Prof. Jennifer McKinley, President of the International Association of Mathematical Geosciences (IAMG), releasing the book during Golden Anniversary of IAMG held at Olomouc, Czech Republic on 04 September 2018.

Qiuming Cheng (China), Frits Agterberg (Canada) and B. S. Daya Sagar (India): Three Ediors of the *Handbook of Mathematical Geosciences: Fifty Years of IAMG*

Petra van Steenbergen, Executive Editor of Springer Nature Publishers, and B. S. Daya Sagar

Daya Sagar, B. S. (ed.); Cheng, Qiuming (ed.); Agterberg, Frits (ed.) * 1391.86001. Handbook of mathematical geosciences. Fifty years of IAMG. Cham: Springer (ISBN 978-3-319-78998-9/hbk; 978-3-319-78999-6/ebook). xxviii, 914 p., open access (2018).

Publisher's description: This Open Access handbook published at the IAMG's 50th anniversary, presents a compilation of invited path-breaking research contributions by award-winning geoscientists who have been instrumental in shaping the IAMG. It contains 45 chapters that are categorized broadly into five parts (i) theory, (ii) general applications, (iii) exploration and resource estimation, (iv) reviews, and (v) reminiscences covering related topics like mathematical geosciences, mathematical morphology, geostatistics, fractals and multifractals, spatial statistics, multipoint geostatistics, compositional data analysis, informatics, geocomputation, numerical methods, and chaos theory in the geosciences. The articles of this volume will not be indexed individually.
—Zentralblatt MATH 1391—1



Encyclopedia of Mathematical Geosciences

7. Appendix-II: Details of Awards and Fellowships of Prof. B. S. Daya Sagar

International Association for Mathematical Geosciences

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Houston, TX 77057
Phone: +1-713-513-2182
Email: president@iamg.org

Vera Pawlowsky-Glahn
President

University of Girona
Dept. of Computer Science and Applied Mathematics
Campus Montilivi, P4
E-17071 Girona, SPAIN

Monday, March 12, 2010

Dr. Behara Seshadri Daya Sagar
Systems Science and Informatics Unit (SSIU)
Indian Statistical Institute-Bangalore Centre
8th Mile, Mysore Road, RVCE PO
Bangalore-560059, Karnataka, India
e-mail: bsdsagar@isibang.ac.in,bsdsagar@yahoo.co.uk

Re: George Matheron Lecture 2011

Dear Dr. Behara Seshadri Daya Sagar,

It is my pleasure to inform you that you have been selected by the IAMG Georges Matheron Lecturer Committee, chaired by our Vice President Qiuming Cheng, as the 2011 Georges Matheron Lecturer.

The Georges Matheron Lecture is held during IAMG annual conferences. It recognizes a scientist who pioneered and made lasting contributions in the fields of spatial statistics and mathematical morphology. We are indebted to the Matheron family for granting the IAMG the honor to organize this event annually from 2006 onward. The GM Lecturer is selected by a committee chaired by the IAMG Vice President Qiuming Cheng. Currently it also comprises Dr. Jean Serra, representing the Fontainebleau group (Ecole de Mines de Paris, France), and Dr. Katsuaki Koike (Kumamoto University, Japan).

The next IAMG annual conference will take place in Salzburg, Austria, September 5–9, 2011. I hope that you will be able to attend this event (your expenses are to be paid by IAMG) and deliver the sixth George Matheron Lecture. A plaque commemorating the occasion will be presented to you.

Please contact Vice President Qiuming Cheng and Treasurer Gina Ross for details.

With best wishes and heartfelt congratulations,

Prof. Dr. Vera Pawlowsky-Glahn
President, International Association for Mathematical Geosciences

Cc: IAMG treasurer Gina Ross, IAMG Secretary General Dr. Daniel Tetzlaff, IAMG Vice-president Dr. Qiuming Cheng, IAMG Office, head Regina van den Boogaart

Prof. B. S. Daya Sagar recieving georges Matheron Award from Prof. Qiuming, Executive Vice President of the IAMG

Prof. B. S. Daya Sagar receiving Georges Matheron Award from Prof. Qiuming, Executive Vice President of the IAMG

