INDIAN CARTOGRAPHER

Volume 41, 2021

XLI INCA INTERNATIONAL CONFERENCE

27-29 OCTOBER, 2021

FOCAL THEME

CARTOGRAPHY FOR SELF-RELIANT INDIA

Organised by

Department of Geography
Panjab University, Chandigarh

Journal of Indian National Cartographic Association

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Editors

Prof. Gaurav Kalotra

Organising Secretary, 41st INCA International Conference

Dr. Vishwa Bandhu Singh Chandel
Joint Secretary, 41st INCA International Conference

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VICE-PRESIDENT OF INDIA

MESSAGE

I am happy that the Department of Geography, Panjab University, Chandigarh is hosting the 41st INCA International Conference of Indian National Cartographic Association on October 27-29, 2021 on the theme of "Cartography for Self-Reliant India".

The use of geospatial technology is fast transforming cartography. The International Conference will hopefully give an opportunity to the students and faculty members to interact, discuss and gain new insights into this discipline.

I extend my warm greetings for the success of the conference and hope that this conference will deepen our knowledge base and enlighten the way forward to use science for the welfare of humanity.

Naidu

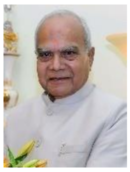
(M. Venkaiah Naidu)

New Delhi
20th October, 2021.

Banwarilal Purohit

Governor of Punjab
and
Administrator
Union Territory, Chandigarh

सत्यमेव जयते



Raj Bhavan
Chandigarh.

October 22, 2021

MESSAGE

I am delighted to know that Department of Geography, Panjab University Chandigarh is hosting the 41st INCA International Conference of Indian National Cartographic Association on Oct 27-29, 2021 on the focal theme Cartography for Self- Reliant India.

The theme of the conference is very vital for deliberations in the light of new challenges being posed by geospatial technology. The use of this technology supports in decision making. It is supporting in bringing transparencies in functioning of the government machineries. All government functionaries are using and promoting the use of satellite data so that actual situation is known for planning. The scientists engaged in this field are expected to innovate its meaningful application for the benefit and progress of the nation.

I am sure that deliberations in the conference will bring forth new ideas and provide practical solutions of various problems. I wish the conference a grand success.

[Banwarilal Purohit]

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नवीन तोमर
Naveen Tomar

भारत के महासर्वेक्षक
Surveyor General of India

भारतीय सर्वेक्षण विभाग
महासर्वेक्षक का कार्यालय
हाथीबड़कला एस्टेट, पोस्ट बॉक्स नं0 37
देहरादून–248001, (उत्तराखण्ड), भारत

SURVEY OF INDIA
Surveyor General's Office
Hathibarkala Estate, Post Box No. 37
Dehradun -248001, (Uttarakhand), India

MESSAGE

*I am extremely happy to learn that **Department of Geography, Panjab University Chandigarh** is hosting the **41st INCA International Conference of Indian National Cartographic Association from 27th–29th October, 2021** on the focal theme **Cartography for Self- Reliant India.***

Mapping is the foundation of all sorts of developmental activities of the country and Cartography is at the heart of mapping activities.Survey of India being a National Mapping Agency has been playing pivotal role in producing most useful maps for varied users. Survey of India maps are now being generated at large scale and are in great demand by every organization. The use of geospatial technologies have supported the map mapping in a big way and it is also enabling us to prepare digital and interactive maps for everyone.

*With promulgation of **"Guidelines for acquiring and producing Geospatial Data and Geospatial Data Services including maps"**, Cartography is going to penetrate among all as the map making field has been liberalized.*

INCA has been guiding the developments in the field of Cartography and provides a plateform in the form of International Congress to deliberate upon the latest development and networking of Ideas.

I extend my all support and convey my greetings to the delegates and organizers for the grand success of the conference.

Naveen Tomar

(NAVEEN TOMAR)

Tel : 00-91-135-2744268 / 2747051-58 Extn. 5001
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Professor Raj Kumar
Vice Chancellor

PANJAB UNIVERSITY
CHANDIGARH, *India* 160 014

MESSAGE

*It is a matter of satisfaction that the **Department of Geography, Panjab University Chandigarh** is hosting the **41st INCA International Conference of Indian National Cartographic Association on Oct 27-29, 2021** on the focal theme **Cartography for Self- Reliant India.***

The theme of the conference is relevant in the context of the emerging significance of geospatial technology in almost every sphere of life. Maps now portray almost real time reality using satellite imagery, GIS, GPS and most recently, drones. Mapping agencies and geospatial industries have revolutionized life. Maps have become a household utility.

I am sure the deliberation at the conference will be mutually beneficial to academia, industry and government in fulfilling and transforming the aspirations of our country. I extend my greetings and good wishes to the organizers and the participants!

RKumar
(Raj Kumar)

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KRISHNA MOHAN
Professor
&
President, INCA

Department of Geography
Panjab University
Chandigarh -160014

Oct21, 2021

MESSAGE

It is a matter of immense pleasure for me that Department of Geography Panjab University Chandigarh is hosting 41st INCA International Conference on Oct 27-29, 2021 on focal theme Cartography for Self-Reliant India. It is third time that Indian National Cartographic Association has given this responsibility to our department in recognition of its distinct performance in 1997 and 2011.Cartography has been a very important component in teaching and every research work of the department constitute a major portion on maps.

Every possible effort is done by the faculty to always remain proactive by including the most recent tools of mapping in curriculum. The course on Masters in Geoinformatics is the most recent endeavour. Our students across the world are shouldering responsibilities in different capacities in the field of map making and its use in almost every field.Cartography is now used and understood by a considerable proportion of people with varied scale. It is becoming utility for everyone.

I am confident that the deliberations by the distinguished delegates in the conference will be very productive. Their recommendations will be of great value in moving ahead towards our vision of Bharat Pratham(India First). I wish the delegates a very healthy discussion and the conference a great success.

Jai Hind!

Krishna Mohan

(Krishna Mohan)

FROM EDITOR'S DESK

We are delighted to bring out the 41st volume of INDIAN CARTOGRAPHER under the aegis of Indian National Cartographic Association (INCA) which has been a guiding force for bringing out and highlighting the key issues relevant to our nation and its progress. The role of cartography in shaping the modern world is universally acknowledged. It not only helps us to realize our place in the world but also play a vital role in establishing geographical associations in fast-changing society. This volume is a compilation of plethora of ideas and discussions held during the 41st INCA International Conference (27-29 October 2021) on 'CARTOGRAPHY FOR SELF-RELIANT INDIA' organised by Indian National Cartographic Association and hosted by the Department of Geography, Panjab University, Chandigarh.

The congress was inaugurated by *His Excellency* Shri Bandaru Dattatraya, *The Governor of Haryana*. Dr Shailesh Nayak, Director, National Institute of Advanced Study, Bengaluru; Former Secretary, MoES, India gave the inaugural address and Sh Naveen Tomar, Surveyor General of India, Government of India delivered the Key Note address. The presence of our esteemed dignitaries set the momentum for three days deliberations. This event held in blended (Offline and Online) mode received tremendous response from scholars from India and abroad. The event was attended by over 100 delegates in person; delegates in high number also joined online. This volume includes full text of Inaugural speech, key note address, speeches by eminent persons during the inaugural and valedictory sessions, memorial lectures, plenary lectures, and invited talks. In addition, as many as 89 participants presented their papers in different technical sessions. Their participation and contribution in making this event a success is deeply acknowledged. Undoubtedly, their ideas have made a mark in highlighting the significance of cartography in solving real world problem and making India self-reliant.

The task of reviewing and editing technical papers was indeed a herculean task. This job was impossible to complete without guidance and support from experienced people. We acknowledge the trust shown in us by INCA President Prof Krishna Mohan to undertake this challenging task. The process of review was challenging and some hard decisions were taken while accepting or rejecting the papers submitted by authors. We appreciate the hard work and timely submission of papers by research. This entire process was not possible without the support of our excellent team of faculty members and research scholars of the Department of Geography, Panjab University Chandigarh. Their academic and technical support was indispensable and any word of praise shall not suffice their help. We sincerely thank all those who lend a helping hand in the compilation of this volume.

We place on record our heartfelt thanks to member of INCA Executive and the Local Organising Committee for helping us in organising 41st INCA International Conference and supporting us in bringing out this volume of Indian Cartography.

Prof. Gaurav Kalotra
Organising Secretary, 41st INCA International Conference

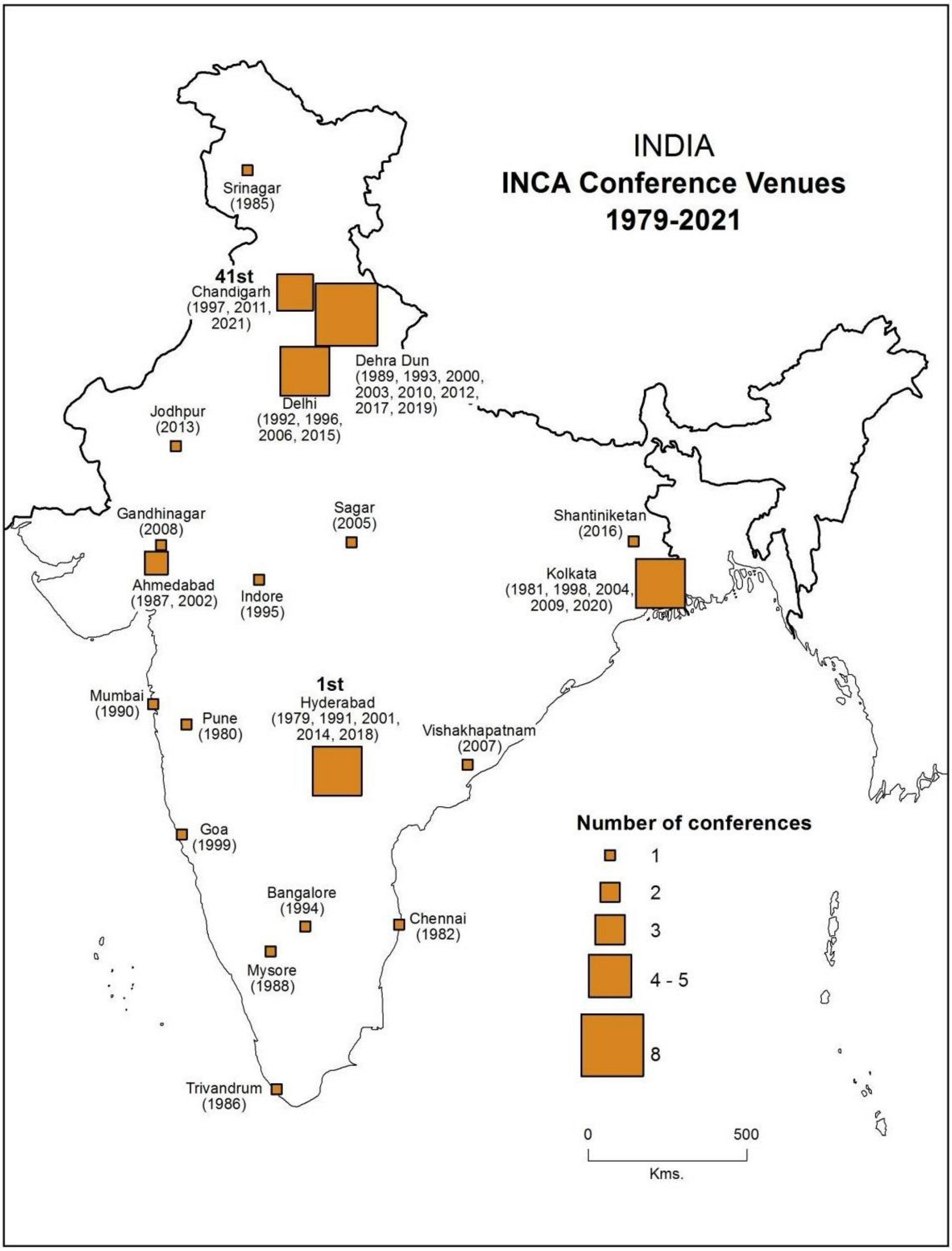
Dr. Vishwa Bandhu Singh Chandel
Joint Secretary, 41st INCA International Conference

INDIAN NATIONAL CARTOGRAPHIC ASSOCIATION

MAPPING THE SUCCESS STORY

THE JOURNEY OF INCA

1978-2021



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1	Maj. Gen. K.L. Khosla	1979	Hyderabad
2	Maj. Gen. K.L. Khosla	1980	Pune
3	Prof. S. Manzoor Alam	1981	Calcutta
	Prof. S.P. Dasgupta	1982	Madras
5	Brig. M.M. Datta	1985	Srinagar
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10	Prof. B. Arunachalam	1990	Bombay
11	Prof. B.L. Deekshatulu	1991	Hyderabad
12	Prof. Majid Husain	1992	New Delhi
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17	Prof. Gopal Krishan	1997	Chandigarh
18	Dr. P. Nag	1998	Calcutta
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20	Lt. Gen. A.K. Ahuja	2000	Dehra Dun

