

## BIODATA OF DR MUKUND KADURSRINIVAS RAO

- 1) **NAME:** Mukund Kadursrinivas Rao
- 2) **DATE OF BIRTH:** January 26, 1959
- 3) **BIRTH PLACE:** Hiriyur, Karnataka
- 4) **NATIVE OF:** Kadur, Karnataka
- 5) **PRESENT ROLE:** Member-Secretary  
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And

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**6) KEY ATTRIBUTES**

*In recent years, important roles and contributions in Karnataka to bring innovative and knowledge inputs - as Member Secretary of Karnataka Jnana Aayoga; conceptualization and development of unique Karnataka-GIS through IT/BT Department of GOK*

*Senior-level role and contributions at national level, through ISRO and Planning Commission, in definition and development of space technology and applications in EO and GIS AND in definition and development of National GIS concept.*

*Leadership role in private sector and business environment for GIS solutions and implementing unique projects for GIS solutions business in India and abroad.*

*Technology and Applications Systems Analysis and Policy Analysis – key studies in forecasting/analysis of future space technology and applications AND GIS.*

*Unique combinative experience of government (24 years) + industries (6 years) + not-for profit domain (6 years).*

*Wide international work experience and global understanding.*

*Wide experience and expertise in scientific and technology applications to society and governance; in-depth understanding and knowledge of scientific/research, technological, applications and policies in Earth Observations/GIS/Space; articulate, focused, result-oriented and intense drive for professional excellence.*

7) **ACADEMIC QUALIFICATIONS:**

<b>Degree</b>	<b>School/University</b>
All India Higher Secondary School Certificate Examination (First Class)	CBSE (Kendriya Vidyalaya, Ahmedabad) (1975)
Bachelor in Science (Geology) (Rank Holder)	Gujarat University (1978)
Master in Science (Geology) (Rank Holder)	Gujarat University (1980)
M Phil (Remote Sensing and GIS)	Andhra University (2002)
Doctor of Philosophy – PhD (RS and GIS)	Andhra University (2006)

## 8) **OVERALL EXPERIENCE:**

Over the past ~36 years, following is summary of my contributions:

- Furthering technological, applications, policy and business “knowledge” in Earth Observation (EO), GIS and space with in-depth expertise in EO and GIS research, applications and policy-making.
  - Leadership in conceptualising and preparing programmatic definition for India’s National natural Resources Management System (NNRMS); National Spatial Data Infrastructure (NSDI); National GIS and Karnataka GIS.
  - First-of unique GIS Applications in private-sector environment in India and outside India.
- Unique experience of governmental + private sector + research environments – able to align/adapt “best of all worlds” to bring efficiency, performance, quality in innovative and futuristic technology, applications and policy:
  - Played a front-end role in ISRO for 24 years and leadership techno-managerial role in erstwhile Planning Commission of India
  - Leadership in private-sector GIS and space technology environment for ~6 years
  - Presently for past ~6 years active in a consulting role. Have also provided major contributions to Karnataka Jnana Aayoga (KJA) activities and techno-managerial leadership in development of Karnataka-GIS

### **Present Positions** (as of October, 2017):

- Chief Executive, Centre for Spatial Analytics and Advanced GIS (C-SAG) under NIAS Council of Management, Bangalore (August, 2017 onwards)
- Adjunct Professor, National Institute of Advanced Studies (NIAS), Bangalore (March, 2011 onwards)
- Member-Secretary, Karnataka Jnana Aayoga (KJA) (August, 2014 onwards)
- Chairman, Karnataka-GIS (K-GIS) Technical Committee (September, 2015 onwards)
- Consulting in EO, GIS and Space (May, 2010 onwards) – providing knowledge inputs and expertise to various Indian government agencies, national and international private sector agencies and academia

### **Past Positions:**

- Principal Investigator, DST Sponsored Project on Standards, Spatial Framework and Technologies for National GIS at NIAS (October 2013 to July, 2015)
- Member of Karnataka Jnana Aayoga (January, 2012 to March, 2013) and Chairman Karnataka-GIS Task Force (March, 2012 to March, 2013)
- Principal Investigator to Department of Science and Technology (DST), India sponsored projects on “GI Policy Perspectives” at NIAS (January, 2012 – November, 2012)
- Adviser, Karnataka State Remote Sensing Applications Centre (KSRSAC), Government of Karnataka, Bangalore (December, 2011-November, 2012)
- Member-Secretary, National GIS Interim Core Group, Government of India (May, 2011 to October, 2011) concurrent with Consultant on National-GIS, Planning Commission of India (May, 2011 - Feb, 2012)
- Member of National Task Force on Geo-spatial Education of MHRD (October 2010 to September, 2013)

- Associate President, Devas Multimedia Limited (May, 2010 to February, 2011)
- President and COO at ESRI India, New Delhi (August 2008 - April, 2010)
- Chief Executive Officer at Navayuga Spatial Technologies Pvt Ltd (NST), Bangalore (India) and Director, Navayuga Middle East FTC, Ras-Al Khaimah (2005 - 2008)
- Deputy Director (Natural Resources Repository; to be Scientist-G level as of January, 2006 in ISRO), Indian Space Research Organisation (2003-2005) - Secretary, Planning Committee of National Natural Resources Management System (PC-NNRMS); Member-Secretary of NNRMS Standing Committee on Urban Management (SC-U), Standing Committee on Cartography (SC-C) and Programme Coordinator (Natural Resources Repository), Indian Space Research Organisation
- Deputy Director (Technology and Systems), Indian Space Research Organisation (1998-2003) and Project Manager (Natural Resources Information System, Indian Space Research Organisation; Member-Secretary of NNRMS Standing Committee on Urban Management (SC-U), Standing Committee on Cartography (SC-C); Member-Secretary, UN CSSTEAP Advisory Committee
- Manager (User Services and Utilisation, Indian Space Research Organisation (1995-1998)
- Scientist/Engineer, Indian Space Research Organisation (1981 – 1995)
- Junior Geologist at Narmada Dam Project, Kevadia, Gujarat (June, 1980 to Jan, 1981)

**9) PAST ~6 YEARS+ - KEY ROLE IN KARNATAKA JNANA AAYOGA; KARNATAKA GIS AND POLICY/TECHNOLOGY RESEARCH IN EARTH OBSERVATION (EO), GIS AND SPACE**

For past 6 years, actively involved in:

- supporting Karnataka state – as Member-Secretary, Karnataka Jnana Aayoga
- conceptualization, design/development of Karnataka-GIS – as Chairman, K-GIS Technical Committee
- technology, applications and policy research in EO/GIS/Space policy research development – process definition and method analysis for Indian space and GIS programmes
- supporting central Government consulting on National GIS design/configuration;
- providing consulting services to private sector in space technology and EO/GIS activities

**MEMBER-SECRETARY OF KARNATAKA JNANA AAYOGA (KJA) FOR GOVERNMENT OF KARNATAKA (GOK)**

Govt. of Karnataka (GOK) has nominated me as Member-Secretary of Karnataka Jnana Aayoga (KJA) – an important group of 30 experts that takes up tasks that are mainly “proof-of-concept” – technical assessments, studies, small demonstrations, proto-typing analysis, policy analysis, social impact assessment etc – which result in important KJA recommendations to GOK.

As Member-Secretary of KJA, my key role has been to establish a smooth institutional frame for operations of KJA – procedures and methods to link the external “expert body” of KJA with the Governance mechanisms/needs of the state so that effective impact is made both-ways between KJA and GOK. My major contribution has been to get the Aayoga to agree that KJA activities should get defined/formulated, either through internal discussions within KJA by its Members – mainly issues of public/societal/technological and knowledge relevance for the state OR are identified through interactions of KJA with GOK departments – mainly issues of governance and development of relevance to the state. I have coordinated to see that all Aayoga tasks are “anchored” with one or more departments of GOK – so that after proof-of-concept stage or study stage by KJA, any executive implementation or project definition can get effectively coordinated by relevant departments of GOK. I have also positioned stringent internal mechanism within KJA for technical and managerial evaluation before initiating any of its activities/studies/pilot-projects etc – by involving best of experts on the subject matter and formal reviews/evaluation process. Based on these expert evaluations, KJA then formally decides further actions or makes its formal recommendations.