Georges Matheron Award - 2011

International Association for Mathematical Geosciences

hereby appoints

Dr. B.S. Daya Sagar

as George Matheron Lecturer

2011

for outstanding research ability in the field of spatial statistics or mathematical morphology

Awarded in Salzburg, Austria, at the 2011 Annual Meeting

Dr. Daniel Tetzlaff, Secretary-General, IAMG

Dr. Vera Pawlowsky-Glahn, President, IAMG

Certificate of Georges Matheron Lectureship Award – 2011

AGU ADVANCING EARTH AND SPACE SCIENCE

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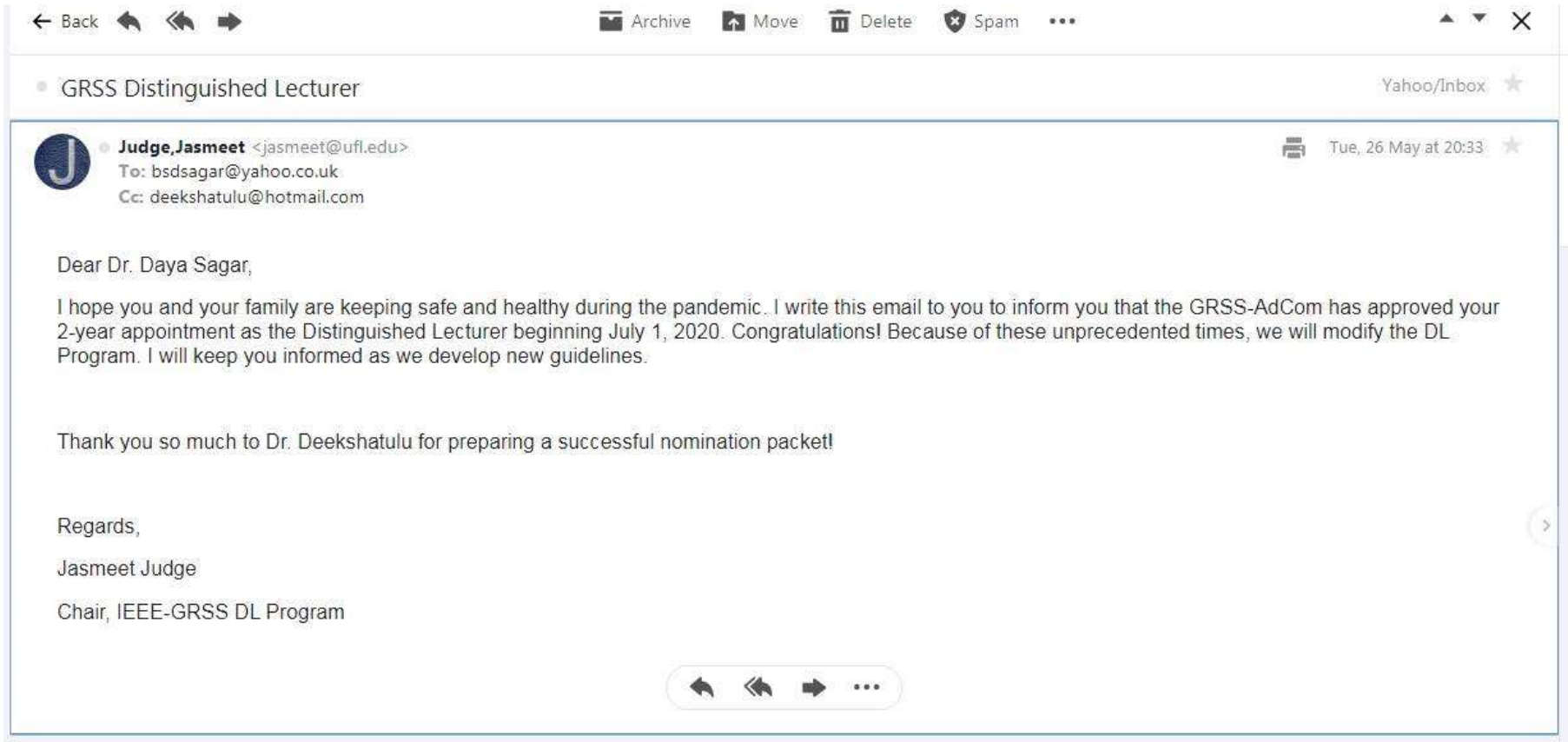