21	Prof. Afzal Mohammad	2001	Hyderabad
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26	Maj. Gen. Gopal Rao	2006	New Delhi
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28	Dr P. K. Srivastava	2008	Gandhinagar
29	Shri. A.K. Malik	2009	Salt Lake Kolkata
30	Maj. Gen.Manoj Tayal	2010	Dehradun
31	Prof. Surya Kant	2011	Chandigarh
32	Rear Admiral S.K.Jha	2012	Dehradun
33	Dr. V.K.Dadhwal	2013	Jodhpur
34		2014	Hyderabad
35	Prof. (Dr.) Anuradha Banerjee	2015	New Delhi
36	Prof.(Dr.) V.C.Jha	2016	Shantiniketan
37	Vice Admiral V.Badhwar	2017	Dehradun
38	V Raghu Venkataraman Director ADRIN	2018	Hyderabad
39	Lt Gen. Girish Kumar	2019	Dehradun
40	Dr Tapati Banerjee	2020	Kolkata
41	Prof. Krishna Mohan	2021	Chandigarh

INCA CONFERENCE THEMES

1978-2021

Sr. No.	Themes	Years	Place
1	New Trends in Cartography	1979	Hyderabad
2	Maps as Tools of Analysis & Communication	1980	Pune
3	Thematic Mapping and Surveying : Problems, Trends & Techniques	1981	Calcutta
	Map Makers & Users	1982	Madras
5	Cartography in National Planning	1985	Srinagar
6	Cartography in Environmental Planning	1986	Trivandrum
7	Satellite Images in Cartographic Applications.	1987	Ahmedabad
8	Cartography and Planning	1988	Mysore
9	Digital Cartography and Potential Users	1989	Dehra Dun
10	Advances in Cartography	1990	Bombay
11	Cartography and Geo-Information System for Planning	1991	Hyderabad
12	Mapping of Environment and Sustainable Development	1992	New Delhi
13	Cartography-The Technological Transition	1993	Dehra Dun
14	Mapping from Space- Cartographic Challenges	1994	Bangalore
15	Cartography- Emerging Technologies and Alliances	1995	Indore
16	Carto-Vision 2001- Earth Resources Management	1996	New Delhi
17	Cartography and Administration	1997	Chandigarh
18	Cartography in Action	1998	Calcutta
19	Modern Cartography for Ocean and Land Management	1999	Goa
20	Cartographic Challenges at the Dawn of New Millenium	2000	Dehra Dun
21	Cartography & E-Governance	2001	Hyderabad
22	Convergence of Imagery, Information and Maps	2002	Ahmedabad

23	Cartography for Sustainable Development from village level upwards	2003	Dehradun
24	Cartographic Technologies for Water, Land & Infrastructure Development	2004	Kolkata
25	Bridging the Digital divide, and taking Cartography to Grassroots level	2005	Sagar
26	Cartography Expanding Horizons	2006	New Delhi
27	Cartography for Costal Management	2007	Visakhapatnam
28	Collaborative Mapping and Space Technology	2008	Gandhinagar
29	Technological Solutions in Urban & Regional Mapping	2009	Salt Lake Kolkata
30	Cartography for Sustainable Environment	2010	Dehradun
31	Cartography for Disaster Management	2011	Chandigarh
32	Cartography for Sustainable Earth Resource Management	2012	Dehradun
33	Integrated Decentralize Planning: Geospatial thinking,ICT and Good Governance	2013	Jodhpur
34		2014	Hyderabad
35	Spatial Governance for Development,Planning Smart Cities and Disaster Management	2015	New Delhi
36	Cartography for Analysis and Management of Climate Change	2016	Shantiniketan
37	Geoinformatics for Carto-diversity and its Management	2017	Dehradun
38	Emerging Technologies in Cartography	2018	Hyderabad
39	New Age Cartography and Geospatial Ttechnology in Digital India	2019	Dehradun
40	Digital Mapping Innovations in Make India Initiatives	2020	Kolkata
41	Cartography For Self-Reliant India	2021	Chandigarh

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Plenary Session	Vice Admiral, Adhir Arora, Chief Hydrographer, GOI	Prof. Smita Bhutani, PU, Chandigarh

THEMES AND SUBTHEMES
2021

Cartography for Self-Reliant India

Cartography for Self-reliant India as a focal theme of the conference derives direction and impetus from the government's vision of Atamnirbhar Bharat. The Government of India in recent past has taken many initiatives in promoting Geo-spatial technology. Bold government policies such as map policy, the remote sensing data policy, drone policy and unlocking space are the most encouraging decisions taken in the recent past. Based on the indigenous potentials, the vision aimed to build five pillars- incremental gains, modern infrastructure, a technology-driven system, vibrant demography, and a strong demand and supply chain of the country's economy. In every economic endeavour, including agriculture, finance, construction, mining, and local enterprise, India's farmers, small businesses, and corporations stand to gain tremendously from the application of innovative technologies based on modern geospatial data technologies and mapping services, according to the Indian Department of Science and Technology. As a result, this conference is designed to adopt a persuasive scholarly approach to the country's self-sufficiency goal. Given the importance of cartography in the geospatial world, the 41st INCA International Conference will be an excellent opportunity to provide decisive results.

Subthemes

- History of Cartography
- Theoretical Cartography
- Marine Cartography
- Mountain Cartography
- Popular Cartography
- Cartography and Public Health
- Cartography and Sustainable Development
- Cartography and Children
- Cartography for Early Warning and
- Crisis Management
- Toponymy in Cartography
- Education and Continuous
- Learning in Cartography
- Cartography, Privacy, and Ethics
- Unlocked Space: Cartographic
- Challenges Ahead
- Emerging Trends in Mapping
- Artificial Intelligence in Mapping
- Location-Based Services and
- Ubiquitous Mapping
- Sensor-Driven Mapping
- Participatory Mapping
- Military Mapping
- Mapping Urban Environments
- Mapping Post-COVID World
- Maps in the service of Humanity
- Maps and Accessibility
- User-Friendly Maps: Emerging Trends
- Digital Photogrammetry
- Open Geospatial Data and
- Technologies
- Spatial Data Infrastructure and Standards
- GNSS Applications
- Digital Image Processing
- Open Source Software
- Development

XLI INCA INTERNATIONAL CONGRESS: 2021
LAYING THE REPORT

Indian National Cartographic Association (INCA), a professional body of Cartographers in India with headquarters at Hyderabad, held its XLI Annual Conference at the Department of Geography, Panjab University, Chandigarh from 27-29 October 2021. **Cartography for Self Reliant India**was the theme of the International Conference organized to mark the occasion. The main theme was further divided into 37 sub-themes namely History of Cartography, Theoretical Cartography,Marine Cartography, Mountain Cartography, Popular Cartography, Cartography andPublic Health, Cartography and Sustainable, DevelopmentCartography and Children, Cartography for Early Warning and, Crisis Management, Toponymy in Cartography, Education and Continuous, Learning in Cartography, Cartography, Privacy, and Ethics, Unlocked Space: Cartographic, Challenges Ahead, Emerging Trends in Mapping, Artificial Intelligence in Mapping, Location-Based Services and, Ubiquitous Mapping, Sensor-Driven Mapping, Participatory Mapping, Military Mapping, Mapping Urban Environments, Mapping Post-COVID World, Maps in the service of Humanity, Maps and Accessibility, User-Friendly Maps: Emerging, Trends, Digital Photogrammetry, Open Geospatial Data andTechnologies, Spatial Data Infrastructure andStandards, GNSS Applications, Digital Image Processing and Open Source SoftwareDevelopment.

The day one of conference (27 October) commenced with the inaugural function started at 11:00 am with lightning of lamp by the dignitaries and *sawaswati vandana* was recited. Dr. Navneet Kaur, member, organizing committee 41st INCA conference, welcomed the dignitaries followed by the floral welcome. His Excellency, Shri Bandaru Dattatraya, Governor of Haryana, was the chief guest of the event. The chief guest was joined by Shri Naveen Tomar, Surveyor General of India, Vice Admiral Adhir Arora, Chief Hydrographer, Government of India and Prof. Raj Kumar, Vice Chancellor, Panjab University, Chandigarh. Dr. Sailesh Nayak, Director National Institute of Advanced Study, Bengluru and Former Director MoES had joined virtually. The inaugural address was delivered by Dr. Sailesh Nayak where he focused on the challenges for the Atmanirbhar Bharat that is to make balance between resources based developmental goals and the protection of the environment. For this, a proper mapping of natural resources, environment and hazards is required which can be fulfilled by GIS and other communication technologies. He concluded his remarks with the need of policy aiming at wider use of geospatial information and laying down broad guidelines for creating, sharing, accessing, and discriminating geospatial data for economic, environmental and societal use. After the inaugural address, the keynote address was delivered by Shri Naveen Tomar, Surveyor General of India. In his speech, he said that the the focus should be on the requirement of data collection on a large scale to make India a self-reliant nation. He also stated that our role in ecosystem is that of a facilitator by transfer of technical knowhow and provide the core infrastructure needed for a robust growth of private industries. We are existed to work in this ecosystem that we need fresh breaths in the organizations to meet this challenge. The policies in case the vision is clear more or less regarding where we want to go and thus the need of the hour to look at the execution model. According to him, the private sector has to invest in the geospatial sector and this will only happen when they have enough confidence for return in investment. The keynote address was followed by the speech of Shri Bandaru Dattatraya, Governor of Haryana who said that geospatial field has tremendous potential for generating employment in the country. He also mentioned that in managing the pandemic Covid maps proved beneficial. The governor further said the application of Geographic Information Sciences (GIS) has become a crucial part of how NASA gents to know the feature of other worlds, develops broader understanding of geophysics and gathers valuable information about our own planet. After this, the audience was addressed by Prof. Raj Kumar, vice-chancellor, PU. He emphasized on the need to come up with an action plant to make cartography multi-disciplinary so that its knowledge can be shared with other domains. The guest of honour remark was given by Vice Admiral Adhir Arora, Chief Hydrographer, Government of India. He illustrated the complexity of ocean surveying and mapping. He explained that search of Malaysian Airline flight 370 become the most expensive in the aviation history with numerous ships and assets deployed and still not located. Having portrayed the complexities and challenges in water mapping, the question will arise why do we need to map the ocean. The shape of this seabed is the fundamental data set for confronting the growing challenge associated with climate change. In addition, ocean bathometry is important in the study of tides, sediment transportation, underwater geohazards, cable routing, fishing, resource exploration and exploitation. Vice Admiral further said that, the government has recently liberalized the mapping and data acquisition policy and in the process of publishing the geospatial policy. These policy decisions are expected to boost the mapping sector and encourage Aatmnirbhar Bharat. The NHO, Dehradun is continued to support this policy and engage with all the stakeholders who are contributing to build the nations blue economy. Cartography in general and marine cartography in particular is increasingly becoming professional and as a result and indispensable contributor to meet the multifaced demand of modern society. Coming through the new ideas, we have marine spatial planning which is been initiated by NITI Ayog and the NHO is the major contributor in the blue economic corporation committee. The address from dignitaries was followed by the felicitation ceremony. Then the chief guest released the Abstract volume and Souvenir brought out by the organizers on this occasion. On the occasion, the chief guest also released several other publications and the maps prepared by NATMO (National Atlas and Thematic Mapping Organization).

INCA National Map Quiz Contest

For several years, the INCA has been organizing national level map quiz, INCA National Map Quiz Contest, to generate interest of young mind in reading and making maps. Student at the school level participate in this event. The awards are given every year by the chief Guest to the winners in the inaugural ceremony of INCA Congress. This year, the first prize was received by Master Kartikeya Sharma from Himachal Pradesh followed by Ms. Monalisa Das from Gujrat and Cdt. Akash Layek from Dehradun receiving the second and third prize respectively.

The inaugural session ended with a vote of thanks given by Professor Guarav KalotraChairperson, Department of Geography, Panjab University, Chandigarh. While proposing the vote of thanks to dignitaries, guests, and delegates, he expressed special thanks for organizations and individuals those providing sponsorships and financial support by the way of advertisement in the souvenir and putting stalls in the exhibition.

The post inaugural session included Todar Mal Memorial Lecture by the speaker Dr. Prithvis Nag, former Surveyor General of India, former Director, NATMO and former Vice Chancellor of Kashi Vidyapeeth. The session was chaired by Prof. Surya Kant, former president of INCA. The session was followed by lunch. After the lunch break, two memorial lectures namely Prof. S.P. Chatterjee Memorial Lecture and Prof. Shah Manjoor Alam Memorial Lecture were delivered by Prof. K.R. Dixit and Prof. Kalpana Markandey respectively. The former session was chaired by Dr. Tapti Banerjee, Director, NATMO and later by Professor V.C. Jha, former Vice Chancellor, Bhagalpur University and former Director NATMO. The introductory session was concluded with GIS industry presentation by Sh. Vishal Anand, Senior Vice President ESRI, India.