I play a dual role in KJA – **as a scientific expert** I bring valuable inputs on various technical activities and support KJA activities and contribute in a significant manner to projects/task forces of KJA by way of new ideations, techno-policy analysis, state-of-art assessments and take up report/policy/recommendations drafting in various areas; **as Member-Secretary of the Aayoga**, I am responsible to coordinate and manage all activities of KJA – calling for working amongst KJA Members, working with GOK Departments, inviting and working with experts and overall coordination of KJA activities. All this work is accomplished with support of a small KJA Secretariat headed by me.

In past ~3 years, I have steered/am steering ~30 important and major knowledge activities (of relevance and importance to state) within KJA – out of which 14 formal recommendations have

already been submitted by KJA to GOK (now these recommendations are taken up/considered for implementation by respective Departments) and rest 7 are being coordinated by me at various stages of completion.

My key role/effort has been in the following major tasks:

- Led the conceptualisation and development of **Karnataka-Geographical Information System (Karnataka-GIS)** – a unique state-wide GIS for whole governance and citizens. I was responsible for its design and programme definition as Chairman of K-GIS Task Force of the KJA. As the lead of the Task Force, in 2012 I have worked out and developed the Vision and User Needs for K-GIS. This was accepted by GOK and approval of cabinet has been obtained by IT/BT Department for implementation at a cost of INR 150 crores.
- **Karnataka State Sports Policy** definition and development under KJA: I was a key Member and involved in defining and development of a holistic Sports Policy for GOK under a KJA Expert Task Group. I was responsible for thought and policy analysis inputs on sports, identifying gaps and deficiencies and in drafting the Sports Policy. I also coordinated for the Sports Policy to be recommended by KJA to GOK – which has been submitted to Dept. of Youth Empowerment and Sports in January, 2016. Now, the Department is to take up actions for its appropriate implementation within GOK.
- Was a key Member that defined, developed and authored the **Karnataka State Education Policy (KSEP)** – my role was in ground-based education system assessment, study of policies in other countries, gap analysis analysis in school and higher education policies, developing “holistic” policy perspectives, structuring a “holistic” governance structure for education and a major role in authoring/drafting the KSEP. I also played a major role in steering the KSEP within KJA, by coordinating with KJA/GOK Depts/Experts, and for its formal recommendation to GOK – which has been accomplished by KJA in October, 2016.
- Designing and developing the proposal, with NASI, for a **Cauvery River Gallery** – a modern, multi-media exposition on the physical/cultural/historical importance of River Cauvery. This is to be a major tourist and education exposition in Karnataka – I played a major role in the design/development of the KJA Recommendation to GOK and now coordinating for its development by Tourism Dept in Mysuru. The Gallery is getting ready for formal inauguration.
- Designing and developing the proposal for a **Biodiversity Park for Madivala Lake** – a ecological method for conservation of lakes. In cooperation with Mr Babu (an eminent expert in Ecology) this KJA proposal was developed and translated into a KJA Recommendation to GOK – which now is being implemented by Karnataka Lake Conservation and Development Authority (KLCDA) at a cost of INR 24 crores. The Madivala Biodiversity park project of KLCDA was inaugurated by Hon’ble CM of Karnataka in September, 2016. The Park will be a ecological and environmentally suited biodiversity habitat with an educational Centre in the Park. This is to be a major public and education “ecological spot” in Karnataka – I played a major role in the design/development of the KJA Recommendation to GOK and now coordinating for its development by KLCDA.

- Technology assessment and preparing a report on **Use of Education Technology in Higher Education and Satellite-based Education plan** for Karnataka. As a key Member of KJA Task force, I was responsible in wide range of education technology assessment, wide consultation with education providers, developing a plan for technology assimilation and preparing the Report. I also coordinated for the report to be evaluated by experts, discussed within KJA and then for its formal submission to GOK – this has been done in March, 2016 and the implementation of KJA recommendations is being taken up by Higher Education Department.
- Developed and steered a KJA Recommendation on **Traditional Health Knowledge Development** based on accurate survey of medicinal plants and its conservation dovetailed with grass-roots health needs. With Trans Disciplinary University (TDU), the Bengaluru the proposal was developed and steered by me in KJA for its formal recommendation as a pilot-project in HDK taluka. The KJA Recommendation has been made to Health and Family Welfare Department for implementation at a cost of ~INR 3-4 crores.
- With Indian Institute of Science (IISc), developed and coordinating the **development of a unique Nursing Training Simulator (NTS)** – a proto-type development activity. I coordinated the ideation design, proposal development by IISc and for its expert review by medical community and its formal KJA approval for project award to IISc. The NTS is now in its final stages of development and will be demonstrated/released by KJA-IISc soon for its commercialization that can be taken up.
- Coordinated for a unique project of using **Remote Sensing and GIS for Archaeological investigation** – worked with NIAS for its proposal formulation, expert reviews and evaluation of NIAS proposal, scoping and technical review/discussion with Archaeology Commissioner of GOK and then for its formal approval by KJA for project award to NIAS as a pilot-project at a cost of INR 24.5 lakhs. The project has been completed by NIAS in 5 archaeological/cultural sites and report has been received by KJA – this is being now taken up for Departmental review of results and then next step of a state-wide programme for Archaeological and Cultural knowledge enhancement using RS and GIS techniques by GOK.
- Development of a **Karnataka Skill Development Plan** through an expert Task Team – the plan identified the need to re-define employment exchanges into career guidance centres and bring in focus on careers rather “jobs”; establishing a Skill/Vocational University that will enable skill development leading to certification/degree and standardisation; corporate involvement in skill development by allowing industry championship for skill development in different sectors; a major thrust to apprenticeship in private sector and government – especially bringing parity in best practices for apprenticeship and engaging large number of government interns in the youth and developing a Skill Department have been recommended. The KJA Recommendation has been submitted to Department for Skill Development, Entrepreneurship and Livelihood for implementation.
- Development of a **Arts Management Strategy for Karnataka** – I played a key role in preparing the KJA Recommendation which has identified capacity building and Expert cadre development - in Arts Administration and Museum Management; inclusion of Museum Design in Curriculum of Architecture courses run by GoK; creation of a world-



class repository/archive of cultural, linguistic, audio-visual, photographic material and intangible Cultural Heritage to make it widely accessible through online resources; developing a “Kalaagraama” in Bengaluru as a Karnataka Arts & Culture Park as both cultural and tourism hub; bringing high-level focus on Arts and Culture through a Ministerial Group on Culture (MGC) and protection of Arts Objects Policy for Karnataka. The Recommendation has been submitted to Department of Kannada and Culture for implementation.

- Development of a **Plan for Development of Machine Intelligence (MI) strategy in Karnataka** – where I played a key role in an expert group assessment of future of MI technology development - inclusion of MI and Robotics as part Higher Education and advanced research ; launch a Karnataka – Open Data Initiative (K-ODI) that commits systematically archiving, making available all data generated by public funds into an open big data architecture; establish an Advanced Centre for Machine Intelligence and Robotics (AdCenMIR) in Karnataka; training and human resources development in Data Analytics in Government and establish a Mission mode programme and 3-tiered management structure in state for implementing the MI strategy. The KJA Recommendation has been submitted to IT/BT Department.
- Conceptualised need for Karnataka to prepare for using **Unmanned Aerial Systems (Drones) technology and applications strategy** for benefit to society and also to take a lead in manufacturing and education/research in UAS. Played key role in definition of UAS Strategy for Karnataka – inclusion of UAS as part of Karnataka Aviation Policy and thrust to manufacturing capability to make Karnataka a global hub for UAS; bringing UAS study as part of Higher Education and research for a “systems experience of UAS” in academics; specific support for indigenous design and manufacturing of UAS by a challenge fund through academia+industry; developing Standard Operating Procedure (SOP) for various Application areas in Governance and establish a Mission mode programme and 3-tiered management structure in state for implementing the UAS strategy. The KJA Recommendation has been submitted to S&T Department.
- Coordinating and supporting development of a **Karnataka Public Health Policy (KPHP)** by an expert group. The KJA Recommendation proposes an inclusive and participatory approach for involvement of all stakeholders in the health sector; defines the objectives, principles and strategies to reach a high standard of healthcare in the state; defines an implementation framework to achieve this standard; specific recommendations in 12 areas of intervention – primary healthcare, Human Resources for health, healthcare technology, training of healthcare staff, health information systems, electronic health records, AYUSH development and integration, state health ombudsman, procedural costing, quality in healthcare, access to affordable medicines and care of the elderly. The KJA Recommendation has been submitted to Health and Family Welfare Department.