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GRSS Distinguished Lecturer

Yahoo/Inbox

Judge,Jasmeet <jasmeet@ufl.edu>
To: bsdsagar@yahoo.co.uk
Cc: deekshatulu@hotmail.com

Tue, 26 May at 20:33

Dear Dr. Daya Sagar,

I hope you and your family are keeping safe and healthy during the pandemic. I write this email to you to inform you that the GRSS-AdCom has approved your 2-year appointment as the Distinguished Lecturer beginning July 1, 2020. Congratulations! Because of these unprecedented times, we will modify the DL Program. I will keep you informed as we develop new guidelines.

Thank you so much to Dr. Deekshatulu for preparing a successful nomination packet!

Regards,

Jasmeet Judge

Chair, IEEE-GRSS DL Program

भारतीय विज्ञान अकादमी
(विज्ञान एंव प्रौद्योगिकी विभाग भारत सरकार के तत्वावधान में एक वृत्तिक के निकाय)
डाक पेटी सं. 8005, सी.वी. रामन अवेन्यू, बेंगलुरु – 560 080, भारत
INDIAN ACADEMY OF SCIENCES
(A Professional body under the aegis of Dept. of Science & Technology, Govt. of India)
P.B No. 8005, CV. Raman Avenue, Bengaluru – 560 080, INDIA

Professor Partha P. Majumder
President

5 January 2022

Professor B S Daya Sagar
Systems Science & Informatics Unit
Indian Statistical Institute
RV College PO
Bengaluru 560 059

Dear Professor Daya Sagar,

The Council of the Indian Academy of Sciences in its meeting held in December 2021 has recommended your election to the Fellowship of the Academy. Please accept my warmest congratulations!

Since its inception in 1934, nearly 2000 of the leading scientists of India (as well as some from outside India) have been elected Fellows of the Indian Academy of Sciences. Through its various activities, our Academy plays a major role in furthering the cause of science in the country, and Fellows of the Academy not only act as spokespersons for their disciplines, but also for the science at the national level.

The activities of the Academy come under three major categories: scholarly publication, science education, and science dissemination. The Academy publishes 13 scientific journals on different subjects, including Current Science (in association with Current Science Association) and organizes several discussion meetings on important topics of scientific interest. In addition, we have a vibrant visitors' programme whereby distinguished colleagues from across the world can be invited to occupy the Raman, Janaki Ammal, Jubilee and Academy-Springer Nature Chair Professorships. Detailed information on these activities is available on our website (www.ias.ac.in).

The Academy has an extensive and active science education programme in which the Fellowship and the scientific community of the country play an important role. There are refresher courses of up to three weeks, summer research mentorship as well as short discussion meetings that are held all across the country. The Academy also selects a few outstanding younger scientists as Associates each year. Both these programmes have been undergoing considerable restructuring in order to help us achieve our objectives in a more equitable manner. A matter that has received particular attention over the past year has been summarised in the document "Scientific Values: Ethics Guidelines and Procedures", the revised guidelines for ethical conduct that we expect all Fellows to uphold.