After a short tea break, the plenary session under the chair of Vice Admiral Adhir Arora, Chief Hydrographer, GoI and Prof. Smita Bhutani, Panjab University, Chandigarh started. The session included the lectures of Prof. Tim Trainor, PresidentInternational Cartographic Association on *Cartography and Cartographers – making our world a better place*, Dr. V. Raghavaswamy, Formal Deputy Director, NRSC, ISRO on *Emerging Trends in Mapping and Open Geospatial Data Technologies*, Dr. Ashwaghosha Ganju, Former Director, SASE, DRDO, India on *Cartography for Early Warning and Crisis Management*, and Dr. Shahnawaz, Director, South and SE Asia, UNIGIS International, University of Salzburg, Austria on *Remote Sensing Based Mapping and Monitoring of Atmospheric Pollution in India.*The session concluded with the honour ceremony. On the behalf of organizing committee, the vote of thanks was given by Prof. Krishna Mohan, President INCA and he invited all the members and participants for the cultural evening and dinner at Chokhi Dhani (Panchkula).

The second day of the 41st INCA International Conference mainly included the three parallel technical sessions in both online and offline mode. The offline (including online streaming) was conducted in the Golden Jublee Hall and other online sessions were hosted in different classrooms of the concerned department. The sessions were also live streamed on YouTube. The technical session A-1 began with plenary lecture by Prof. Garry Fehr, University of Fraser Valley, Canada. He gave his lecture on the evolution of participatory mapping. This session was chaired and Co-chaired by Prof. M.S.

Jaglan, Kurukshetra University (online) and Prof. Dhian Kaur, Panjab University, Chandigarh (offline) respectively. In this session six research papers were presented including invited/ lead lecture by Prof. Bimal Kumar Kar on the topic “Impact of Urban Growth and Green Space Dynamics on Micro Climate: A Case Study of Siliguri City West Bengal”.

The technical session B-1 (online), hosted from the Department of Geography, started with plenary lecture by Dr. M.R. Bhutiyani, Former Director, Defence Terrain Research Laboratory (DTRL), Delhi, India on topic “Application of Advanced Geo-spatial Technology; A Defence Perspective”. This session was chaired and co-chaired by Prof. Ravindra G. Jaybhaye, Savitribai Phule Pune Universityand Dr. Navneet Kaur, Panjab University Chandigarh respectively. In this session, four research papers were presented including invited/lecture by Prof. R. Jaganthan on topic “Trends Ubiquitous Cartography”.

The technical session C-1 (online) Chaired by Prof. M.S. Rana, MDU Rohtakand Co-Chaired by Dr. Vishwa B.S. Chandel, Panjab University, Chandigarh which included four research paper presentations with invited/lead lecture by prof. Sahab Fazal on topic “The Realities of Urban Land use Planning in India: A Case Study”.

The technical sessions were followed by Panel Discussion on theme “Use, Misuse and Abuse of Geo-spatial Technology: Defence Perspective”. The main speakers of the even were Maj. General Raj Mehta, Maj General Samsher Jamwal and Maj. General RC Padhi with Lt. General KJ Singh as the moderator. A drone mapping demonstration was conducted alongside the panel discussion in the university ground conducted by Survey of India (SoI), which was followed by lunch break.

The post lunch break was followed by parallel technical sessions. The technical session A-2 (offline) was chaired byDr. Shahnawaz and Prof. Ravinder Kaur, Panjab University, Chandigarhin which eight research papers were presented. The technical session B-2 (online) was chaired and co-chaired by Prof. Dev Dutt Sharma, HPU Shimla and Prof. K.K. Brar, Panjab University, Chandigarh. This session included seven research paper presentations in total. The technical session C-2 (online) Chaired by Prof. S.P. Kaushik, MDU, Rohtak and Co-chaired by Dr. Vishwa B. S. Chandel, Panjab University, Chandigarh included seven research paper presentations.

After the tea break, the technical session A-3 (offline) chaired by Prof. Gaurav Kalotra, Panjab University, Cahndigarh and Co-chaired by Dr. Shahnawaz which included six research paper presentations with invited/lead lecture by Prof. Atiqur Rahman on Mapping Post Covid World.The technical session B-3 (online) Chaired by Prof. Ravindra G Jaybhaye, SPPU Pune and Co-chaired by Dr Navneet Kaur, Panjab University, Chandigarh included six research paper presentations with invited/lead lecture by Dr. Surinder Paul on Cartography and Sustainable Development. The technical session C-3 (online) was Chaired by Prof. P.S. Tiwari, Chennai and Co-Chaired by Prof. Ravinder Kaur, Panjab University, Chandigarh. The session included six research paper presentations with invited/lead lecture by Prof. Nand Kumar Sawant on “Coastal Tourism, Development and Sustainability: Cartographic”.

The technical sessions were followed by AGM (Annual General Body Meeting) where Prof. Krishna Mohan, President INCA delivered the presidential address followed by agenda discussion and minutes of 40th INCA AGM. The event progressed with the presentation of the report by the Secretary General, INCA, election of coming office bearers, address by outgoing president and incoming president of INCA. Vice Admiral Adhir Arora, Chief Hydrographer, Government of India was elected as the new president of INCA. The meeting ended with the felicitation of the outgoing and incoming presidents of INCA. The vote of thanks was given by Rajesh Kumar Khatri, Secretary, INCA.

The 3rd day of 41st INCA International Conference began with parallel technical sessions. The technical session A-4 (offline) was Chaired by Dr. Pramod Kumar, Scientist, Advanced Data Processing Research Institute (ADRIN) ISRO and Professor Krishna Mohan, President, INCA. The session included nine research paper presentations. The technical session B-4 (online) was chaired by Rajiv Patnaik, Panjab University, Chandigarh and Co-Chaired by Dr. Sucha Singh, Panjab University, Chandigarh including seven research paper presentations, while the technical session C-4 (online) was Chaired by Prof. Lokesh Srivastava, Director, HRDC, Jabalpur, MP and Co-Chaired by Prof. Gaurav Kalotra, Panjab University, Chandigarh. This session included six research paper presentations in total. The technical sessions were followed by poster presentations after a short tea break. A total of nine posters were put on presentation encompassing diverse topics such as snow avalanche vulnerability mapping for Siachen, water logging mapping in central Haryana, and mapping child friendly public places in Chandigarh etc.

After the technical sessions commenced before-noon, the valedictory function started at 12:30 pm. Dr. Navneet Kaur, Panjab University, welcomed the dignitaries of the valedictory function. The dice was shared by Prof V.R. Sinha, Dean of University Instruction, Panjab University, Dr. Bijendra Pateriya, Director, Punjab Remote Sensing Centre (PRSC), Government of Punjab, Dr. Pramod K Satyawali, Director, Defence Geoinformatics Research Establishment (DGRE) GoI, Prof. Krishna Mohan, President, INCA and Dr. Pramod Kumar, Secretary, INCA. The dignitaries were felicitated with flowers by Professor Gaurav Kalotra, Chairperson, Department of Geography, Panjab University, Dr. Vishwa B.S. Chandel, Department of Geography, PU Chandigarh, Dr. Sucha Singh, PU Chandigarh, and Professor Krishna Mohan, President INCA. Thereafter, a report of the conference was presented by Prof. Gaurav Kalotra, Organizing Secretary, INCA 2021. He gave brief details of different activities including the geographical representation in the conference, highlights of inaugural function, themes covered and the number of papers presented (121) in the different technical sessions and the guest/special lectures delivered. He observed that there has been wide geographical representation from different parts of India (participants from almost 30 cities) and good representation from the outside of the country especially USA, Canada, France and Austria making it an International Conference in real sense of the word, and a very wide representation of the students, research scholars and young scientists and good quality presentations made by them. He said that the conference was held in both offline and virtual mode and an exhibition was held in the conference displayed by Survey of India, NATMO, NSDI and ESRI India. He announced the award ceremony of giving best paper presentation award and one best poster presentation award. The organising secretary concluded his report with a vote of thanks to the whole public involved in the conference.

The valedictory address was given by Dr. Brijendra Pateriya, Director, Punjab Remote Sensing Centre (PRSC) Govt. of Punjab on the topic of *Panchayat to Parliament – A G-Governance Model for Self Reliance Using Geospatial*. His focus was on evolving geospatial technology and utility of E-Governance that can help in formulating the Panchyat level action plan based on different indices and models especially in Punjab. The guest of honour address was given by Dr. Promod K Satyawali, Director, Defence Geoinformatics Research Establishment (DGRE), GoI. His focus was on the channelization of the human resource and the role of geoiformatics for the betterment of human life along with preservation of nature and minimizing the risk of natural hazards with the help of geospatial technologies. The government has taken many initiatives with the impetus of 'Atmanirbhar Bharat' in promoting geospatial technologies by making policies such as map policies, remote sensing data policy, drone policy, unlocking space are some initiatives taken in recent past. He has found that the 41st INCA conference towards the vision of promoting Geoinformatics/geospatial technology would certainly help to realise it. He congratulated the organisers of INCA for making it a grand success. Prof. VR Sinha, Dean of University Instruction (DUI) Panjab University, Chandigarh.

The Chief Guest address was delivered byProf. VR Sinha, Dean of University Instruction (DUI) Panjab University, Chandigarh. He first congratulated the president of INCA and the organising committee for organising such a wonderful program in a very challenging time. His focus was on pollution especially the river pollution. He emphasised the use of geo-technology for the betterment of human life related to resource management and maintenance and disposal of waste material. The technology can be useful even for the remote areas where otherwise could not be reached. Parking and traffic control can be done with the help of this technology. The technology can also help in reaching to those people who are or have suffered from the natural hazards such as landslide and avalanche. He congratulate all participants and experts deliberating the conference, showing their knowledge and experience to the younger generation especially the students. In his conclusion, he congratulated INCA and Department of Geography for organizing a wonderful and meaningful seminar. After this, all the dignitaries were honoured by Professor Krishna Mohan, President INCA. Dr. Pramod Kumar, scientist, ISRO invited Professor Krishna Mohan, president, INCA to honour Professor Gaurav Kalotra, Organizing Secretory 41st INCA conference, Dr. Vishwa B.S. Chandel, Joint Organizing Secretory 41st INCA conference, Dr. Sucha Singh, Treasurer, Dr. Navneet Kaur, member of organising committee and Professor Dhian Kaur, member of organising committee.

Best Paper and Poster Presentation Awards

After the felicitation of the members of INCA organising committee, Dr. Pramod Kumar announced the best paper and poster presentation awards. Out of 86 papers presented in the conference, three best paper presentation awards were given to Dr. Mahesh Thakur, Centre of Advanced Study in Geology, Panjab University, Chandigarh, Mr. Vivek, Department of Geography, Panjab University Chandigarh and Ms. Deepika, Panjab University, Chandigarh. The best poster presentation award was received by Mr. Ankit Sagar, France and Ms. Shiwani Pathak, ESRI R&D Centre, New Delhi.

After the award ceremony, Professor V.R. Sinha, DUI, Panjab University, Chandigarh honoured the students who voluntarily worked day and night and helped in making the conference successful. The tokens were received by Mr. Ajay Kumar, Mr. Abhishek Goyat, Mr. Abhishek Malik, Ms. Preeti, Mr. Vivek, Mr. Rahul, Mr. Rohit, Ms. Kavita, Mr. Mohammad Irfan, Mr. Shubham, Mr. Ankush, Mr. Jagdeep, Ms. Prawal, Mr. Rohit, Ms. Harmanjot, Ms. Aman, Mr. Bhaskar, Mr. Rahul Ratnam and Mr. Suresh Chand.

After the honouring ceremony, Dr. Navneet Kaur called upon the dice Dr. Vishwa B. S. Chandel, Joint Organising Secretary for the vote of thanks. He expressed gratitude to all the participants and dignitaries to make the 41st INCA conference a success. He also showed appreciation to the executive council and the members of INCA for their support and participation. He acknowledged the contribution of all session chairs, co-chairs and invited speakers. He also thanked Professor Krishna Mohan, President INCA and Professor Gaurav Kalotra, Chairperson, Department of Geography & Organising Secretary of 41st INCA conference for organising the event. He also expressed thanks to Dr. Navneet Kaur for handling the sessions of the conference proficiently. He also made gratitude to the Panjab University teaching and non-teaching fraternity for their unconditional support. He also thanked the volunteers of INCA conference including the scholars and students who worked tirelessly for the smooth functioning of the conference. He concluded his vote of thanks by thanking all the members who participated in the conference with a hope to meet again.

INAUGURAL SESSION

PRESIDENTIAL ADDRESS

Professor Krishna Mohan
President, INCA
Department of Geography
Panjab University, Chandigarh

Esteemed EC Members, Life Members of INCA participating in the 41st International Conference, Delegates, invited guests, Faculty Colleagues, Research Scholars, Students, Ladies and Gentlemen.