I am coordinating and contributing to the following on-going/new activities in KJA:

- Study for Graduate level Project emphasis – assessment of improving project skills for graduate course students; a Centre for Wood-work and Toys – promoting the word-works and toys arts/knowledge in Karnataka; Waste-water management strategies; evaluation of proposal for Preparation of the Encyclopedia of the Heritage of Indian Science and Technology; Karnataka Water Policy; Cyber Security – a future strategy for Karnataka; Future of Governance – Policy and Actions; Big Data and DA for Policy Analysis etc

**CHAIRMAN, KARNATAKA-GIS TECHNICAL COMMITTEE FOR GOVERNMENT OF KARNATAKA**

In 2013, as Chairman, Karnataka Jnana Aayoga's GIS Task Force and in role of advising KRSRAC, I have led the definition of:

- **Karnataka-GIS Visioning and User Needs Assessment:** Undertook a visioning exercise for a State GIS system for Karnataka – dove-tailed to National GIS and led the development of a comprehensive assessment of user needs, in terms of GIS data and applications for various state departments, citizens etc. Reports on Vision of K-GIS and User Needs for K-GIS have been brought out and submitted to GOK.
- **Development of (first ever) proto-type GIS Portal for Karnataka:** Technically leading and guiding Karnataka state in the design and development of a (first ever) GIS Portal for Karnataka – based on available image/map layers and web-interface for user display and query operations. The Portal is a proto-type GIS Portal demonstrating K-GIS concept.

From 2015 onwards, I have been nominated to be **Chairman of K-GIS Technical Committee and Member of K-GIS Empowered Committee** for providing technical guidance and overseeing design and development of Karnataka-GIS by IT/BT Department. In this role, I am technically guiding Karnataka State Remote Sensing Applications Centre (KRSRAC) in implementation of Karnataka-GIS in following areas:

- Design and development of a ~221 layered GIS database for whole state
- a Karnataka Spatial Framework has been designed and is being organised for precision registration of all maps/data for the state
- GIS based Decision Support System applications have been designed and being developed for 8-10 Departments – Higher Education, Primary and Secondary Education, Health, Water Resources Department, State Pollution Control Board, Agriculture, Urban Development and others.
- GIS Applications for 18 other GOK departments are being defined and designed.
- Capacity Building and Training needs for Karnataka-GIS are under definition
- Designing and Architecturing the Karnataka-GIS Infrastructure of servers, GIS engine, DBMS engine and overall system design.

From 2016 onwards, I have also been identified to Chair the Karnataka-GIS Interview and Selection Committee for hiring key senior and mid-level professionals required for Karnataka-GIS.

**CHIEF EXECUTIVE OF C-SAG**

From August, 2017 onwards, I have taken the role of Chief Executive of Centre for Spatial Analytics and Advanced GIS (C-SAG) – which has been established under the aegis of NIAS Council of Management (COM) in Bengaluru. This Centre works in the field of Spatial Analytics (SA) and advanced GIS and develops suites of Intellectual Property and GIS Apps for various areas of societal development.

My role is to provide leadership to the centre and develop an Agri-GIS engine for areas in S Odisha as a beneficiary oriented GIS advisory system for farmers. Studies and projects on use of

Unmanned Aerial Systems (UAS), Data Analytics, Big Data, Spatial Search, 3D GIS etc are also being undertaken.

### **EO, GIS AND SPACE RESEARCH AT NIAS**

“Think-tank studies related to space-based EO and GIS eco-system for advanced technological and policy aspects of Earth Observation, GIS and Space in National Institute of Advanced Studies (NIAS):

- **National GI Policy:** For a DST Sponsored project to NIAS, led the study for a policy-analysis on Geographic Information (GI) in the context of National GIS. Undertook an exhaustive analysis of policies of world and of Indian scenario and a parametric analysis for GI Policy for India. A NIAS report has been published for this study including a proposed a draft GI Policy for India.
- **National GIS Standards, Spatial Framework and Technologies:** Led the DST Sponsored techno-study at NIAS to define GIS Standards, define and design Spatial Framework and identify technology-slate for National GIS. Assessing the world status of GIS Standards and also the Indian scene of GIS Standards. A report has been published by NIAS and submitted to DST, GOI.
- **Space Policy Perspective study** – assessing global space policy status, assessing Indian Space metrics, assessing space technology requirements and envisioning and articulating future long-term space policy tenets for India. A paper on Renewing Indian Space Policy has been prepared.
- **International Cooperation of Indian Space** – analysis of the development of international cooperation in India space and learnings for the future. This study is ongoing and report being prepared.
- **Space Eco-system** study – continuation of space policy definition, I am working on looking at the metrics of achievements of space in India and estimating the future space missions required for India – logically determining the best combine of a “national space eco-system” consisting of vanguard of ISRO+industries+academia – each a critical element of the future space system in the country. 5 papers on this have been published.
- **Regional Space Policy Analysis in AP region** – leading a NIAS-University of Tokyo collaborative study on Asia Pacific regional space policy assessment and identifying possible areas of space cooperation – at bi- and multi-lateral level. Space Policy of India, Japan, Singapore, Philippines and Malaysia have been studied and specific cooperation possibilities between India and Japan in space have been identified. 3 Papers on this study have been published.
- **“Game-changers” for Indian Space** – a study to identify key actions that can change the overall space environment for the future in India. The thrust is to be on privatization of operational space missions in India; global market access in space by Indian industry; new and advanced technology development for India and consideration new missions and programmes for next 20-30 years. A key paer on this has been published.

- **Key Considerations and Possible Process for definition of Indian Human Space Flight Programme** – a study that identifies the range of technological, social, economic and political perspectives for a decision on Indian Human Space Flight Programme. The study also outlines a possible national process that could be adopted for the Human Space Flight programme decision. A key paper on this has been published.

#### **EXPERT ON NATIONAL GIS FOR PLANNING COMMISSION**

Served as Member-Secretary of National GIS Interim Core Group constituted by Planning Commission vide Order No 12016/8/2010-S&T of April 25, 2010 and provided leadership to conceptualization and definition of the National GIS vision and also strong advocacy for implementation of a nation-wide GIS for governance, enterprises and citizens. As part of this my major role has been in:

- Coordinating and steering the National GIS Interim Core group and its activities over a series of nation-wide, ministry-wide and state-wide meetings for National GIS.
- Preparation of the National GIS Vision/Programme document and coordinating a visioning exercise.
- Supporting Planning Commission for drafting the proposals on National GIS and INGO for various approval cycles.

#### **CONSULTING IN EO/GIS/SPACE**

Provide technical expertise in consulting assignments to private sector agencies – national and international level in terms of EO/GIS/Space project architecturing - systems design/configuration; EO/GIS applications solution design and T&E; review project performance metrics through standards definition for test and evaluation and quality assessment processes. I have provided technical expertise for EO/GIS solutions in New-Zealand projects, US projects and also for Indian projects to different private sector agencies.

#### **OTHER ACTIVITIES**

Invited and participate in many national and international media interactions (national and local TV and print) for TV debates, TV discussions and articles/interviews on topics related to EO, GIS and Space.