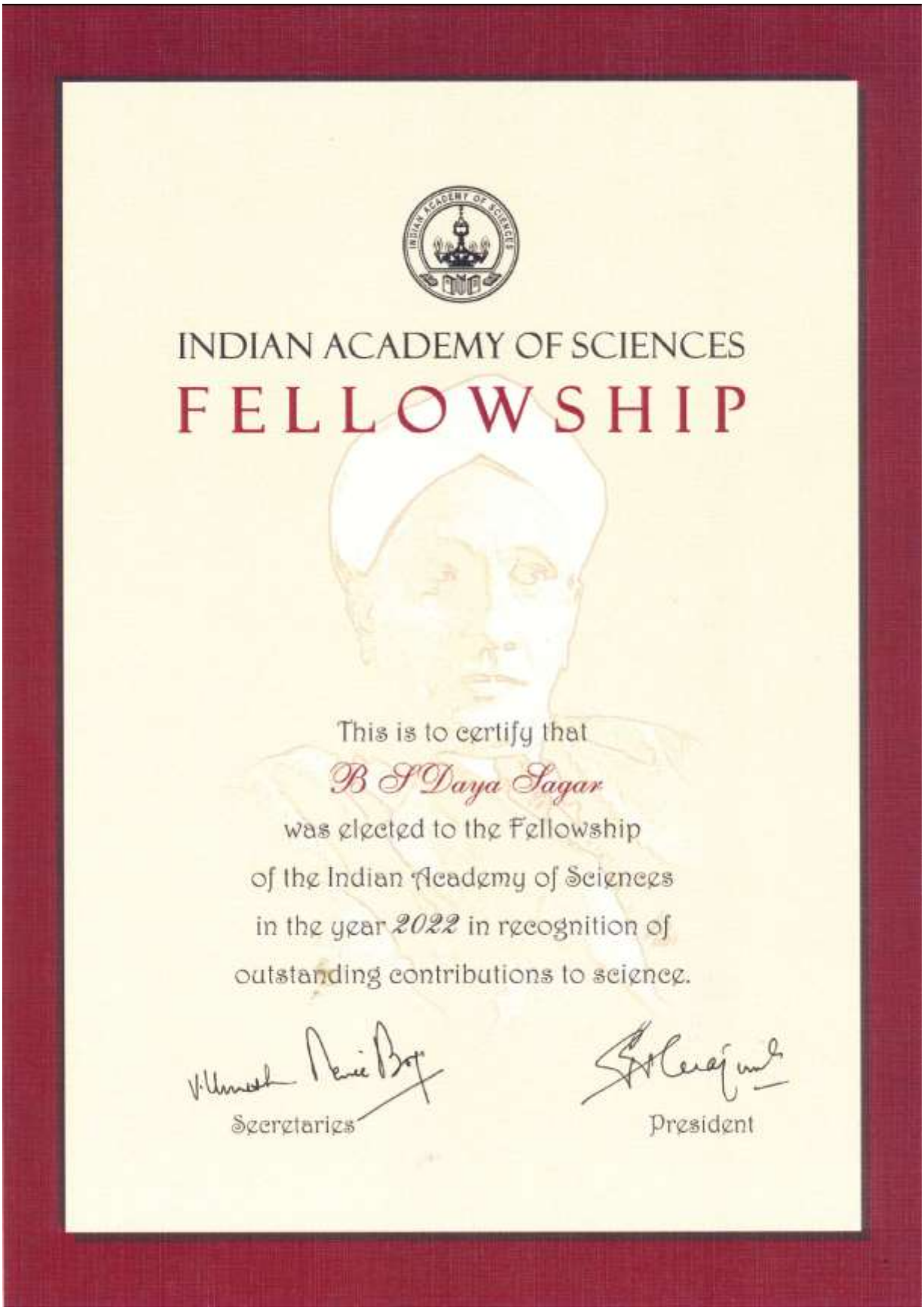
The Academy meets twice a year, the mid-year meeting being in late June/early July, and an annual meeting held in the first week of November. I hope that it will be possible for you to attend one of the meetings of the Academy during this year, and also regularly in subsequent years. Your participation in the activities of the Academy and your help in promoting its programmes will be crucial.

I look forward to your active involvement and will be happy to hear from you as to how we can strengthen these activities. With best wishes for a very happy New Year 2022, and with my personal regards,

Sincerely,

Partha P. Majumder

office@ias.ac.in



INDIAN ACADEMY OF SCIENCES

FELLOWSHIP

This is to certify that

B S Daya Sagar

was elected to the Fellowship

of the Indian Academy of Sciences

in the year *2022* in recognition of

outstanding contributions to science.

Secretaries

President

भारतीय राष्ट्रीय विज्ञान अकादमी
बहादुर शाह ज़फर मार्ग, नई दिल्ली–110002
INDIAN NATIONAL SCIENCE ACADEMY
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प्रोफेसर आशुतोष शर्मा
अध्यक्ष
Prof. Ashutosh Sharma
President

No. CC/
12th September, 2023

Election as Fellow

Dear Professor Daya Sagar,

I am delighted to inform that you have been elected as a Fellow of the Indian National Science Academy at the Annual General Meeting on September 12, 2023. My hearty congratulations to you for this recognition. The Fellowship will become effective from January 1, 2024.