First of all, I express my gratitude to INCA and its life members for giving me the responsibility of its president. I accepted it with all humbleness and humility. I took over as President in February 2021and I believe, it was the shortest tenure of the president in the history of INCA.The task of convening the Conference in 2021 was taken in a mission mode, in spite of all challenges faced due to covid-19 situations but with the support of our considerate EC members, the ongoing conference could see its light.

Honorable Members and life members, as far as cartography is concerned, I put before you three challenges. These are challenges as map producers. There are challenges before us as map users and there are challenges before us to prepare maps for everyone. To begin with, I would like to share some of the emerging situations across the world. One of them, to my understanding, is that the phase of information sharing in classes and to students is over. Google library does it. Students believe this library more than us. Second, the transition of chalk board teacher to digital, laptop, virtual more dynamic locations based teachers has become a reality. Number three, in place of University teacher, world is aiming towards universal teacher.

What are the challenges as far as we are concerned as a teacher when we teach cartography in geography in most of the universities. Our syllabi in the curriculum are outdated and, therefore, there is a need to make it more relevant, to make it more meaningful and to make it latest. The second challenge before the teachers, across the nation relates to inadequate training and, therefore, what we find that we are unable to adequately address the requirements of the emerging cartographic needs of industry, geospatial technology and, therefore, my appeal will be for all the policy makers and decision makers that in order to make cartography more meaningful, training of teachers in the field of geospatial technology must be supported in all possible ways.

Honorable members, 40 years back when we were learning Geography we found the use of cartography very limited. Today what we find cartography and use of maps have become a utility for everybody. Be it an auto driver, be it managers of Swiggy, Zomato or be it location based service provider. What we find now, that map users have grown manifold across the nation and, therefore, I personally believe that cartography is no more confined to the domain of cartographers. Cartography has reached a stage where it has become one of the most popular technologies which had its place and space in almost every discipline. This pervading importance of cartography cannot be denied and in the years to come this is going to further increase because its application is going to multiply in every field.

The challenge relates to production of maps. While a large number of maps are produced as cartographer, there is a need that cartography principles are strictly adhered. I found in large number of journals where maps are produced and even when the students are presenting their research papers, they do not follow cartographic principles. It happens because a large number of map producers are acting like a painter. Cartography is not a painting, cartography is a science of map making and, therefore, my appeal will be that we have to adhere to the cartographic principles. When I say so, what I mean. I mean the symbols, the colours, the scales, the reference grids need to be compatible with internationally accepted conventions. I visited some Remote Sensing Centres, I visited some space application centres and I found the colour schemes followed were incorrect. In place of using white color for snow they were using red colours and in place of using green colour for vegetation they were using any other colour. This kind of non-conventional use of symbols has become more a problem. It indicates that we do not have cartographic understanding.

Thirdly friends, the maps which we had in 60's 70's 80's and90s, they wereassemblage of information collected over a long period of time and, therefore, some information was 70 years old, some information was 40 years old, some information was 30 years old and so on and today we cannot survive with those maps as information is very old. Maps need to be of near real time. That is a very important requirement for any country. We cannot think of using a map of 1970 to plan for a village today. We require a map of village which has information of 10 days back or if possible the latest. Needs are changing very quickly because the world is dynamic. Last point which we have to consider as cartographer relates to our concerned map users. Whenever we are making maps for a particular section of population we must make maps friendly. I would like to appreciate the contribution of our NATMO when they first prepared an Atlas for the blind people and it was a big contribution that blind persons can read the maps. Maps became very friendly. Similarly we have to look forward for maps where children can understand them very easily, where illiterate population can understand maps very easily, where people having technical knowledge can understand map very easily. We conducted Geography Literacy Test on doctors of PGI sometime back and we found that their understanding of maps inadequate. They were even unable to locate their own place of work or locate own place of residence which was really very painful. So what we require is not only to make maps for engineers but we are to prepare maps which are for different sections of populations and maps should be user friendly.

Friends, we must focus on skilling and up skilling of the young people. We must evolve the courses in which job opportunities are there. Unfortunately the cartographers are not given proper recognitions. They are treated as draftsmen. When we are teaching our students in the class, they are more theoretical in nature. There is always a need to provide opportunity for internship; internship in private sector, internship in government sector so that they are prepared for nation, so that they are prepared to accept the responsibility. I have told in the beginning that cartography is no more a domain of subject. So what we expect is interdisciplinary cooperation. That is very important and that is the need of the time and lastly friends, whatever is produced at a particular level, must reach the people well in time. Sometime back, I was delivering a talk to the university teachers and when I asked them, were they aware of Map Policy 2005, a large number of teachers teaching geography across this nation were not aware of Map Policy 2005. I asked them whether they were aware of RSDP2001, they said they were not aware. I asked them whether they were aware of Drone Policy, they said no and this kind of situation is not good. Why it happens? Whatever we as teachers, policy makers, decision makers do at top must reach the last person. That is more meaningful and most important. Finally friends, we always claim that we have potential and our students have potentials. Where is the problem? The potentials need to be translated into reality. The entire exercise of teaching & learning will become meaningful. We cannot make our country as Atam Nirbhar Bharat without considering all these points very sincerely, very honestly and with all sensitivity and responsibility.

Thank you, Jai Hind!

INAUGURAL ADDRESS

Shri Bandaru Dattatraya
His Excellency
The Governor of Haryana

Good morning to all

I am graceful to acknowledge esteemed guests on the dais Shri Naveen Tomar Ji, Surveyor General of India, Prof. Raj Kumar Ji, Vice Chancellor Panjab University, Chandigarh, Vice Admiral Adhir Arora, Chief Hydrographer, Survey of India, Prof. Krishna Mohan ji, President, Indian National Cartographic Association and Dr. Shailesh Nayak ji, Director, NIAS Bengaluru who has joined us virtually. I would like to extend my warm greetings and good wishes for organizing 41st INCA conference on the topic "Cartography for Self-Reliant India". I am glad to see that the efforts are being made from all stakeholders to realize the dream of Atmanirbhar Bharat. Cartography is in the stage of transition like any other disciplines. Cartography deals with geographic phenomena in real and virtual.

The application of GI Sciences continues to grow as a global research stream for understanding the layer around us. Cartography, a process of making maps has greatly benefitted from the advancement in GIS technology in recent years. GIS space exploration has become crucial part now NASA gets to know the features of other worlds in addition to gathering valuable information of our own planet. Geospatial sector in the country has enormous potential in creating employment. Development of industries and dissemination of knowledge is continuously following social and economic progress.

I am happy to share that India will have a coherent national locational data framework by 2030, which will assist the country towards e-economics, e-service and e-commerce and improving services to citizens. The organizations like Survey of India since 1767 have been doing wonderful work in production and circulation of maps. The unlocking of space this year for private owners is a welcome step, but new challenges need to be addressed. It is a matter of pride that Survey of India is doing a leadership role in providing user focussed cost effective reliable and quality geospatial data information and intelligence for increasing the needs of national security. Data centres also play crucial role. Revisions in map policy and relieving restrictions have opened many opportunities before many students. In the management of covid crisis, the world realizes the significance of maps in tracking and treating infected persons. The drone mapping use regular geospatial data almost in real time. Land records are digitized and its licences are going to be only click away for each of us. Hence cartography is a new utility in out life. Modern cartography allows GIS professionals to understand everything from climate change where company should open businesses. Latest cartographic tools are also contributing to give accessibility in urban planning, public education, public safety programmes and more. It helps prevent and caution the disasters.

The number of students earning the degrees in cartography is expected to rise to keep pace with the demands of technology and customers needs. GIS professionals also have the opportunity to go into the commercial or defence markets to put all these skill tools. Swamitva a national scheme of the centre is a reforming step towards establishing clear ownership of properties in rural inhabited areas and mapping of land parcels using drone technology. It will help us for a comprehensive village level planning which will be the stepping stone to achieving gram swaraj in true sense and making rural India Aatmnirbhar. The region of the country comprising Haryana, Himachal Pradesh and Punjab has a huge natural reserve forest, protected forest and unclassified forest. Even Chandigarh has a good green cover area. Proper mapping of green cover will be helpful in protecting our environment and reducing the problem of ecological imbalance. Haryana has introduced a GIS mapping programme at a large scale in the entire state. 44212 square kilometres area is being mapped through GIS.

I am sure that the deliberations in this international conference will go a long way in ensuring weather application and understanding of cartography for the welfare of humanity. I wish the conference all the best

Thank You,

Jai Hind.

INAUGURAL ADDRESS

Dr. Shailesh Nayak
Director, National Institute of Advanced Study, Bengaluru
Former Secretary, MoES, India

Honourable Governor of Haryana Shri Bandaru Dattatreya ji, Prof. Raj Kumar, Vice Chancellor of Panjab University, Dr. Krishna Mohan, President, Indian National Cartographic Association, Sh. Naveen Tomar, Surveyor General of India, Admiral Adil Arora, Chief Hydrographer of National Hydrographic Office, Delhi, Dear Delegates, Ladies and Gentlemen, Very Good Morning to all of you. Its really my honour and privilege to greet you on the inauguration of 41st International Conference on Cartography for Self-Reliant India. One of the greatest challenges for the Atmanirbhar Bharat is to balance between resource based developmental goals and the protection of the environment. The challenges related to poverty and inequality, ensuring food and nutrition and water scarcity, providing affordable healthcare and education, transforming from fossil fuel-based energy generation to green energy. Developing sustainable cities etc. are to be addressed to attain sustainable development. These developmental goals are to be synchronized with the conservation of the earth's environment. The transformation of India will depend on our understanding of the needs and aspirations of the society, participation of the citizens, academia, industry, accountability of governance system and delivery of effective services. Maps are in the transformation process. A map represents relationship between different physical objects or processes or phenomenon or functions with natural resources, infrastructure, climate and society, thus the maps help in mainstay since beginning of the civilization.

The first map like the presentation of mountains, valleys, rivers, routes as the cave printing found in Czech Republic has been dated 25000 years before from the Common Era. The transition from the historical, artistic depiction in form of a map to complex digital cartography has been led to progressive development of photogrammetric and cartographic techniques. The advances in in-situ data collection, the advent of satellite based remote sensing and navigation data which are organized around GIS facilitate acquisition of the digital information. Along with these technologies the advances in computer and communication technologies lead to emergence of effective information systems for mapping natural resources, environment and hazards. Today in India, having indigenous and mature programmes on remote sensing and navigation systems, expertise in geographic information systems, advance communication technology, decision support system has been built and location and web-based services, such as tsunami warning systems potential fishing zone services and agrometeorological services for farmers today a few being provided routinely. There are still scientific and technical challenges to be addressed and I am sure, during this conference these will be addressed. Some of them are the creating and maintaining geodatabases, spatio-temporal image data bases including human and social dimensions and automatic updating of this data bases. Development of spatio-temporal data models is spatially to mange the dynamic information. Use of geo-sensor networks such as wireless sensors in dynamic scenarios. Integration and arborization of different data sources such an image, CAD, Topographic, Physical, Biological as well as the Sociological data. Developing and updating the standards for data sets, data exchange, quality, meta data web and location-based services and lastly, the analysis, modelling and computing for big data mining techniques, object base image analysis. The indigenous geo spatial industry which is growing very rapidly is going to be very crucial for Aatmnirbhar Bharat. But it is still constrained by the colonial rule. Today Indian geospatial industry employees more than 1 million people and contributing significantly in the national development.

In my opinion, we need a policy which is aimed at wider use of geospatial information and lay down broad guidelines for creating, sharing, accessing and discriminating geospatial data for economic, environmental and societal use. The policy should be such which has global relevance while supporting national needs. Having competent geospatial professionals, a vibrant industry, innovative entrepreneurs and creative scientists. I am sure that we can support the transforming India to Aatmnirbhar Bharat.

Thank You Very Much.