Also guide students for their project dissertations, PhD courses etc.

## **10) 24 YEARS IN ISRO - GOVERNEMENT EXPERIENCE IN SPACE APPLICATIONS AND RESEARCH (Jan 1981 – Aug 2005)**

Over 24 years in ISRO, was charging its EO Applications programmes through active involvement in IRS programme; National Natural Resources Management System (NNRMS); India's National Spatial Data Infrastructure (NSDI) and also furthering EO Applications and SDI concepts at international levels. Key accomplishments include:

- In 1981, developed (first time) EO applications based on **digital analysis of EO images** and GIS integration for change analysis of Ahmedabad city;
- During 1982-1988, contributed significantly in coordination of ISROs **Joint Experiments Programme (JEP)** – especially programme monitoring and implementation for geological applications. Later, significantly contributed in definition of **Indian Remote Sensing Utilisation Programme (IRS-UP)** and its systems implementation coordination.
- During 1983-1987, was one of key persons involved in conceptualization of ISRO's nation-wide **Natural Resources Information System (NRIS)** and initial demo-studies for Mineral Exploration and landuse change analysis. Undertook an exhaustive design re-engineering study for GIS software.
- During 1984-1990, led a team to **implement the first GIS projects in urban management and regional planning** – GIS for Delhi Metropolitan Area (DMA); GIS for Mumbai MRDA; GIS for regional district planning (Bharatpur); GIS Wasteland development (Dungarpur) and National Capital Region (NCR) GIS. Worked on standardizing design of GIS projects – especially focusing on multi-layered GIS data for districts focusing on GIS for District planning.
- During 1988-1994, was principal scientist and lead of technical team that **developed ISROs indigenous GIS software – ISROGIS**. Key person involved in design, development coordination, testing and systems applications – resulting in India's first GIS software that was available in market under ISRO technology transfer.
- Have actively contributing to **national- and international-level efforts at EO/GIS standardization** – developed and scripted GISMARK – a test suite for GIS package evaluation in 1988; defined inter-operable EO/GIS Design Standards in 1994; significantly contributed to EO-based NRIS Standards in 1996; led the development of geo-spatial Metadata Standards for NSDI in 2004 and provided leadership in development of the widely-referenced NNRMS Standards for EO and GIS Applications in 2005.
- During 1995-2002, played a programmatic lead role in **implementation of the nation-wide NRIS programme as a multi-institutional GIS effort** in 35 districts and 17 states – GIS concepts and applications were taken into state and district environments for first time.
- From 1994 onwards, was **coordinating the EOS programme in ISRO** by working for planning and management of IRS programme. Worked as Programme Manager of ISROs Natural Resources Information System (NRIS) programme and for various NNRMS application programmes.
- Was key person in developing, for the first time, the **Remote Sensing Data Policy** for India and also in shaping India's National Map Policy.
- Played a leading role in ISRO for developing the **ISRO EO-2025 Strategy** – defining key actions for growth and leadership of Indian EO programme and definition of a 25-years rolling road-map of IRS missions and applications of benefit to society and commercial development.

- In ISRO, **provided leadership and coordinated various international space activities** – Committee on EO Satellites (CEOS) as its 1998-Secretary and Working Group Chair/Member; United Nations UNISPACE-III Secretariat Member; ESCAP RS and GIS programme support; International Astronautical Federation (IAF) as its Vice-President; International Academy of Astronautics (IAA) Study Group on Space for Peace Rapporteur and many others.
- During 2001-2003, was key person for ISRO undertaking a Secretary-level **inter-departmental Peer-Review of RS Applications** that involved 12 ministries/users in India and worked for developing frameworks of national RS and GIS applications leading to definition of some important user-ministry led RS and GIS initiatives - National Urban Information System (NUIS), National Soil and Land Degradation mapping, National Geomorphological Mapping project and many others.
- Was actively involved in development of **ISROs 9th and 10th Five-Year plans** for IRS and EO applications.
- From 1994 onwards, as **Member-Secretary, NNRMS Standing Committee** on Urban Management (SC-U), key person in conceptualizing/developing NUIS programme – in terms of design and definition, project proposal preparation, NUIS Standards preparation and working with MUD/TCPO to make the programme into a reality.
- During 2000-2005, key anchoring person for the **conceptualization and development of India's National Spatial data Infrastructure (NSDI) Strategy and Action Plan** and have been spear-heading the propagation of SDI concepts through enterprise GIS Applications development. In 2002, undertook the first demonstration of NSDI at national level. In 2004, conceptualized and operationalised the NNRMS Portal enabling the first-of “EO and GIS Data Services”.
- In 2003, steered the re-structuring of NNRMS activities under a new programme of Natural Resources Repository (NRR) and **headed the NRR programme as its Programme Coordinator** – steering concept and implementation of Natural Resources Census using satellite images, Natural resources Data Base (NRDB) as a repository of all data, Cadastral Referencing database (CRD) to bring in cadastral reference to satellite images, Large Scale Mapping (LSM) for mapping at 1:10000 scale from images and development of a NNRMS Portal – a single gateway for NNRMS data. Heading NRR, was the key person who prepared the NNRMS Standards report (for Eo images, Thematic Maps and GIS) in 2005.
- In 2004-2005, through ISRO worked with NIC and Planning Commission and undertook the design and **establishment of National GIS demonstration exercise** with nation-wide GIS data and visualisation/query.
- In ISRO, **provided leadership and intense efforts at institutional building** – establishment of UN-CSSTEAP, its international level management and developing education programmes and accreditation; preparatory activities coordination and establishment of North Eastern – Space Applications Centre (NE-SAC); providing headquarters coordination for EO and GIS activities of SAC/ISRO, NRSA, RRSSCs, State RS Applications Centre and constant development of user-interfaces with large number of Ministries and departments at centre and state-level.
- **Coordinated major conferences/seminars.** Served as Local organizing Secretary for the 90<sup>th</sup> Indian Science Congress of 2003; Organising Secretary for India – United States Conference On Space Science, Applications, and Commerce - Strengthening and Expanding Cooperation (2004); IAA Asia Pacific Regional Conference on Advances in Planetary Exploration (2005) and others.

**11) ~6 YRS INDUSTRY LEADERHIP IN EO/GIS:**

After 2005, as CEO in a start-up GIS company (Navayuga Spatial Technology Pvt Lrd) and later as President/COO in a leading Indian GIS company (NIIT-GIS – distributor of ESRI in India), established efficient and successful business models for GIS Applications and Enterprise GIS Solutions. Major achievement was to convert a start-up into a leading GIS solutions/services company within 3 years; in bringing solution-centric efficiency for distribution of GIS software in India and positioning GIS as an important element of business processes and architecturing large GIS solutions with an efficient business model.

I was instrumental in acquiring large GIS solution projects in India/ME/Japan/US and other geographies. Provided technical leadership in positioning efficient delivery processes for GIS projects - bringing profit-centricity to GIS projects and addressing unique GIS solutions and services.

Key leadership role in architecturing the Delhi SDI based on images/GIS; the NSDI Geo-Portal development; the UAE-Ras Al-Khaimah Enterprise Image/GIS solution; Singapore's 1-Map Geo-Portal solution; Kanpur's Municipal GIS solution based on EO; CRRI's Road Information System Portal on images/GIS; Karnataka's EO-based Disaster Management Portal; the design of Mumbai EO/GIS solution; design of Power-Utility Image/GIS solutions and many other projects.