The Academy derives its strength in meeting its objectives from its Fellowship. I am certain that you will take active interest in the programmes and activities of the Academy.

The newly elected Fellows are expected to deliver a lecture on a subject of his/her choice during the Anniversary General Meeting of the Academy to be held in December, 2023. The programme of the Anniversary General Meeting will be sent to you in due course.

I sincerely request and wish that you will very soon contribute at least one of your papers to the Academy's Journal of your choice. This will also be a medium to showcase the work of a newly elected Fellow to rest of the Fellowship of the Academy.

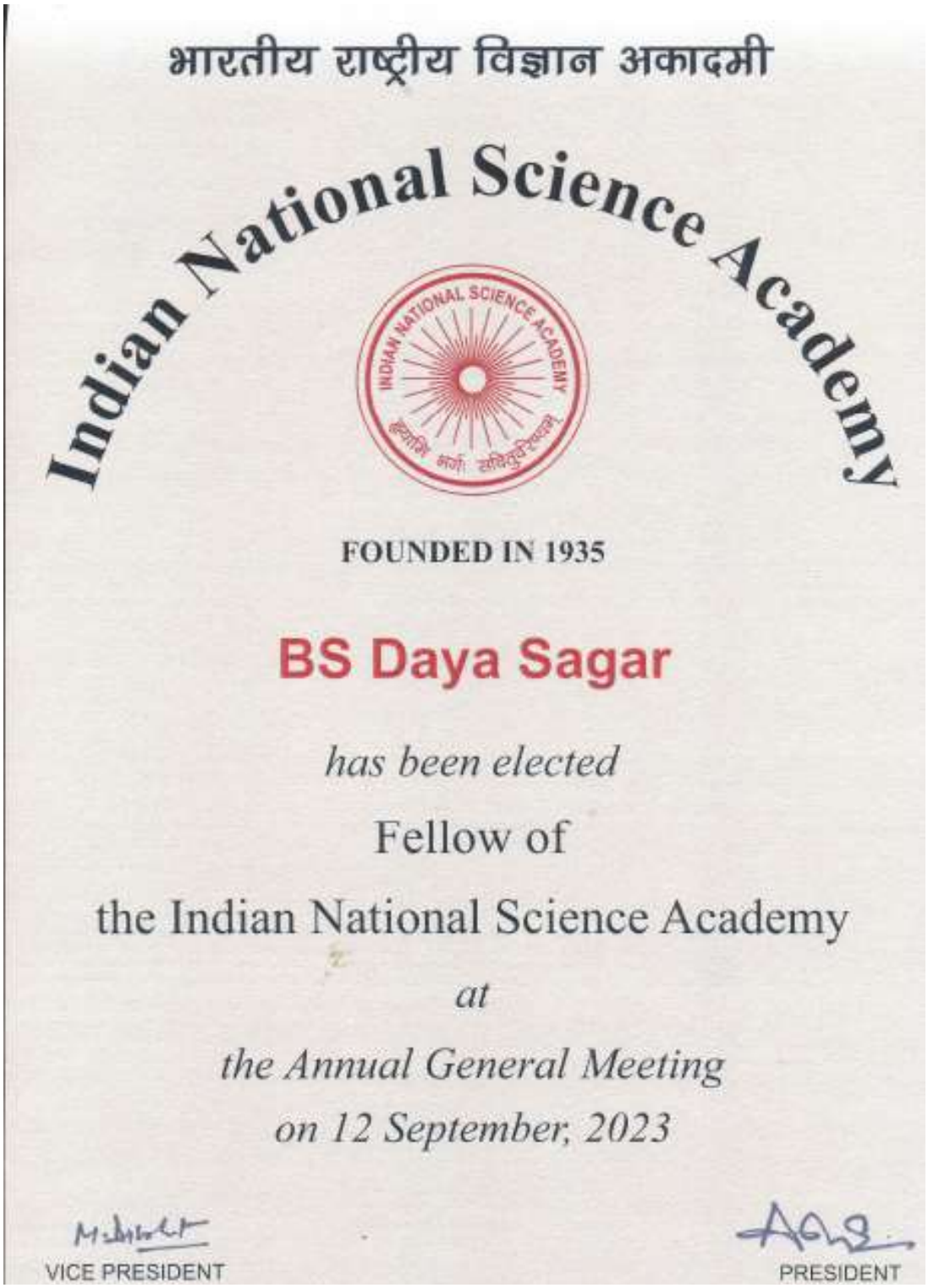
I shall appreciate if you can acknowledge receipt of this communication and confirm your acceptance of the Fellowship.