INAUGURAL ADDRESS

Shri Naveen Tomar
Surveyor General of India
Government of India

His Excellency Governor of Haryana Shri Bandaru Dattatreya ji, Prof. Raj Kumar, Vice Chancellor of Panjab University, Dr. Krishna Mohan, President, Indian National Cartographic Association (INCA), Dr. Sailesh Nayak, Director, NIAS, distinguish members of INCA, other dignitaries, delegates, students and friends,Ladies and Gentlemen, a very good morning to all. It is my pleasure to speak to such an august audience on this prestigious event. Friends, why geography is so important and 90 percent of all existing database have a geospatial component, simply because human eyes has limitation and can see a very limited areas all around itself. Whereas the area required for any planning and decision making in much larger. Moreover, when we see different objects in their spatial context with their association they gave much interpretation and better understanding. All over, the use of geospatial information was not so common until the advent of mobile navigational acts, which have near become the de facto guide for going to any new place by common person. The geospatial domain has the attention at the highest level in the government in a huge way and now the occupies the centre stage. The announcement of Gati Shakti with 1100 trillion rupees for an integrated infrastructure growth, which is envisioned to have reduced logistic cost and make economy competitive, requires seamlessly and efficiently moving of goods and people across various modes of transport. However, achieving an efficient seamless multi-model transport network is not so simple and it requires independent government departments to what includes coordination and collaboration guided by an overworking master plan. This makes a paradigm shift in decision making which will break the cellulose of departmentalism and now onwards, individual projects of different align ministries will be examined and sanctioned within the parameters of this overall plan ensuring synchronisation of efforts an efficient education within the shortest possible time. The driving engine of this national plan will be GIS based enterprise resource planning system. If 200 plus layers for evidence based decision-making and use of satellite imageries for monitoring. As all of you are aware, with the advent of new geospatial guidelines and new geospatial data policy, the whole geo spatial ecosystem has changed considerably. Now, it has given food for thought to all the stakeholders. Recent launch Indian National Space Promotion an authorisation centre in space an autonomous organisation to coordinate with space industries working on the development of India’s space technology and regulating the space activities by hand holding and monitoring is a clear indication of the government vision for integrated efforts. Now it seems to me that our role in ecosystem is that of a facilitator by transfer of technical knowhow and provide the core infrastructure needed for a robust growth of private industries. We are existed to work in this ecosystem that we need fresh breaths in the organizations to meet this challenge. The policies in case the vision is clear more or less regarding where we want to go and thus the need of the hour to look at the execution model. I feel the united nation recommended integrated geospatial information framework (IGIF) has every ingredient for execution model, and only needs to be customise to suit our requirements. The framework provides the strategic guidelines that enable every country specific action plan has to be prepared and implemented.

In my opinion, the goal is very simple, we have to become the nation that shares, integrates and uses a wide range of data to achieve social, economic and environmental benefits in real sense. This requires more situational collaboration, interoperability and integration across the various national data information system and platforms that exists. Essential data management policies practices integration and analytical capabilities are currently limited in many organizations. Geospatial information has been typically collected in organization cellulose resulting in data duplication and the use of different standards and formats and classification which has made data harmonization, maintenance and integration difficult. This all requires in simple terms in strengthening of existing national spatial data infrastructure NSDI in a significant way.

I feel that business model of funding in this sector needs a drastic change for any meaningful outcome of liberalized regime. All the stakeholders have to work in a collaborative manner. We have to rethink public private partnership (PPP) framework and come up with a collaborative business model. The private sector has to invest in the geospatial sector and this will only happen when they have enough confidence for return in investment. It seems that there is a need to formulate comprehensive national public private partnership policy which should clearly spell out the objectives, scopes and implementing principles of PPP programmes envisaged by the government. As you all are aware that Survey of India is a technology partner in the Ministry of Panchayati Raj in implementation of prestigious Swamitva scheme i.e. the task of mapping of 6.62 lakh villages across the country. There are other large scale mapping projects for modelization of land records of state governments.

INCA provides a wonderful platform to all stakeholders and presenting their research finding and work done in the field of cartography mapping, geospatial science, remote sensing etc. collaboration that will be going to held in this conference will provide a fruitful insight to all the stakeholders specifically service organizations like Survey of India, which has the mandate of providing foundation of geospatial data sets to the users.

I wish that deliberation during INCA will help to formulate a workable action plan for the rapid holistic growth of the geospatial domain encouraging the liberalizing regime.

Thank You and Jai Hind.

INAUGURAL ADDRESS

Vice Admiral Adhir Arora
Chief Hydrographer
Government of India

His excellency, Shri Bandaru Dattatreya, Honourable Governor of Haryana, DR. Shailesh Nayak, the former secretary MOES India, Shri Naveen Tomar, Survey General of India, Prof. Raj Kumar, Vice Chancellor Panjab Unviersity, Chandigarh, and Prof. Krishna Mohan, President INCA. At the outset, I would like thank INCA for giving me this opportunity to show my thoughts on the most important and valuable thing Cartography for Self-Reliant India with this august gathering in a defence perspective where the previous spokespersons have said about the geospatial technology, what about the ocean and the seas? For the 71 percent of the world covering with water, the sea topography is far less known than the surfaces of the Mercury, Venus, Mars and the several planets moon including our own. Earth's landmass covers 29 percent of its surface, and the widely available maps of the space show features down to a size of good 30 metres accuracy. This stands in start contrast ocean floor which covers the rest of the ocean surface and seabed have not been accurately measured. As per the International Hydrography Organization report of 2020, only 20 percent of the ocean has been systematically mapped and surveyed. Using modern hydrographic techniques what does this means for us? Mapping and creating a digital representation of the ocean by 2030 to meet one of the objectives of the United Nations Decade of the ocean is the tremendous challenge with the current technology and it will require nearly 1000 ship years.

Allow me to illustrate the complexity of ocean surveying and mapping. The search of Malaysian Airline flight 370 become the most expensive in the aviation history with numerous ships and assets deployed and still not located. Having portrayed the complexities and challenges in water mapping, the question will arise why do we need to map the ocean. The shape of this seabed is the fundamental data set for confronting the growing challenge associated with climate change. In addition, ocean bathometry is important in the study of tides, sediment transportation, underwater geohazards, cable routing, fishing, resource exploration and exploitation.

Ladies and gentlemen, Surveying and mapping at sea is a herculean and complex task. It needs a lot of perseverance and patience and over and above adjusting to unpredictable measures of oceans dynamics. The international shipping industry is responsible for the carriage of around 90 percent of the world's trade resulting in exponential increase in maritime traffic at an average 100,000 ship travels through the Indian ocean every year. It is obvious that the world trade is dependent on the oceans and therefore we need to provide up to date and accurate navigation CHA (Competent Harbour Authority) which is a legal document for safety of navigation at sea for waters around India. The hydrographical department of India i.e NHO Dehradun does this in both paper and in electronic form.

Let’s see what we have in future to conclude? The government has recently liberalized the mapping and data acquisition policy and in the process of publishing the geospatial policy. These policy decisions are expected to boost the mapping sector and encourage Aatmnirbhar Bharat. The NHO, Dehradun is continued to support this policy and engage with all the stakeholders who are contributing to build the nations blue economy. Cartography in general and marine cartography in particular is increasingly becoming professional and as a result and indispensable contributor to meet the multifaced demand of modern society. Coming through the new ideas, we have marine spatial planning which is been initiated by NITI Ayog and the NHO is the major contributor in the blue economic corporation committee.

Coming to the e-navigation is one of the most important steps in achieving autonomous surface navigation. A Contemporary topic is been discussed at the international maritime organization to be introduced in the near future. and last but not least, coming to the autonomous shipping better known as mass (Maritime Autonomous Service Shipping) which is the name as described would be an autonomous or remote-control ship. The operating system of a ship would be able to make decisions and determined actions itself. It would be similar to an unmanned Tesla car nearly 1000 times bigger in size. It is the electronic navigational charge going to be produced by the marine cartographers that would play a vital role in assisting the decisions support of the system.

To conclude what else I elucidated just the tip of the eyes and there lies ahead much more in the future of cartographers. I have no doubt that after interacting with the cartographic community here, that the future of the nation particularly the initiative of INCA would pay way to be a Self-Reliant India in the field of cartography. I wish that the outcome of INCA meeting will provide cartographic professionals and marine cartographers quite provoking thoughts towards effectively achieving out Prime Minister’s mission of Aatmnirbhar Bharat.

Jai Hind

Thank You

MEMORIAL LECTURES

TODAR MAL LECTURE

Dr Prithvish Nag
Chairman, NSDI Data Committee &
Former President INCA

National Spatial Data Infrastructure or NSDI was established in 2006 under the aegis of the Department of Science & Technology with the support of Survey of India. It was suppose to look into the interoperability issues of spatial data which was due to (a) different scales, (b) different contents, (c) different formats, (d) lack of standards, and (e) problems of locating spatial data. It also considered the then latest technology consisting of advanced computing facilities, high resolution remote sensing data, GPS, laser mapping and the GIS. Nevertheless, the issues continued in one way or other in sharing of the data; time, money and efforts spent in finding the data; and of course unnecessary duplication in standardization and harmonizing of data. The technical or interoperability, organizational and institutional issues were given priority by the NSDI. Several steps were taken regarding the thematic content, spatial resolution, temporal resolution, positional accuracy, degree of up-to-datedness, and readiness and suitability for use. Conferences, publications and meetings were held in order to resolve NSDI standards, metadata, nodes, protocols and user interface which should contribute towards awareness programmes for much desired e-governance.

Even with the *National Map Policy of 2005* and the *National Data Sharing Policy of 2012* the success of NSDI was not up to the desirable level. Meanwhile, on 15th February 2021, the Government of India issued the *National Geospatial Guidelines* (NGG) which is aimed at opening the geospatial sector by (a) democratizing, (b) liberalizing, and (c) making provisions for ease of doing business. Unnecessary regulations and procedures were excluded. The status of globally available data and technology was also considered. All these efforts have explicit and implicit implications for NSDI. In some sectors, it has helped NSDI to take forward its efforts for co-operation in handing the geospatial data. On the other hand, in a few segments, a new role of NSDI is expected. For example, though there is an option of “self-certification” of data, the Indian entities may prefer to get their data certified from NSDI. What should be the protocol and business model for this purpose? How to make the national data registry effective for promoting business and avoiding duplication? These are some of the issues to be sorted out. A recent study suggests that NSDI should be a statutory arm of the government. Nevertheless to say, there is an opportunity for NSDI to assume a very pivotal role under the new guidelines and the forthcoming geospatial policy to be issued soon.

PROF. SHAH MANZOOR ALAM MEMORIAL LECTURE

Modern Cartography and the use of Geospatial data

by

Kalpana Markandey
Hyderabad

I thank the organizers of INCA especially Prof. Krishna Mohan the President of the Association and his colleagues for considering my name to deliver this prestigious lecture.

Learned audience I will give a cursory insight into

Cartography of yore was based on planimeters, mylar sheets and such other traditional devices. However, the scenario is different today with digital cartography on the anvil. Cartography is vitally oriented towards representation, while GIS which is the mapping face of Digital Cartography with analysis of spatial relationships, also has a time element attached to it. Digital Cartography relies on GPS, GIS and remote sensing (Fig. 1). **GPS** is used extensively for land surveying, navigation, tracking traffic, locating features like facilities and amenities on the ground besides a whole horde of other uses. **GIS** is a computer aided system for capture, storage, retrieval, analysis and display of spatial data. Spatial analysis is carried out by one and all, knowingly or unknowingly. Cloud computing which is a later day development, helps users to take GISon the go and makes real time mapping possible. **Remote SensingSatellites** help in updating land use, land cover and other maps like those of wastelands, water features etc. Today **aerial photography** banks to a large extent on unmanned aerial vehicles (UAVs) which are better understood as drones. They make large scale mapping, change detection and record keeping easy. **Sensors** can be used to detect change, events and physical characteristics of an area like undulations etc. LIDAR is a good example of a sensor which enables 3-D laser based aerial mapping and modelling. The Digital phase of cartography with its grounding in geospatial data and technology, has made cartography more accurate and comprehensive in scope.

Components of Digital Cartography:

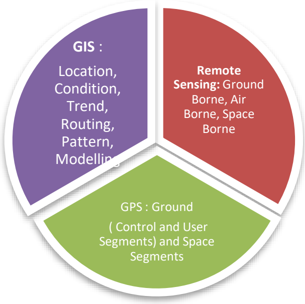


Fig. 1

The government of India has relaxed several guidelines on the collection and use of geospatial data, which enables and aids its strategy towards Atmanirbhar (self- reliant) Bharat. The Department of Science and Technology (DST), Government of India, will lay out rules on the usage of this data, and the users will have to follow them. While most of the areas are open to mapping, DST will outline the sensitive attributes that cannot be linked to mapped data. The process of data acquisition will be abridged and greater lucidity will be built into the same. The redundant government policies of the olden days will thus be dispensed with and replaced. The new procedures will be helpful in embracing the geospatial technology. The requirement of obtaining permission from Ministries and government bodies will be done away with under this dispensation. This would mean a great economy of time as well in carrying out the mapping processes.

Geospatial technology aids in spatial analysis i.e. knowing the location of things, the interrelationship of places, which stem from areal differentiation and the consequent decisions which flow out of them followed by actions. Spatial analysis helps in finding answers to questions pertaining to location (where and what is at a particular place?), conditions (what are the causative factors for its occurrence?), trends (the pattern of change or inclination), routing (the best possible way in terms of time or cost or distance travelled), pattern (the form of a particular feature which can be correlated with other underlying geographical conditions) and modelling (exhibiting an ideal situation or a future tendency).