Provided ideating and designing of new applications through synergy of personalized satellite communications technology with GPS/GIS technology to position unique integrated solutions/services for government sector - Railways Real-time Positioning and Tracking solution, Defence and Security field communication and positioning solution, Cadastral Tracker etc

**12) INTERNATIONAL POSITIONS/EXPERIENCE:**

Have held many important international positions:

- Member of CEOS Working group on Information Systems and Services (1995-2005)
- Member of IAF EO Committee (1996-continuing)
- ISRO Member of international Committee on Earth Observations Satellites (CEOS) Secretariat (1996-99)
- first Chairman of CEOS Working group on Education (1999-2005); Member of UNISPACE-III Secretariat (1999)
- Member of UN CSSTEAP Advisory Committee (1998-2005)
- Vice-President of the International Astronautical Federation (IAF) (2002-2006)
- founding and first President of the international Global Spatial Data Infrastructure Association (GSDI) (2003-2004)
- Member of International Academy of Astronautics (IAA) (2004-Continuing)
- Member of IAA Study Group on Space for Peace (2003-2004)
- Member of International Institute of Space Law (IISL) (2013 onwards)
- Member of IAF Satellite Communications and navigation committee (2014-continuing)
- Fellow of Survey and Mapping Association of India (2016 onwards)
- Vice-Chair of Space Policy and Law Network in Asia Pacific (SPLANAP) region (2015 onwards)

Have been an active participant in International Society for Photogrammetry and Remote Sensing (ISPRS) activities and also supported UN-Office for Outer Space Affairs and UN-ESCAP activities.

During 1995-1996, served as Consultant to ESCAP's Space Technology and Applications programme for preparing a "Handbook for GIS" – which was published by ESCAP in 1997.

Played a major role in the IAA study on "Space for Peace" which helped IAA to position an inter-agency initiative for peace activities and reconstruction of Afghanistan using space technology.



### **13) MAJOR ORGANISATIONAL RESPONSIBILITIES**

Have also organized major national and international Conferences/Seminars – bringing outreach and visibility to Indian EO and GIS and also enabling a forum for Indian experts to learn international trends/prospects:

- Organising the Committee on Earth Observation Satellites (CEOS) Working group on Information Systems and Services Meeting in Bangalore, India in October, 1998.
- As CEOS Secretariat, organised international Committee on Earth Observation Satellites (CEOS) Plenary and International Global Observing Strategy (IGOS) Forum meeting in Bangalore, India in November, 1998.
- Organising Secretary of 91st Indian Science Congress (ISC) in Bangalore, India in January, 2003.
- Presidential leadership for the 7th GSDI Conference in Bangalore, India during February, 2004 and taking over as President of GSDI association in 2003 for 2 years.
- Coordinating, steering and conduct of the Indo-US Conference on Space Technology Cooperation and Commercialization in Bangalore, India in 2004 – which paved the way for adoption of a Indo-US Space Vision that has been the basis of subsequent space cooperation activities between India and US.
- Coordinating and conduct of the International Academy of Astronautics & International Institute of Space Law Conference on “Advances in Space Exploration” and “Bringing Space Benefits to Asia Pacific region” – a major international initiative of ISRO in 2005.
- Organizing the NIAS University of Tokyo Roundtable Meetings in NIAS, Bengaluru in August 2014, August 2015 and August 2016.
- Organizing the Workshop on GI Policies in NIAS during August, 2012.
- Organizing the Consultation Meeting on National GIS Standards at NIAS during April, 2014.

#### **14) IMPORTANT POSITIONS/AFFILIATIONS:**

Have contributed through following international/national positions:

1. Member-Secretary of Karnataka Jnana Aayoga (from 2014 onwards).
2. Member of Karnataka Jnana Aayoga (2011-2013)
3. Chairman of KJA Task Force on Karnataka-GIS (2011-2013)
4. Chairman of Karnataka GIS Technical Committee (June 2015 onwards)
5. Member of Karnataka's RFD Review Committee for IT/BT Department (2013-2016)
6. Founding President of the Global Spatial Data Infrastructure (GSDI) (2003-2004) – the leading international professional body of spatial technology and applications professionals. Subsequently, President (Past) of the Global Spatial Data Infrastructure Association (GSDI) (2005 onwards)
7. Vice President of the International Astronautical Federation (IAF) (2002 to 2006) – the leading professional body of space technologists, industries and agencies.
8. Elected Member of the International Academy of Astronautics (IAA) (2006 onwards) – the leading professional association of space scientists
9. Member of Commission-V on Space Policy and Legal Aspects of International Academy of Astronautics (IAA) (2006 onwards)
10. Member of the American Institute of Aeronautics and Astronautics (2004 onwards)
11. Member of the Earth Observation Committee of the International Astronautical Federation (IAF) (from 1999 onwards continuing)
12. Member of the Education Committee of the International Astronautical Federation (IAF) (from 2001 onwards)
13. Member of Editorial Board of Space Policy (2005 onwards) – a leading international journal for policy research and studies
14. Member of Editorial Board of New Space Journal (2014 onwards) – a leading space technology journal
15. Editorial Board Member of Geospatial Today magazine (2006 onwards) – one of the leading GIS publications of India
16. Secretariat Member of international Committee on Earth Observation Satellites (CEOS) (1997-1999) – the leading multi-lateral cooperation committee of national space agencies
17. Chairman of the Working Group on Earth Observation Education and Training (WGEdu) of the Committee of Earth Observation Satellites (CEOS) (from 2000 - 2005).
18. Member-Secretary of the International Advisory Committee of the UN Centre for Space Science and Technology Education in Asia and the Pacific (from 1998 - 2005) – the UN education institution established in India.
19. Member of the Steering Committee of the Global Spatial Data Infrastructure (GSDI) (from 2000 - 2003).
20. Member-Secretary of international IAA Study Group on “Space for Peace: Reconstruction of Afghanistan” (2001-2004) – a unique study project for defining applications of space for peace and reconstruction activities in Afghanistan.
21. Deputy Organiser of the COSPARs Panel on Space Research in Developing Countries (PSRDC) (from 2000 - 2002).
22. Member of the Working Group on Information System and Services (WGISS) of the Committee of Earth Observation Satellites (1998 – 2005).
23. Vice President of the Indian Society of Remote Sensing for term 2000-2002 and Member of the ISRS Executive Council for term 2002-2004.
24. Vice President of Indian Society of Geomatics for term 2001-2003.

25. Local/Organising Secretary of the 90<sup>th</sup> Indian Science Congress organised by the Indian Science Congress Association, Kolkata, India (2002-2003).
26. Member of the Committee on Liaison for Developing Countries of the International Astronautical Federation (IAF) (2001-2006).
27. Member of MHRD Geospatial Education Task Force (Sep 2010-June, 2013).
28. Life Member of Indian Society of Remote Sensing (ISRS) (1985 onwards).
29. Founding Life Member of Indian Society of Geomatics (ISG) (1989 onwards).
30. Life Member of Astronautical Society of India (ASI) (2000 onwards).
31. Fellow of Survey and Mapping Association (2016 onwards)

**15) AWARDS/DISTINCTIONS:**

Have been honored with many distinctions/awards:

- Recognized as a “GIS HERO” in ArcNews ([www.esri.com](http://www.esri.com)) in Winter/2010 issue.
- GIS Professional of 2009 Award at the Map India, 2010 Conference
- National Geospatial Award for Excellence in Spatial Technology of the Indian Society of Remote Sensing (ISRS) in 2009
- Exemplary Service Medal from international Global Spatial Data Infrastructure (GSDI) association in 2009
- Hari Om Ashram's Vikram Sarabhai Young Scientist Award in the area of "Systems Analysis and Management" in 2002.

## **16) PUBLICATIONS**

Have about 239+ publications/reports – technical reports/publications, peer-reviewed Conference Publications, Journal publications, Study Reports and International Study-Group publications.

October, 2017

(Mukund Kadursrinivas Rao)

**LIST OF PUBLICATIONS (JOURNAL PAPERS, GOVT/OTHER REPORTS AND CONFERENCE PAPERS)****1] 1982 (1/1)**

- 1) **IRS-Utilisation Programme - Programme Plan.** *Mukund Rao* as Utilisation Cell team member. A Space Applications Centre, ISRO report - SAC/IRS-UP/PP-01/April 1982.