With warmest regards,

Yours sincerely,

(Ashutosh Sharma)

Professor BS Daya Sagar
Professor (HAG) and Former Head
System Science and Informatics Unit
Indian Statistical Institute- Bengaluru Centre
8th Mile Mysore Road, RV College PO
Bengaluru-560059



भारतीय राष्ट्रीय विज्ञान अकादमी

Indian National Science Academy

FOUNDED IN 1935

BS Daya Sagar

has been elected

Fellow of

the Indian National Science Academy

at

the Annual General Meeting

on 12 September, 2023

VICE PRESIDENT

PRESIDENT

Prof. B. S. Daya Sagar; Indian Statistical Institute-Bangalore Centre

IEEE

IEEE Geoscience and Remote Sensing Society

Presents this Certificate of Appreciation to

Dr. BS Daya Sagar

For his contribution to the GRSS Webinar Program with the lecture

"Mathematical Morphology in Geoscience, Remote Sensing and Geospatial Data Science: an Overview"

Presented on March 2, 2021

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The Distinguished Lecturer Program (DLP) is a service of the GRSS and its members to support our chapter activities. Our goal is to provide chapters with access to with leading professionals in geoscience and remote sensing and discuss novel topics in current research. This is an opportunity for the GRSS membership to hear interesting talks about work being done in our fields of interest and to meet some of the prominent members of our Society.

In light of the ongoing pandemic and uncertain travel restrictions, for the calendar year 2021, lectures and presentations under the Distinguished Lecturers or Industry Distinguished Lecturer program should be given virtually. That is, at this time, GRSS and IEEE are not approving travel fund requests.

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LECTURER NOMINATIONS

Available Speakers

B.S. DAYA SAGAR
INDIAN STATISTICAL INSTITUTE-BANGALORE CENTRE

(1) Mathematical Morphology in Geoscience, Remote Sensing and Geospatial Data Science: An Overview;
(2) Processing and Analysis of Digital Elevation Models (DEMs) via Binary and Grayscale Granulometries, Morphological Interpolations, and Morphological Distances

CARLOS LÓPEZ MARTÍNEZ
UNIVERSITAT POLITÈCNICA DE CATALUNYA, BARCELONA, SPAIN

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(2) SAR Polarimetry: Theory and Applications;
(3) SAR, SAR Polarimetry & Multitemporal SAR Statistical Description

MIHAI DATCU
GERMAN AEROSPACE CENTER DLR, GERMANY

(1) Earth Observation Data Intelligence and Knowledge Discovery & (2) Artificial Intelligence for Earth Observation

QIHAO WENG
INDIANA STATE UNIVERSITY, USA

(1) Remote Sensing of Surface Urban Heat Islands: Progress and Prospects; (2) Remote Sensing of Cities: Day and Night

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MIT LINCOLN LABORATORY, USA

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ROYAL GEOGRAPHICAL SOCIETY
(WITH THE INSTITUTE OF BRITISH GEOGRAPHERS)
1 Kensington Gore • London SW7 2AR

6 September 1999

This is to certify that

Dr B.S. Daya Sagar

has this day been elected a Fellow of the Royal Geographical Society (with The Institute of British Geographers) subject to the conditions governing the completion of such Election as provided in the Bye Laws.