GIS helps in measuring size, shape and distributions of phenomena or other attributes pertaining to an area, analyzing differences and the connections, finding ideal location for facilities and amenities and predicting for the future. It can also be used as a dashboard for real work as for instance, before establishing a school in a locality, the relevant variables like children of school going age, accessibility etc can be considered for different sites in the locality and the optimal location picked up. Thus, description, analysis and prediction as they are the sequential stages in the development of any science are all embedded in the geospatial technologies and these enable a head on tackling of the spatial problems of an area. Spatial reasoning and dialogue are also built into mapping with the help of these technologies which are readily updatable and facilitate spatial correlations with ease and **alacrity.** Due to their easily updatable nature, they are amenable to dynamic mapping and decision making based on it. It may be mentioned that GIS provides an easy and effective decision support tool to the policy makers. In other words, it enables science- based planning.

The geospatial tools help in gaining an in-depth view into the spatial features, lending a kind of spatial intelligence to the user. Spatial intelligence or locational intelligence helps the government take smart decisions with regard to tackling disasters, risks and laying out policies and plans for the development of an area.

Geospatial data can also be used effortlessly for **disastermanagement** and even early warning like the track of a cyclone or the spread of an epidemic, disease, vector monitoring and spatial correlation analysis of the occurrence of the disease with other underlying factors, as for instance the contamination of a source of water and related diseases etc. When a disaster occurs, relief can reach the affected people quickly when the agencies providing relief rely on this data for ascertaining the intensity of impact of the disaster in different pockets. Areas with varying intensity of impact can be identified with the help of GIS and can accordingly be served by the agencies. GIS also helps in selecting a hassle-free route, which does not have roads that are impacted by the disasters like flood or avalanche besides others; supplies to the affected people can thus be provided from an obstacle free and fast route. Safe roads can be identified to reach the supplies like relief material, water, medicines and food to the affected people and to carry out rescue and relief operations; likewise, evacuation and subsequent rehabilitation and re-construction of roads, houses or shelters can be planned with the help of GIS. Crowdsourced data also comes in handy in the case of disasters. It helps to manage, infer, and integrate details into the work process. Data from the cloud is also being used extensively and it is low on cost, productive, adaptable and aids quick results. Real time data can be built into the relief operations to know how the floods etc have been spreading or receding. Real time data also makes for better allocation of resources by the response teams by opening a window into the ground reality.

GIS is also useful for the mapping of **hazard zones**. GIS in combination with remote sensing can help in preparedness for hazards, adaptation and also mitigation plans. Safe zones for rehabilitation can be identified as also those where it is not advisable to carry out construction. Geotechnology can help to locate the quickest route to a hospital considering the traffic and other obstacles. GIS and GPS can help in ambulance routing with ease and effectiveness.

Businesses can make use of high-resolution data and can use advanced technology to locate mobile devices more precisely. Earlier it required a lot of government permissions to produce, access, or distribute such geospatial data, leading to extensive delays. Geospatial data is the cornerstone of many businesses today: E commerce websites such as Amazon, Meesho and Flipkart use it to organize consignments, look for the optimal location of warehouses etc; food delivery apps like Swiggy and Zomato resort to geospatial data to reach their customers, transport apps like Uber, Ola etc use it to plan their trips and pricing based on the demand for their services. This data also helps businesses to become conversant with the customers. E.g., a store that aims a particular age group can create maps showing the concentration of that age group so that they can aim their selling activities at those areas. Alternatively, areas with the highest household income within a specified distance from a store can be located so that they can be targeted for selling luxury products. This technology, thus aids business and marketing for targeted planning, improved decision making, better communication and also precise maintenance of records.

With regard to **Agriculture,** geospatial data helps in ascertaining thesoil moisture, weather conditions etc, which can assist farmers in their agricultural operations. The farmers can also ascertain the appropriate crop to be grown in an area based on its characteristics like soil, weather and topography besides others. These technologies also aid crop management decisions to maximize yields and help with optimal fertilizer input, as well as organic or genetic tracking.

GIS can be used to study **weather conditions** like clouds, rainfall, wind direction and intensity, track weather hazards, thus enabling a quick forecast of the weather conditions which can be of use to the farmers, fishermen, aviators and the people at large in making smart decisions.

Geospatial technology also helps in the analysis of **climate change**. An eye in the sky or the satellites can detect melting ice caps or receding glaciers, rising temperatures of sea water, disappearing islands as a result of the rise in the sea level and changes in land cover. GIS can help to assimilate data pertaining to atmospheric conditions, environmental changes and the people’s response to climate change. These techniques including Digital Terrain Models (DTM) can be instrumental in the decision-making process and finding solutions to the environmental problems.

Archaeology and heritage studiesalso rely impressively of satellite data, GPS, sensors and GIS. Under - sea investigations for the remains of historical sites through sensors, collating information from diverse sources and putting it in the framework of GIS enable fast and reliable archeological studies in the present-day context. Space - time patterns can be generated in the archeological arena with the help of geospatial technologies.

Geospatial technologies also come in handy in the **finance** sector, where financial inclusion becomes easy with the help of these technologies. For instance, the location of ATMs, bank branches etc can be planned with the spatial database of the customers. While alienation of select groups in remote locations can be handled with the help of this data, it also helps in identifying the densely populated area which may require a greater concentration of these services. Point buffers of accessibility to financial services can be prepared. Spatial gaps in the provision of these services can thus be aimed at and tackled.

Geospatial technologies are used in handling **medical services** as well**.** Apart from routes of least resistance, as has been noted in the case of ambulances, these technologies havemade a mark during the Covid 19 period. Nations have been tracking the spread of this disease through contact tracing, movements of sick people, parks and other spots that they visit, car, phone and credit card transaction tracking all of which are spatial measures enabled by GPS. India also has its own Arogya Setu App which gives a dynamic insight into the presence of Covid 19 positive cases within specified buffer zones from a person. Recently drones are also known to have delivered medical kits and vaccines showcasing the empowerment of technology in reaching out to people in need and salvaging the providers from many hurdles.

GIS along with GPS is used in **transport planning** where information pertaining to the assets of the transport department like bridges, tunnels, signals, switches, sidings, road crossings, junctions, their location and value as well as their requirement of maintenance, site selection, locating houses on streets besides a lot of other things can be mapped and used in fine tuning the services. If road widening is required, then a 50 feet buffer using GIS can be made astride the road and properties falling within the buffer can be identified. GIS can help in finding the property owners and they can be contacted by the government in a short span of time, thus saving time and resources for the government. Map data becomes interactive and hence more advantageous, when GIS and related geospatial technologies are used. For instance, one can click on a street map and get an insight into the number of lanes, speed limit, need for repairs to the road if any and other attributes of the road like pot-holes, road cracks, weeds or plants on the road and the need to control them.

As GIS can integrate and assimilate volumesof data, it is useful in **route alignment** where a multitude of variables have to be taken into consideration. GIS with the effective tool of DEM, which takes care of gradient, aspect, slope etc, apart from a horde of other features like soil and susceptibility of landslides have to be taken into consideration in route alignment. The geospatial technologies enable this in a short duration of time through computer algorithms and iteration.

GIS along with GPS is used aggressively in **real estate** business, where an agent can support a picture of the property with a map of the neighborhood, roads, accessibility, neighboring properties along with the attributes of the occupants. It gives an immense value addition to their efforts of selling the properties they intend to.

GIS is also used in **crime mapping** where the hot spots of crimes can be delineated based on the incidence of various types of crimes and safe passage routes can be defined. Geospatial Technology can also be used for investigating crime scenes and correlating it with collateral data. Emerging areas of crime, the gradient of crime from the hotspots as identified by the isopleths of crime intensity can be identified. It makes available evidence in several cases of crime and is an evidence- based aid in predicting and resolving them. The law enforcement agencies can rely on these techniques and can do a temporal profiling of the areas also so far as different types of crimes are concerned.

Mappingand by extension geospatial technology found its initial users in the **defense** field, Digital Elevation models (DEM) are used extensively by the defense personnel. They help in easily finding the line of sight and enable cross – country visibility, apart from giving an insight into slope convexity, slope concavity, aspect, steepness of slope and these come in handy for strategic operations. Satellite data is also used extensively in logistics, whether it is from the military point of view or for relief workers. Modern day wars are largely planned in the board room with the help of GIS and satellite data besides other geospatial technologies.

In other contexts, **DEMs** are also used to find out the altitude of soil layers, contact zones of soil and rock, water table, drainage basin delineation, etc. Cut and fill issues in road design and other civil and military engineering missions can be handled with the help of DEM. DEM can also be used for planning location of dams, routes of roads and for statistical comparison of varying kinds of topography. Erosion and run- off can also be estimated with the help of DEMs. By substituting altitude with any other continuously varying attribute, DEM can be used to represent travel surfaces by way of travel time and travel cost; levels of pollution, population growth or population density. Trend surfaces of various features can thus be represented.

Remote Sensing and UAVs can be used for planning for **sustainable development,** taking care o**f natural resources like forests** by measuring the extent of damage caused by forest fires, fire hot spots, mapping and modelling potential areas of occurrence, aerial guidance for spraying to extinguish the fires, besides cloud seeding etc,

GIS is not being used extensively for **landscape architecture,** though it has a lot of potential. As GIS has excellent graphical qualities apart from its basic analytical and collating properties, it can be used very efficiently for landscape design. This fact should be highlighted by the researchers for the benefit of Landscape planners.

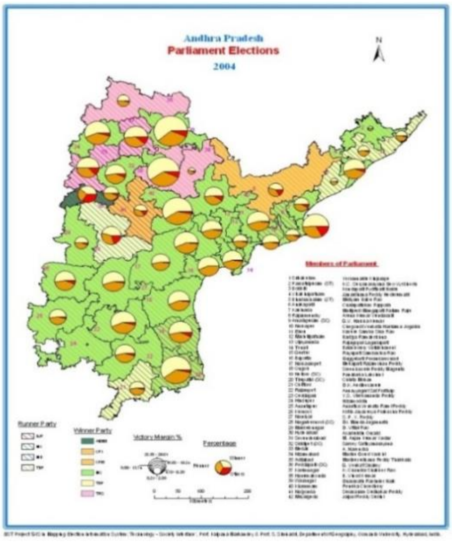
Regional and community planning, would benefit immensely from these revised rules of the GOI and that would be beneficial for the economy in the ultimate analysis.

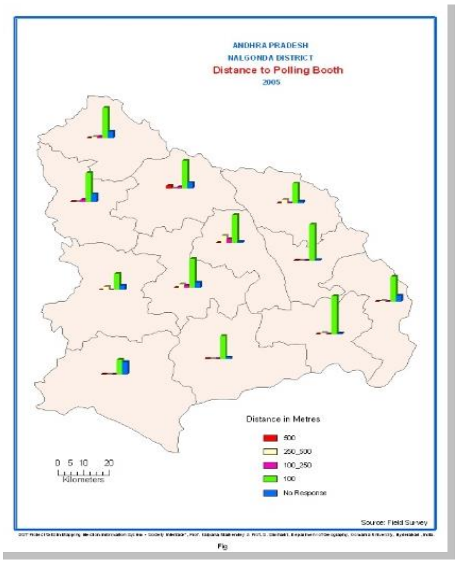
Data pertaining to **water resources,** watersheds and drainage, treatment maps – check - dams, water harvesting structure, ground water potential, **soil survey information, fishing zones, biodiversity, coastal zones, wetlands, shoreline shift, oil slicks, turbidity, siltation, surface flow analysis, change of river course, erosion, contamination, sedimentation and eutrophication in lakes** can also be effectively studied and tackled with the help of Geospatial Technologies.

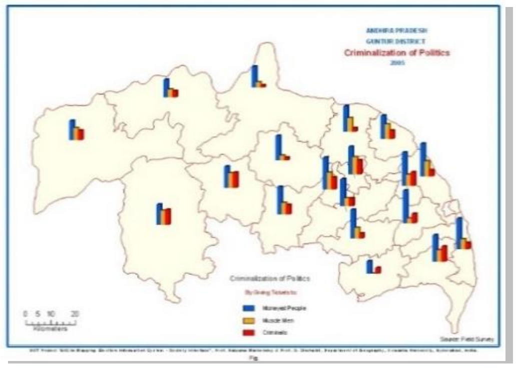
Geospatial data helps in finding locations in **urban areas**, like the location of a restaurant, petrol pump, mall and other facilities and amenities as well as fixing and being reminded of the maintenance schedules of these amenities and facilities. Data pertaining to carbon footprints, slums, indiscriminate waste disposal, pockets of pollution, land use change and haphazard growth of cities can enable proof – based planning for better cities in the future. **Asset mapping** can be done with ease, questions pertaining to the location, characteristics, optimal utilization, repair of assets, maintenance schedules of assets and mapping of inventories can be done. Data from thermal sensors can be used to identify heat islands in urban areas. Apart from this satellite data can also help identify slums in urban areas with the help of their spectral signatures. Much before the municipalities notify the slums; they appear on the urban landscape as squatter settlements. At this stage if they can be recognized with the help of their signatures (Fig. 2) and ameliorative measures taken, the cities administrators can avoid the burgeoning problems that accompany them. The 'Slum Signature Library' can thus help in creating awareness and knowledge base, which can arm the government, forewarn it and help it in taking preventive measures towards the taking root of slums.