**2] 1983 (5/6)**

- 1) **Data Products requirements vis-a-vis IRS-UP** - *Mukund Rao* as Committee Member-secretary. A Space Applications Centre, ISRO report - of April 1983.
- 2) **Natural Resources Information System** - AR Dasgupta, Bhaskar Das, OP Gautam, AV Kulkarni, TR Madhavan, *Mukund Rao*, RR Navalgund, RP Sharma and ST Chari. Paper presented and published in the proceedings of National Natural Resources Management System seminar held at NRSA, Hyderabad in May 1983.
- 3) **Existing Geological Information System - Background note for formulating an approach to evolution of an Information System for Geology** - *Mukund Rao*. A Space Applications Centre, ISRO report - SAC/RSA/UC/SN-07/September 1983.
- 4) **A note on Information requirements - Geological Information System** - *Mukund Rao*. A Space Applications Centre, ISRO report - SAC/RSA/UC/SN-08/October 1983.
- 5) **Urban landuse/landcover change detection around Ahmedabad city using Landsat data** - PS Thakker, *Mukund Rao*, Bharati Ramola and Asha Jadeja. Paper presented and published in proceedings of International Seminar on Environmental Maps and Atlases, Calcutta in December 1983.

**3] 1984 (7/13)**

- 1) **Remote Sensing for Urban Landuse and landcover map of Ahmedabad** - *Mukund Rao*, PS Thakker and AR Dasgupta. A Space Applications Centre, ISRO report - SAC/RSA/UC/IN-01/January 1984. (In NNRMS Bulletin of February 1985).
- 2) **Special Products - A user-specified product** - AR Dasgupta and *Mukund Rao*. A Space Applications Centre, ISRO report - SAC/IRS-UP/SMO/IN-02/March 1984.
- 3) **An approach to quantification of satellite data products for IRS-UP projects** - *Mukund Rao*. A Space Applications Centre, ISRO report - SAC/IRS-UP/SMO/TN-04/June 1984.
- 4) **Baseline software requirements on PASIPS** - *Mukund Rao* and AR Dasgupta. A Space Applications Centre, ISRO report - SAC/IRS-UP/SMO/IN-03/June 1984.
- 5) **Digital Processing for IRS-UP (SAC): Load estimation and facility requirements** - *Mukund Rao* as committee member. A Space Applications Centre, ISRO report - IRS-UP/SAC/AD/CR-04 June 1984.

- 6) **An approach to quantify digital analysis facility for IRS-UP** - *Mukund Rao*. A Space Applications Centre, ISRO report - SAC/IRS-UP/SMO/TN-05/June 1984.
- 7) **A sample Natural Resources Information System - a case study in Mineral Exploration** - AR Dasgupta, RK Goel and *Mukund Rao*. A Space Applications Centre, ISRO report - SAC/RSA/UC/TN-07/September 1984.
- 4] **1985 (5/18)**
  - 1) **Monitoring the urban growth of a city using Remote Sensing - A case study of Ahmedabad** - *Mukund Rao*, PS Thakker and AR Dasgupta. Presented at and published in proceedings of the UN-ESCAP International Seminar on Application of Remote Sensing in developing countries held at Yogyakarta, Indonesia in March, 1985.
  - 2) **Digital analysis facility for IRS-UP (SAC)** - *Mukund Rao* as Committee member. A Space Applications Centre, ISRO report - IRS-UP/SAC/AD/CR-03 June 1985.
  - 3) **Assessment of software requirement for IRS-UP (SAC)** - MC Gupta, M Chakraborty, VK Dhadwal and *Mukund Rao*. A Space Applications Centre, ISRO report - IRS-UP/SAC/AD/CR-04 June 1985.
  - 4) **Augmentation of Image Processing system at SAC** - *Mukund Rao* as Committee member. A Space Applications Centre, ISRO report - IRS-UP/SAC/AD/CR-07/October 1985.
  - 5) **Reflectance data of rock types/surface materials and their utility for mapping** - *Mukund Rao*, RK Goel and AR Dasgupta. In Proceedings of the Sixth Asian Conference on Remote Sensing, Hyderabad held in November 1985. pp 170-175.
- 5] **1986 (2/20)**
  - 1) **Accuracy assessment of thematic maps prepared from digital Remote Sensing data** - *Mukund Rao*, PS Thakker and AR Dasgupta. In Proceedings of International Seminar on Photogrammetry and Remote Sensing for the Developing Countries held at New Delhi in March 1986 and as a Space Applications Centre, ISRO report - SAC/RSA/SPUCC/TR-14 of April, 1986.
  - 2) **Scientific Investigations and application demonstration using ERS- data - A Proposal from India** - Co-ordinated by *Mukund Rao*. A Space Applications Centre publication of October 1986.
- 6] **1987 (7/27)**
  - 1) **MRSP - Programme plan - Contributed to the Application and Utilisation aspects of the plan.** A Space Applications Centre publication of Early 1987.
  - 2) **Information system for Geology and a case study for Mineral Exploration** - *Mukund Rao* and A R Dasgupta. A Space Applications Centre, ISRO report - SAC/RSA/SPUCC/TN-16/June 1987.

- 3) **Aerial survey for ERS-1 investigation** - *Mukund Rao*. A Space Applications Centre, ISRO report - SAC/RSA/SPUCC/PL-33/June 1987.
  - 4) **A system for planning and monitoring the data products acquisition for Remote Sensing Applications Mission** - Farhana Rangwala, Ketki Vora and *Mukund Rao*. A Space Applications Centre, ISRO report - SAC/RSA/SPUCC/TR-21/July 1987.
  - 5) **Implementation of a part of the Mineral Exploration Information System using a GIS package** - *Mukund Rao* as Project team member. A joint Space Applications Centre and Directorate of Geology and Mining, Ahmedabad report - SAC/RSA/SPUCC/TN-17/August 1987.
  - 6) **A note on the use of microwave data available at SAC** - Co-ordinated by *Mukund Rao*. A Space Applications Centre, ISRO report - SAC/RSA/IN-01/October 1987.
  - 7) **A note on the evaluation of ISRO-SLAR data** - Co-ordinated by *Mukund Rao*. A Space Applications Centre, ISRO report - SAC/RSA/IN-02/October 1987.
- 7] **1988 (4/31)**
- 1) **A comparative study of spatial data structures for MEIS** - ES Murthy, *Mukund Rao* and RK Goel. A Space Applications Centre, ISRO report of January 1988.
  - 2) **Optimal gain setting for IRS payload** - Coordinates by *Mukund Rao* as Committee member-secretary. A Space Applications Centre, ISRO report - SAC/RSA/SPUCC/CR-44/January 1988.
  - 3) **Report of Phase-I ATP of DIPIX system** - Co-ordinated as Member-secretary. A Space Applications Centre, ISRO report - IRS-UP/SMO/CR-53/August 1988.
  - 4) **Case study proposals on applications of Geographical Information Systems** - A Committee report - *Mukund Rao* as a Committee member. A Space Applications Centre, ISRO report - SAC/RSA/SPUCC/CR-59/November 1988.
- 8] **1989 (4/35)**
- 1) **Natural Resources Information System - Programme document** - *Mukund Rao* as a RSAM-MC Committee member. A Space Applications Centre, ISRO report - SAC/RSA/SPUCC/PP-62/July 1989.
  - 2) **Natural Resources Information System - A position paper** - *Mukund Rao* and AR Dasgupta. A Space Applications Centre, ISRO report - SAC/RSA/SPUCC/TN-63/October 1989.
  - 3) **Pilot study for Wasteland Development - A GIS based approach** - RK Goel, *Mukund Rao*, TP Singh and AR Dasgupta. A Space Applications Centre, ISRO report - SAC/RSA/SPUCC/TN-64/October 1989.