Rita Gardner

Director and Secretary


IEEE
In recognition of professional standing
the Officers and Board of Directors of
the IEEE certify that
Behara S. Daya Sagar
has been elected to the grade of
Senior Member

Frank Harary Endowment Lecture – 2019 by B. S. Daya Sagar delivered on 8th June 2019 at the International Conference on Discrete Mathematics - 2019 (ICDM - 2019) held at the Christ University, Bangalore.
More details could be seen at: https://www.icdm19.in/speakers

International Association for Mathematical Geosciences

Jennifer McKinley
President
Queen's University Belfast
Northern Ireland
United Kingdom BT7 1NN

j.mckinley@qub.ac.uk

1st March 2018

Certificate of Appreciation and Invitation to the 50th Anniversary celebration of the IAMG (IAMG2018)

Dear Professor B.S. Daya Sagar,

The IAMG Certificate of Appreciation recognizes exceptional work on behalf of the IAMG. The IAMG Executive and Council recognize your dedication to the IAMG in undertaking the immense and complex task of producing the Golden Anniversary book: "Fifty Years of IAMG". This is a wonderful record of achievement of the IAMG community to date and will become a seminal contribution to the IAMG narrative.

I am extremely honoured and pleased, as the current IAMG President, to invite you to the 50th Anniversary celebration and Annual Conference of the IAMG in Olomouc, Czech Republic 4-7 September 2018 to receive this award. The IAMG will cover reasonable travel and accommodation expenses for you to attend IAMG2018 and the cost of transportation from Olomouc to Prague, the $75 registration cost and one night's accommodation to attend the Social Commemorative Event in Prague on 8 September. Treasurer David Collins will take care of your travel expense reimbursement and can be contacted by email (drc_iamg@hotmail.com) or by post (P.O. Box 442504 in Lawrence).

.

On behalf of the IAMG, I am very pleased to extend this invitation to attend the 50th Anniversary celebration of the IAMG and receive the Certificate of Appreciation as a measure of our esteem.

With warmest wishes and greetings

Yours sincerely

Jennifer McKinley.

Dr. Jennifer McKinley
President, International Association for Mathematical Geosciences