Fig. 2: ***Nagamaiah Kunta*** *slum in Hyderabad has an elongated pattern of layout and the shape, tone, texture and pattern of structures on its west merge with those of the slum on the west and those on the east merge with the structures on the east, which are of a more regular nature Only the western part of the slum has a typical slum signature and the eastern part forms a transitional zone with the regular built up area*

Even studies pertaining to **Elections** have made extensive use of GIS and it can help in understanding the Electoral Geography of a state or district or whatever the unit of study. It also helps in making the elected representatives, party workers and the common man more spatially enabled and more enlightened and equipped to understand the nitty - gritty of the correlations and co – variations that associate with the electoral outcomes (Fig. 3).







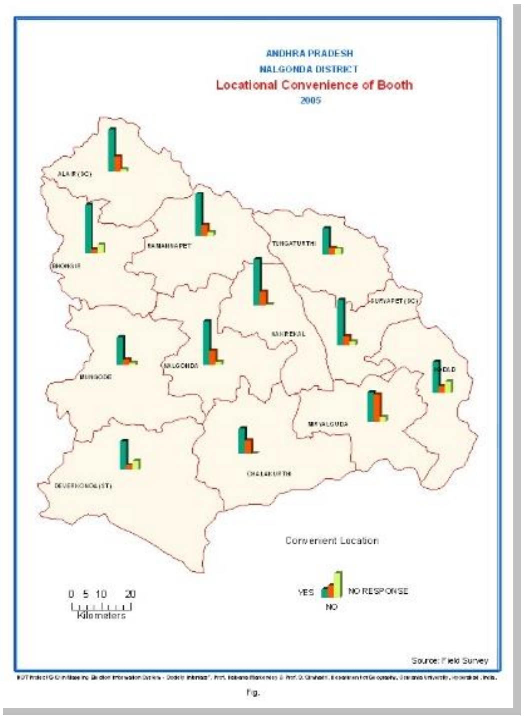


Fig. 3

Details of **wastelands, aquaculture, assessing the condition of avenue plantations** are also provided with ease by the geospatial technologies. GPS along with GIS can be used in the study of **forestry,** for **land, park and wildlife management** starting withspecies distribution mapping, counts of species and mapping migration patterns. They can be used for the study of the number of trees in a forest, tree species, diameter of trees, timber estimation, diseased trees, optimal routes for transportation of logs, forest boundaries, roads and allied infrastructure

These new geospatial policies will aid in **land surveys**, which will become more disturbance free. While traditional land surveys to record the ownership status are unwieldy, drones can assist in updation of land records. They can get the details of land use effortlessly and with perfection. An efficient land information system will enable easy cadastre administration, zoning of land uses, land acquisition if required and help with taxation.

Where establishments are required to meet government regulations pertaining to pollution and trade, GIS offers tools to help them conform to the government regulations. Local and Regional Governments can take the help of GIS in planning Public Works and utilities and devising an efficient **Land Information System.**

An Information system at a micro level can also be made with the help of GIS, as for instance a **Campus Information System**, which can be used to improve the state of amenities and facilities in the Campus in an interactive play and plug mode, be it a university campus or any other institutional campus. An example of this in a static mode is presented in Fig. 4.

Fig. 4

Apart from this **Digital Atlases** can now be prepared which will present results of spatial information in an interactive mode and help in making informed decisions.

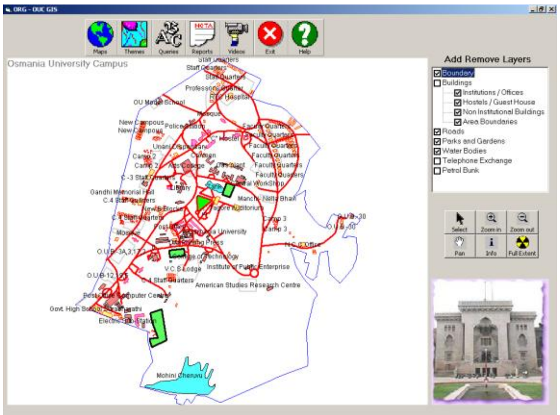
GIS has also embarked into **location-based services (LBS).** LBS allows fleet tracking, vehicle navigation (telematics), clinical health care operations, emergency response, personnel monitoring, and other facilities and amenities in close vicinity, with the help of GPS enabled mobile devices.

Environmental degradation owing to exploitation of land resources like mining activity, water pollution due to indiscriminate disposal of mine wastes, mine drainage, coal washing operations, land degradation due to massive excavation, landslides in hilly terrain, deforestation due to chopping of trees for construction of roads and for fuel, damage of sites of cultural, historical and scenic importance, can all be tackled by GIS by simulating alternatives for effective decision making.

Satellite data offers evidence about various natural resources on a periodic basis and changes can be monitored in a dynamic framework and corrective measures to arrest or minimize deterioration of environment can be taken up.

Geotechnology can be effectively used for **environmental impact assessment**. GIS layers of different attributes pertaining to the environment can help in effective decision making for obtaining optimal results. Capturing of features and regular updating will aid in this effort.

Object-oriented program design, big data, mobile mapping, WebGIS and such other techniques have lent a new dimension to GIS and by implication mapping. Mapping is no longer the domain of the cartographers. Almost anyone who deals with spatial data, be it an academician, a researcher, a planner, a government official, a strategist or any one related to any discipline or even the person on the street, they all require mapping with its present-day embodiment of Geospatial Technologies. These technologies have brought mapping to the doorstep or rather the palm top of all and sundry and have a long way to go in enhancing awareness and responsiveness of all concerned.



GUEST LECTURES

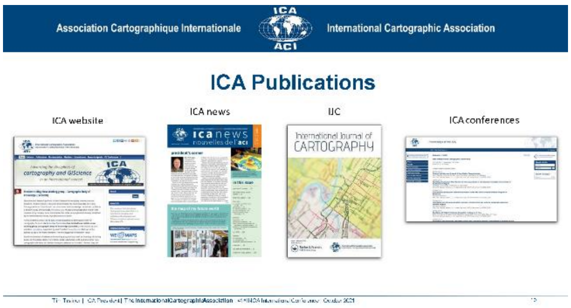
GUEST LECTURE

Cartography and Cartographers – Making Our World a Better Place

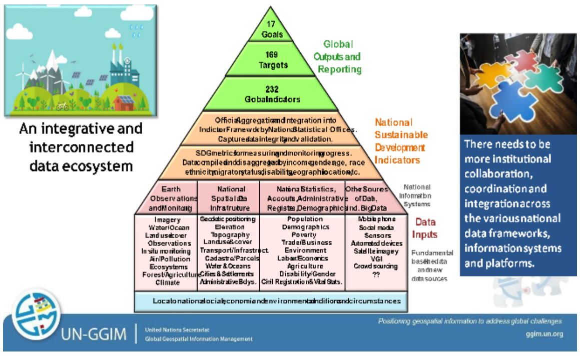
by
Tim Trainor
President, International Cartographic Association

Welcome everyone to this session. Today I am talking little bit about ICA (International Cartographic Association) and relationship with the UN (United Nations). So, greetings from the ICA executive committee made up of ten members from ten different countries. I am going to emphasize the aim of the ICA is to ensure that cartography andGIScience areemployed to maximum effect and full potential for the benefit ofsociety and science through promotion and representation of thedisciplines and professions of cartography and GIScienceinternationally. There are 73 national members of ICA around the world. These members are usually comprising national mapping and geospatial agency, National Cartographic Association and National Committee for Cartography. We also have 34 affiliate members including companies, agencies and other organization having interested in ICA.

The strength of ICA is specially the people in which 28 commissions focussed on specific cartographic and geospatial topics. Also 5 working groups created to address specific topics for the current term.



and international collaboration. We have the Barbara Petchenik Children's Map Competition every 2 years. We are facing unprecedented challengeslocally and globally. Maps show the plight of people and cancontribute to a way out of our current troublesSo, What's Next? As all of you are aware of 17 SDG's available to the United Nations, they are tough, not every and one way to do that is to look at these indicators i.e., 260 indicators and try to determine whether there is mapping purpose, geospatial data requirement. The diagram shows the relationship between those goals, targets, and indicators. And I want to focus on the mid of the area i.e. national spatial data infrastructure going to the left we have earth observation and monitoring system.

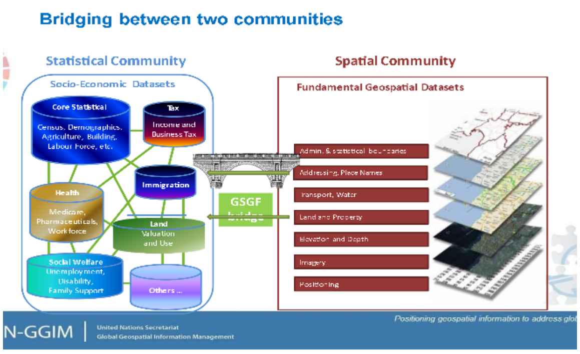


We have all hosts of statistical data organized in a geospatial context for biogeography. And then we have other data sources including data group that could be the social media mobile phone, sensor, automated devices, satellite imageries and crowd sourcing. I suggest this area to be a kind of disruptions. There is huge amount of data we are not sure how to utilize that data, but it is available to us, so we need to be thinking about this. So, in the response of UN side, UNGGIM created this framework i.e., Integrated Geospatial Information Framework.

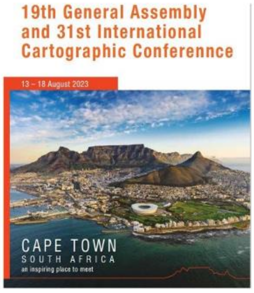
It is the next rendition of what is NSDI (National Spatial Data Infrastructure). I have been involved with this concept since the beginning. They are principally data focussed. So that is the challenge. Some of the other pathways under here are related to NSDI and some of them are not. So the question is what do we need how to have holistic program for geospatial information to support everyday need that we have, and the IFIF is just that response. So here is the relationship between ICA and this framework. Those the topics coming after the numbers are titles of different commissions within the ICA commissions of working groups in which there is relationship with one of the pathways.

If you look at the different data types and the national systems of data, all of items in the left are numbers/statistics, so the way to create a bridge between spatial community with statistical community is through different frameworks of geospatial statistics called GSGF (Global Statistical Geospatial Framework) and this about data integration. These are the principals of GSGF. So, what is next for us? The focus is on user needs, interests and requirements to expand the relevance of cartography and GI Science.

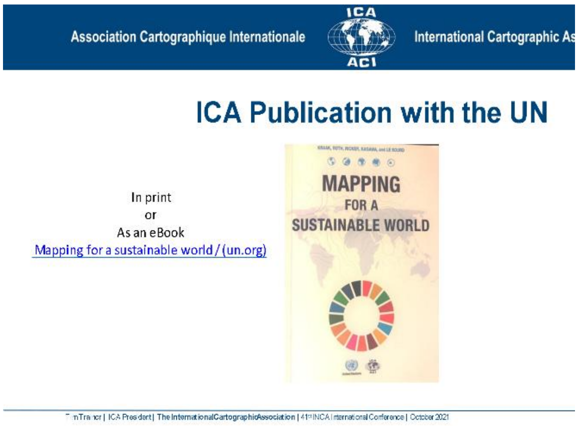
In today's world, if we are not focused on national priorities and national circumstances, then we are challenging our relevance and we really need to focus on these topics. In response to the SDG's goals, the ICA has published different posters available for the public use. Those posters ended with collaboration of an E-Book called "Mapping for a Sustainable World". We also have some future



cartographic conferences in Italy in December 2021 and in Cape Town in August 2023. So how do you get involved?



- Check if there are ICA Commissions in your field of interest.
- Participate in the work of the ICA Commissions to learn and influencenew developments in cartography and geospatial science.
- Come and present your work at our various conferences
- Display your accomplished works at the International Map Exhibition
- Help/sponsor young professionals to participate in ICA Commissions and
- International/Regional Cartographic Conferences



We cartographers have much to contribute and we need to show how we can make a difference for our communities and our world.

I want to thank you for the opportunity to share some thoughts with you today and I wish the best for you for the rest of the conference.

Thank You

RESEARCH PAPERS

Active Fault and Landslide Investigation in the Northwestern Himalaya, India

Mahesh Thakur

Abstract

The study of natural hazards such as landslides and earthquakes are of major concern in this climate changing scenario of 21st century. The increased demand of energy has led to the development of more dams, highways in the mountainous regions destabilizing the natural slopes. For sustainable development, the continuous monitoring of slopes along with development of energy tapping projects is crucial for the developing countries like India. In this paper, a new light is shed on the retrospective study of Landslides in inferring the trace of potential subsurface faults or surface exposures of active fault-rupture zones in the sub-Himalaya, lesser and higher Himalayan region of Northwestern Himalaya, India.