- 4) **Demonstration of URIS using a GIS package - Baseline design document** - *Mukund Rao* as Project team member. A Space Applications Centre, ISRO report - SAC/RSA/NRIS-URIS/PP-01/October 1989.
- 9] **1990 (4/39)**
  - 1) **Design and organisation of GIS on ISROVISION** - PD Yadav, *Mukund Rao*, IC Matieda and KL Majumder. A Space Applications Centre, ISRO report - SAC/IPDPG/IPPD/TN-15 March 1990.
  - 2) **Design and development of a Geographical Information System (GIS) - Preliminary design document** - *Mukund Rao* as Design team member. A Space Applications Centre, ISRO report - SAC/RSA/IPDPG/RD-20/August 1990.
  - 3) **NRIS District Node: A suggested framework** - *Mukund Rao* and AR Dasgupta. A Space Applications Centre, ISRO report - SAC/RSA/SPUCC/TN-68/November 1990.
  - 4) **Organisation of sectoral databases for GIS (Based on datafiles from NIC terminal, Bharatpur)** - SVC Sastry, Ketki Kharod and *Mukund Rao* from SAC and J Premnath Singh and ML Chotani from TCPO. A joint Space Applications Centre, Ahmedabad and Town and Country Planning Organisation, New Delhi report - SAC/RSA/NRIS-URIS/TN-05/November 1990.
- 10] **1991 (11/50)**
  - 1) **Test plan for Indigenous Geographical Information System (GIS)** - *Mukund Rao* as Design Team member. A Space Applications Centre, ISRO report - SAC/RSA/IPDPG/TP-01/January 1991.
  - 2) **A weighted index model for urban suitability assessment - a GIS approach (Case study for BMR)** - *Mukund Rao*, SVC Sastry, PD Yadav, Ketki Kharod, SK Pathan, PS Dhinwa and KL Majumder from SAC and D Sampathakumar, VN Patkar and VK Phatak from BMRDA. A joint Space Applications Centre, Ahmedabad and Bombay Metropolitan region Development Authority, Bombay report - SAC/RSA/NRIS-URIS/TN-03/February 1991.
  - 3) **Organisation of Spatial Information System for Regional Development - A case study for Bharatpur district** - *Mukund Rao*, SVC Sastry, PD Yadav, PS Dhinwa, SK Pathan, Ketki Kharod and KL Majumder. Presented at the National Seminar on Computer and Remote Sensing applications in Agriculture, Rural development and water management organised by Computer Society of India, Division III and Ahmedabad Chapter in February 1991 at Ahmedabad.
  - 4) **Organising a GIS database on ISROVISION - A case study for Delhi Metropolitan Area (DMA)** - *Mukund Rao* as Study team member. A joint Space Applications Centre, Ahmedabad and National Capital Region Planning Board (NCRPB), New Delhi report - SAC/RSA/IPPD/TN-14/May 1991.
  - 5) **IRS-1E MEOSS Utilisation Plan** - *Mukund Rao* as a Committee member. A Space Applications Centre, ISRO report - SAC/RSA/MEOSS/CR-01/July 1991.

- 6) **INDGIS - User-interface document** - *Mukund Rao* as a Design team member. A Space Applications Centre, ISRO report of August 1990.
- 7) **A comparative study of priority weighing methods in a multi-criteria based GIS application** - SVC Sastry, *Mukund Rao*, SK Pathan, PD Yadav and KL Majumder from SAC and VN Patkar and D Sampathakumar from BMRDA. A joint Space Applications Centre, Ahmedabad and Bombay Metropolitan region Development Authority, Bombay report - SAC/RSA/NRIS-URIS/TN-04/October 1991.
- 8) **Oceanographic and Atmospheric Science Investigation satellite (OASIS) (Mission Scenario and Payload Configuration)** - *Mukund Rao* as Committee member. A Space Applications Centre, ISRO report - SAC/RSA/IRS-OASIS/CR-07/October 1991.
- 9) **ERS-1 Utilisation - Plan document** - Co-ordinated by *Mukund Rao*. A Space Applications Centre, ISRO report - SAC/RSA/ERS-UTIL/PP-01/October 1991.
- 10) **Landuse change analysis of Bharatpur district using GIS** - *Mukund Rao* as Team member. A joint Space Applications Centre, Ahmedabad & Town & Country Planning Organisation, New Delhi report - SAC/RSA/NRIS-URIS-BHA/TN-12/December 1991.
- 11) **Land Capability analysis of Bharatpur district using GIS** - *Mukund Rao* as Team member. A joint Space Applications Centre, Ahmedabad & Town & Country Planning Organisation, New Delhi report - SAC/RSA/NRIS-URIS-BHA/TN-13/December 1991.
- 11] **1992 (16/66)**
  - 1) **Test results of ISROGIS** - *Mukund Rao* as Design team member. A Space Applications Centre, ISRO report - SAC/RSA/IPDPG/TN-01/January 1992.
  - 2) **ISROGIS software document** - coordinated by *Mukund Rao* as design team member. A joint Space Applications Centre, Ahmedabad; ERA Software Systems, Hyderabad and PEGASUS Software Consultants, Bangalore publication - SAC/RSA/IPDPG/TN-02 February 1992.
  - 3) **ISROGIS User's manual** - *Mukund Rao* as member of Project Team and Co-ordinator. A joint Space Applications Centre, Ahmedabad; ERA Software Systems, Hyderabad and PEGASUS Software Consultants, Bangalore publication - SAC/RSA/IPDPG/TN-03 February 1992.
  - 4) **An environmental assessment of Bombay Metropolitan region - A GIS approach** - *Mukund Rao*, SVC Sastry, SK Pathan, Ketki Kharod, PD Yadav, PS Dhinwa and KL Majumder from SAC and D Sampathakumar, S Pendharkar, VN Patkar and VK Phatak from BMRDA. A joint Space Applications Centre, Ahmedabad and Bombay Metropolitan region Development Authority, Bombay report - SAC/RSA/NRIS-URIS/TN-05/February 1992.
  - 5) **Integrating census village boundaries to SOI map base using a GIS package - Methodology and an assessment of errors** - Ketki Kharod, PS Dhinwa, SVC Sastry, PD

- Yadav, SK Pathan and *Mukund Rao*. A Space Applications Centre, Ahmedabad report - SAC/RSA/NRIS-URIS/TN -15/February 1992.
- 6) **Macro-level Urban Information System - A GIS case study for BMR - Mukund Rao** as Project Team member. A joint Space Applications Centre, Ahmedabad and Bombay Metropolitan region Development Authority, Bombay report - SAC/RSA/NRIS-URIS/PR-15 March 1992.
  - 7) **Database transfer document for BMR-GIS - Mukund Rao** as Project Team member and Co-ordinated. A joint Space Applications Centre, Ahmedabad and Bombay Metropolitan region Development Authority, Bombay report - SAC/RSA/NRIS-URIS/BMR/TN-19 March 1992.
  - 8) **Design and development of data structure for a 3D module of a GIS** - Project report of Sunil Bagai with *Mukund Rao* as guide. A SAC report, April 1992.
  - 9) **3D module for ISROGIS: Functional requirements and design considerations** - *Mukund Rao*, Yogini Vanikar, PD Yadav, KL Majumder. A Space Applications Centre, ISRO report - SAC/RSA/IPDPG/TN-09/April 1992.
  - 10) **GIS based information system for regional planning - A case study for Bharatpur district** - *Mukund Rao* as Project Team member. A joint Space Applications Centre, Ahmedabad and Town and Country Planning Organisation, New Delhi report - SAC/RSA/NRIS-URIS/PR-15 July 1992.
  - 11) **GIS Database transfer document for URIS Bharatpur (Around PC-ARC/INFO)** - *Mukund Rao* as Project Team member and Co-ordinated. A Space Applications Centre, Ahmedabad report - SAC/RSA/NRIS-URIS/BHA/TN-21 July 1992.
  - 12) **NRIS Programme Plan (EC-NRIS Committee report)** - as member of EC-NRIS. A Space Applications Centre, ISRO report - SAC/RSA/NRIS/PP-01/July 1992.
  - 13) **ISROGIS Map-mosaic and Edge-match (Design Considerations)** - Yogini Vanikar, *Mukund Rao* and KL Majumder. A Space Applications Centre, ISRO report - SAC/RSA/IPPD/TN-19/October 1992.
  - 14) **Network module for ISROGIS - Design consideration and specifications** - *Mukund Rao*, SVC Sastry, Yogini Vanikar and KL Majumder. A Space Applications Centre, ISRO report - SAC/RSA/SPUCC/TN-73/December 1992.
  - 15) **Landuse change analysis of Bharatpur district using GIS** - PS Dhinwa, SP Pathan, SVC Sastry, *Mukund Rao* and KL Majumder from SAC and ML Chotani, J Premnath Singh and RLP Sinha from TCPO. In Journal of the Indian Society of Remote Sensing, Vol. 20, No. 4, December 1992. pp 237-250.
  - 16) **Spatial Information System for macro-level urban planning using IRS-1A data** - KL Majumder, *Mukund Rao*, SVC Sastry, SK Pathan, PS Dhinwa, Ketki Kharod from SAC and VK Phatak, VN Patkar, S Sampathkumar, SP Pendharkar from BMRDA and A Arunachalam, SB Verma and JN Berman from NCRPB. In "Natural Resources Management - a new perspective", A NNRMS, DOS publication of 1992. pp 386-393.