International Association for Mathematical Geosciences

IAMG Certificate of Appreciation

2018

for exceptional work on behalf of the IAMG

Prof. B.S. Daya Sagar

Awarded in Olomouc, Czech Republic, at the 2018 Annual Meeting

Dr. Eric Grunsky, Secretary-General, IAMG

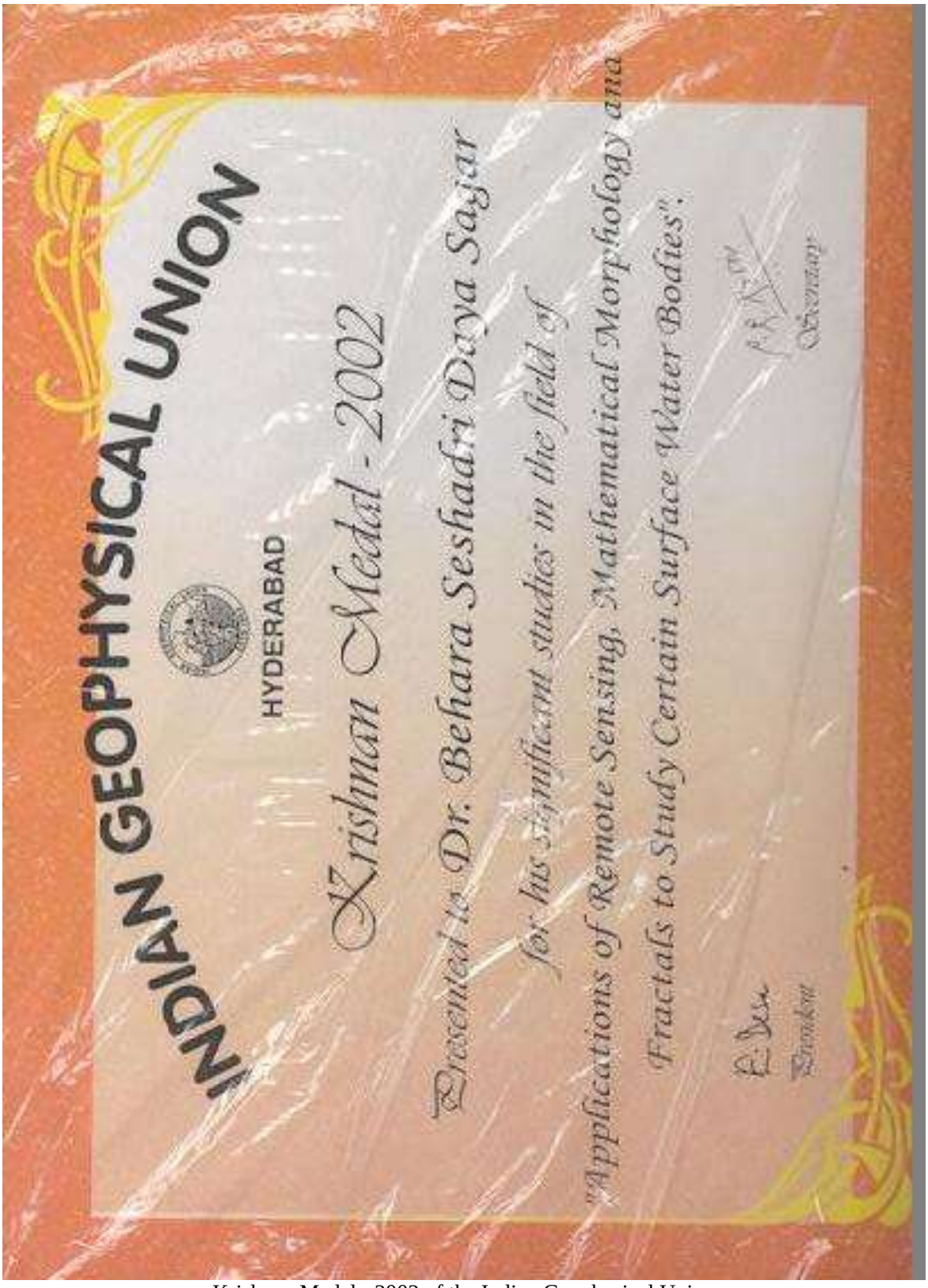
Dr. Jennifer McKinley, President, IAMG

IAMG Certificate of Appreciation Award - 2018

Prof. B. S. Daya Sagar, Indian Statistical Institute-Bangalore Centre

IAMG Certificate of Appreciation Award - 2018 received on 6th September 2018 at Olomouc, Czech Republic

IAMG Certificate of Appreciation Award - 2018 received from Dr. Jennifer McKinley and Dr. Eric Grunsky, the President and the Secretary General of the IAMG on 6th September 2018 at Olomouc, Czech Republic



Krishnan Medal - 2002 of the Indian Geophysical Union

Krishnan Medal - 2002 of the Indian Geophysical Union

PhD Supervisor (Prof. B Surya Prakasa Rao) of Prof. B. S. Daya Sagar receiving Krishnan Medal - 2002 of the Indian Geophysical Union on behalf of Prof. B. S. Daya Sagar from the then Minister of Petroleum and Natural Gas, Shri Santosh Gangwar

INDIAN GEOPHYSICAL UNION

Head Office: National Geophysical Research Institute Campus,
Uppal Road, Hyderabad - 500 007, India.

It is hereby certified that

Prof. B. S. Daya Sagar
Indian Statistical Institute, Bangalore

is admitted to the Life ~~Membership~~ / Fellowship / ~~Foreign~~ ~~Fellowship~~ of the Union and shall be entitled to all the privileges outlined in the constitution.

SECRETARY

PRESIDENT

Date : 27-01-2011

ANDHRA PRADESH AKADEMI OF SCIENCES
VISAKHAPATNAM REGIONAL CENTRE

is pleased to present

DR. BALAKRISHNA MEMORIAL AWARD, 1995
(Sponsored by Electrotek International Inc., Madras)

to

Dr. B.S. Dayasagar

Research Associate, Department of Geoengineering, Andhra University, Visakhapatnam
for his paper entitled
Attempts to establish an Integrated Mathematical Approach to study certain Geoscientific Aspects
presented at the Seminar on Earth Sciences on 17th November '95
at the Department of Geophysics, Andhra University, Visakhapatnam.

Visakhapatnam
18-11-1995

M. KRISHNA MURTHY
President

G. SIVARAMA SASTRY
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I.V. RADHAKRISHNA MURTHY
Convener, Regional Centre

Dr. S. Balakrishna Memorial Award of the Regional Centre of Andhra Pradesh Akademi of Sciences

IEEE

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Felicitates

Dr. B. S. Daya Sagar

For publication of technical paper/s in
IEEE Journal / Transactions for the year 2010

6th February 2011

V V Srinivasan
Chairman