**12] 1993 (23/89)**

- 1) **GISMARK - A Benchmark application for GIS packages** - *Mukund Rao & AR Dasgupta*. A Space Applications Centre, ISRO report - SAC/RSA/SPUCC/TN-74/March 1993.
- 2) **Application of GIS for Wasteland Development Planning (A case study for Aspur tehsil, Dungarpur district)** - Member of Project Team. A Space Applications Centre, ISRO report - SAC/RSA/NRIS-WLD/PR-02/March 1993.
- 3) **GIS Database Transfer document (Bharatpur district) - Member of Project Team** . A Space Applications Centre, ISRO report - SAC/RSA/NRIS-URIS/TN-22/April 1993.
- 4) **ISROGIS Phase-II: Baseline design (3D module, NETWORK, Symbol Manager and Customisation toolkit)** - *Mukund Rao* as Design team Member. A Space Applications Centre, ISRO report - SAC/IPDPG/IPPD/TN-06/April 1993.
- 5) **Performance evaluation of ISROGIS and PC-ARC/INFO** - *Ketki Kharod, RJ Bhanderi and Mukund Rao*. A Space Applications Centre, ISRO report - SAC/RSA/SPUCC/TN-75/May 1993.
- 6) **Design and development of a 3D module for a GIS (With a GUI) - Project report of Abhinaya Nagar** with *Mukund Rao* as guide. A Space Applications Centre, ISRO report - SAC/RSA/SPUCC/TN-76/May 1993.
- 7) **Design and development of a NETWORK module for a GIS (With a GUI) - Project report of Rajevee Rajan** with *Mukund Rao* as guide. A Space Applications Centre, ISRO report - SAC/RSA/SPUCC/TN-77/May 1993.
- 8) **Thrust areas of Remote Sensing applications in Developing countries** - *George Joseph and Mukund Rao*. Paper submitted
- 9) **Benchmarking GIS packages using GISMARK** - *Mukund Rao* and *KLN Sastry*. Lecture note prepared for the Training course on GIS for Resources Management and Development Planning held at Space Applications Centre , Ahmedabad during August 23, 1993 to September 11, 1993.
- 10) **GIS Database design and Organisation** - *Mukund Rao*. Lecture note prepared for the Training course on GIS for Resources Management and Development Planning held at Space Applications Centre , Ahmedabad during August 23, 1993 to September 11, 1993.
- 11) **Application Modelling using GIS** - *Mukund Rao*. Lecture note prepared for the Training course on GIS for Resources Management and Development Planning held at Space Applications Centre , Ahmedabad during August 23, 1993 to September 11, 1993.
- 12) **3D GIS - Concepts** - *Mukund Rao*. Lecture note prepared for the Training course on GIS for Resources Management and Development Planning held at Space Applications Centre , Ahmedabad during August 23, 1993 to September 11, 1993.

- 13) **NETWORKS in GIS: Concepts** - *Mukund Rao*. Lecture note prepared for the Training course on GIS for Resources Management and Development Planning held at Space Applications Centre , Ahmedabad during August 23, 1993 to September 11, 1993.
  - 14) **ISROGIS - An Overview** - *Mukund Rao*. Lecture note prepared for the Training course on GIS for Resources Management and Development Planning held at Space Applications Centre , Ahmedabad during August 23, 1993 to September 11, 1993.
  - 15) **GIS Applications for regional planning** - *Mukund Rao*. Lecture note prepared for the Training course on GIS for Resources Management and Development Planning held at Space Applications Centre , Ahmedabad during August 23, 1993 to September 11, 1993.
  - 16) **Object-oriented GIS: Concepts and framework** - *Mukund Rao* and AR Dasgupta. Lecture note prepared for the Training course on GIS for Resources Management and Development Planning held at Space Applications Centre , Ahmedabad during August 23, 1993 to September 11, 1993.
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- 2) **Remote Sensing Images and GI – Policy and Legal perspectives.** Mukund Rao & K R Sridhara Murthi. Paper Presented and published in the proceedings of IISL Regional Conference on “Bringing Space Benefits to the Asia-Pacific Region” held in Bangalore, India during June 26 – 29, 2005
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- 5) **EO & GIS standards for establishing a National Natural Resources Repository – The Indian Experience in NNRMS.** *Mukund Rao*, PS Roy, Rajeev Kumar Jaiswal & AR Dasgupta. Presented at 56<sup>th</sup> IAC, Fukuoka of November, 2005: Session B1.6: Data Processing and GIS Session
- 6) **Legal Issues relating to convergence of imaging, positioning and spatial databases.** *Mukund Rao* & K R Sridhara Murthi. Paper Presented at 56<sup>th</sup> IAC, Fukuoka of November, 2005: Session E6.3. Legal Issues Related to New Developments in Space Applications: Navigation, Remote Sensing and GIS

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- 2) **An architecture for Spatial Data Infrastructures.** *Mukund Rao & R Sivakumar.* Paper Presented at 57th IAC, Valencia, Spain of October, 2006: Session.
- 3) **Spatial technologies and Applications – A perspective for Industry cooperation.** *Mukund Rao.* Paper presented at 12<sup>th</sup> technology Summit and Technology platform organized by Confederation of Indian Industries (CII) in Delhi during November, 2006.
- 4) **Keeping up with remote sensing and GI advances—Policy and legal perspectives.** *Mukund Rao, K.R. Sridhara Murthi.* Space Policy 22 (2006) pp 262-273.

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- 1) **First NSDI – and then onto Enterprise GIS platform for India.** *Mukund Rao.* Invited Talk at Mapworld Forum held in Hyderabad during January, 2007.
- 2) **NSDI – Then, Now and (When)Ever.** *Mukund Rao.* Invited Paper presented at 6<sup>th</sup> NSDI Conference in Goa during June, 2007.
- 3) **Spatial Technology for Urban Planning and Management.** *Mukund Rao.* Paper presented at IT Governance Workshop of the Indian Urban Space 2007 Conference held in Mumbai in September, 2007.
- 4) **Keeping up with remote sensing and GI advances—Policy and legal perspectives.** *Mukund Rao, K.R. Sridhara Murthi.* (ADAPTED AND BASED ON THE CORE STUDY PUBLISHED IN SPACE POLICY AND FURTHER ENHANCED FOR IAC-2007). Paper presented at 58th International Astronautical Congress of October, 2007 in Hyderabad, India in Space Law session.

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- 1) **Every City must have a GIS.** *Mukund Rao.* Keynote Paper Presented at the Workshop on Comprehensive Development Planning for Cities in Rajasthan: Challenges and Opportunities, Jaipur held in June 2008.
- 2) **Spatial Technology for Governance – A perspective.** *Mukund Rao.* Invited Paper presented at GIS Day Meeting of Wipro Technologies held in Bangalore in October, 2008.

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