Keywords: Landslides, Paleolandslides, Active faults, Northwestern Himalaya

Introduction

The study of natural hazards such as Landslides and Earthquakes are of major concern in this climate changing scenario of 21st century. The increased demand of energy has led to the development of more dams, highways in the mountainous regions destabilizing the natural slopes. For sustainable development, the continuous monitoring of slopes along with development of energy tapping projects is crucial for the developing countries like India. Landslides and Earthquakes are related to each other considering the inherent nature of their occurrence. Earthquakes also act as a triggering factor for landslide occurrence in the young orogenic belts such as The Himalayas, The Alps etc. Froude and Petley (2018) demonstrated that throughout globe anthropogenic activities are more responsible for the recent landslides as compared to climate driven factors. The South-East Asia and East Asia regions are dominantly affected by Landslides (Froude and Petley, 2018). The post-earthquake investigation of landslides is carried all over the world to quantify the relations between their occurrence andvarious geologic and seismic parameters responsible for landslides. The comprehensive study demonstrating the correlations between landslides and earthquakes is done by Keefer, 1984, 2002. Keefer (1984) studied the correlations between earthquake magnitude and distance to landslide from fault-rupture zone as well as earthquake magnitude versus area affected by landslides.

In this paper, the retrospective study of landslides in inferring the potential fault-rupture zones is done. This study can be used as a tool in establishing the correlation between landslides and active fault-rupture zones throughout globe especially to the active orogenic belts such as The Himalayas. This paper is organized in the form of case studies from different regions of northwestern Himalaya encompassing landslides and active fault-rupture zones.

Case study I: The Umri Landslide

The Umri landslide is located on the Panchkula-Morni road, Haryana, India. The landslide is present in the vicinity of Nahan Thrust (Singh and Thakur, 2019). The rock mass of Umri landslide is composed of alternating sandstone and mud/clay stone layers making it susceptible to failure. Along with this, Umri landslide shows signatures of normal faults and also a strike slip fault passes across this landslide. The heterogeneity of competent-incompetent rocks and presence of strike slip fault across this landslide is the main reason for instability in this landslide.

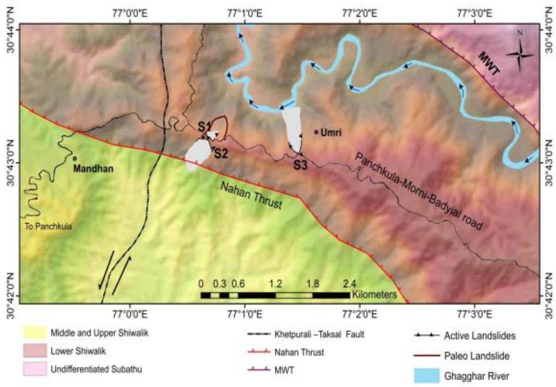


Figure 1. Location of Umri landslide, S3 indicates Umri landslide (after Singh and Thakur, 2019)

Case study II: The Kotropi Landslide

In the state of Himachal Pradesh, India, Kotropi landslide occurred on 13th August, 2017 in Mandi district, which buried two buses beneath the debris and killed 46 people, making it one of the most disastrous landslides occurred in Himalaya (Pradhan et al. 2019). The presence of fault signatures in the exposed face of Kotropi landslide revealed its complex nature and describe it as a prime factor in the occurrence of this landslide.

Case study III: The Kaliasaur Landslide

The Kaliasaur landslide is present along the Srinagar-Rudraprayag road, Uttarakhand, India. The main rock types present in Kaliasaur landslide are Haryali Quartzite and Karanprayag Metavolcanics (Thakur et al. 2017). The Kaliasaur landslide encompasses pulverized quartzite rocks (Thakur et al. 2017) due to presence of regional Kaliasaur Fault. Kaliasaur Fault have weakened the rock mass and pulverized the rocks increasing the instability of Kaliasaur landslide especially during rainy seasons.

Figure 2. Location of Kotropi landslide (Source: www.jogindernagar.com)

Figure 3. Location of Kaliasaur landslide (after Thakur et al. 2017)

Case study IV: The Sataun Landslide

The Sataun landslide is present along the NH-72 (National Highway-72) between Sirmauri Tal and Sataun towns of Sirmaur district of Himachal Pradesh, Northwestern Himalaya, India. Geologically, the Sataun landslide is composed of Middle Siwalik sandstones, which are highly fractured and faulted due to the interaction of the active Sirmauri Tal Fault zone and the Malgi Fault at the site of the Sataun landslide (Thakur et al. 2022).

Figure 4. Location of Sataun landslide (Source: ANI News)

Conclusions

In this study, four case studies are discussed indicating the critical role of active fault-rupture zones as a dominant and prime factor inducing the landslides in the Northwestern Himalayas, India. The Comprehensive studies are conducted across continents to quantify the effects of earthquake magnitude on the occurrence of landslides. However, the retrospective study of landslides to infer the trace of sub surface or surface exposures of active fault-rupture zones is never done before. Through this study it is proposed to generate the database of landslides in the Northwestern Himalaya and infer the trace of active fault-rupture zones. This type of study can play a vital role in the paleoseismic interpretation of many areas, particularly those lacking fault exposures in the Himalayas such as region of Higher Himalaya and Lesser Himalaya. Also this database of Landslide studies in the Northwestern Himalaya will help in characterizing the shaking history of a site or region irrespective of the earthquake source. This study thus can be valuable tool in hazard and risk studies that are more concerned with shaking hazards than with interpretation of themovement histories of individual faults.

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Spatio-Temporal Distribution of Towns around Chennai from 1901 to 2011

Ahalya Sukumar and B. Sukumar

Abstract

Spatial dimensions and temporal variations are very important for urban geography and town planning. Chennai was known as Madras. The Government of Tamil Nadu officially changed the name of Madras to Chennai in 1996. Madras was the short name of the fishing village Madraspatnam, where the British East India Company built a fort in 1639-40. Later it had become the Administrative and commercial capital of British Rulers and it is the state capital of Tamil Nadu. Chennai is the sixth largest urban agglomeration city in India (Census 2011) and 30th largest city in the World. In this paper, an attempt is made to study the growth of towns from 1901 around Chennai. Towns were mapped to show the size and spatial distribution. QGIS is used for the mapping and analysis. Census of India Reports was used as data source. Four districts viz., Chennai, Thiruvallur, Kancheepuram and Chengalpattu were considered for the study as they are the surrounded districts of Chennai. In 1901, Chennai had a population of 5, 41,167 with 12 towns around. By 2011, number of towns has increased to 132 around Chennai. Population of the city has increased to 46, 46,732. In the initial stages it had grown along the main roads and railways. Later infilling took place. After 1970s vertical growth and also there was an increase of towns around Chennai. The trend, size and spatial distribution are an important aspect of urbanisation. Numbers of towns have increased towards south western side of Chennai Corporation. The growth of towns in the north and west are less compared to the south west. When it is explained with maps, many things can be inferred and it is useful for the future planning.

Key words: Urbanisation, Urban agglomeration, spatial distribution

Introduction

Spatial dimensions and temporal variations are very important for urban geography and town planning. Chennai was known as Madras. The Government of Tamil Nadu officially changed the name of Madras to Chennai in 1996. Madras was the short name of the fishing village Madraspatnam, where the British East India Company built a fort in 1639-40. Later it had become the Administrative and commercial capital of British Rulers and it is the state capital of Tamil Nadu. Chennai ranks 13th among the cities in India by area. Chennai is the sixth largest urban agglomeration city, in India (Census 2011) and 30th largest city in the World.

Aim and Objectives

In this paper, an attempt is made to study the growth of towns from 1901 around Chennai. Towns were mapped to show the size and spatial distribution.

Materials and Methodology

QGIS was used for the mapping and analysis. Census of India Reports were used as data source. Four districts viz., Chennai, Thiruvallur, Kancheepuram and Chengalpattu were considered for the study as they are the surrounded districts of Chennai. Proportionate circles were drawn to show the size, spatial distribution and trend of growth of towns.

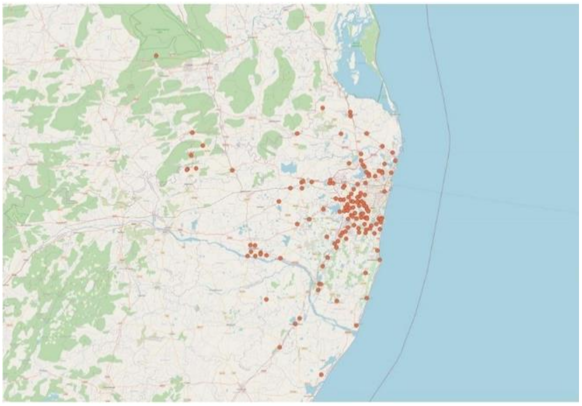
Analysis and Discussion

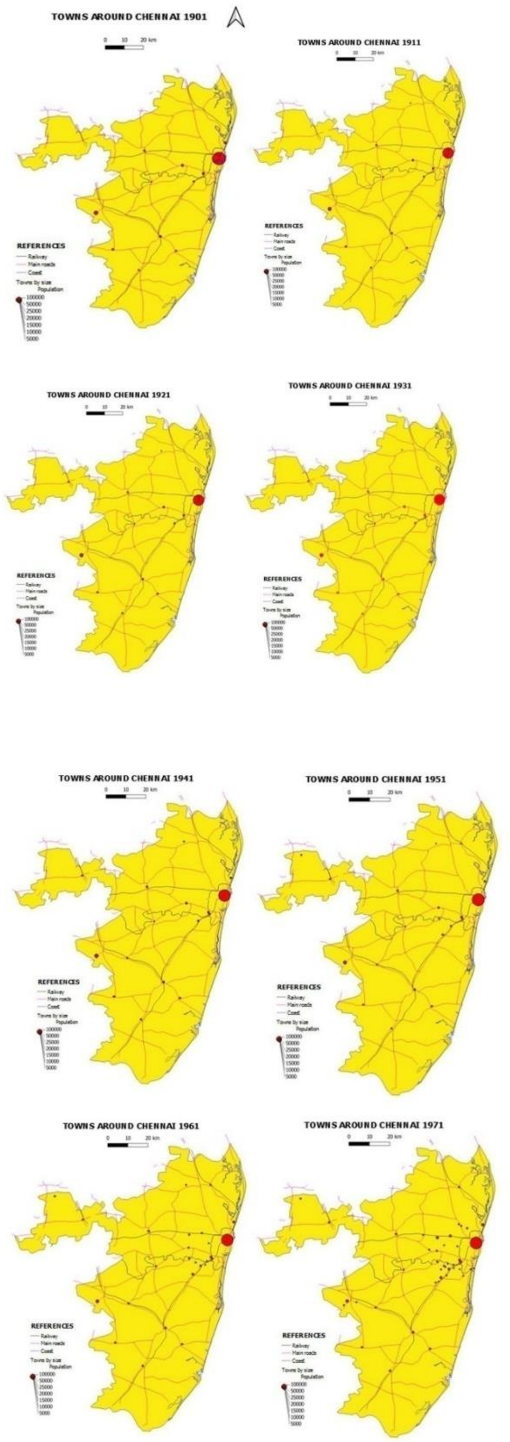
In 1901, there were 12 towns. Chennai was the only Municipal Corporation. There were 7 Municipalities. According to the classification of towns, there were 4 Class I towns including Chennai. They were Chennai, Kanchipuram, Tiruvottiyur and Pallavaram. In 1911, 5 Class I towns. Alandur joined as fifth rank town. In 1941, there were 16 towns. Class I towns remained the same but the ranks of the towns changed as Chennai, Kanchipuram, Tiruvottiyur, Alandur and Pallavaram. In 1951, towns numbers increased to 20. There were 6 Class I towns. They were Chennai, Kanchipuram, Tiruvottiyur, Tambaram, Alandur and Pallavaram. In 1961, towns increased to 20 and there were 8 Class I towns. They were Chennai, Kanchipuram, Tiruvottiyur, Tambaram, Alandur, Pallavaram, Avadi, and Ambattur. In 1971, there were 44 towns. Class I towns increased to 9. They were Chennai, Kanchipuram, Tiruvottiyur, Avadi, Alandur, Tambaram, Ambattur, Pallavaram and Madavaram. In 1981 number of towns increased to 48. Class I numbers remained the same and the towns were Chennai, Tiruvottiyur, Kanchipuram, Avadi, Ambattur, Alandur, Tambaram, Pallavaram and Madavaram. In 1991, there were 59 towns. Class I towns number remained the same. Only ranks of the towns were changed as Chennai, Ambattur, Avadi, Tiruvottiyur, Kanchipuram, Alandur, Pallavaram, Tambaram and Madavaram. In 2001, there were 88 towns. Class I towns remained 9. They were Chennai, Ambattur, Avadi, Tiruvottiyur, there were 13 towns. Class I towns remained the same. In 1921, towns increased to 14. Class I remained the same. Only ranks were changed. Pallavaram ranked third and Tiruvottiyur ranked 4th. In 1931, there were 15 towns. There were

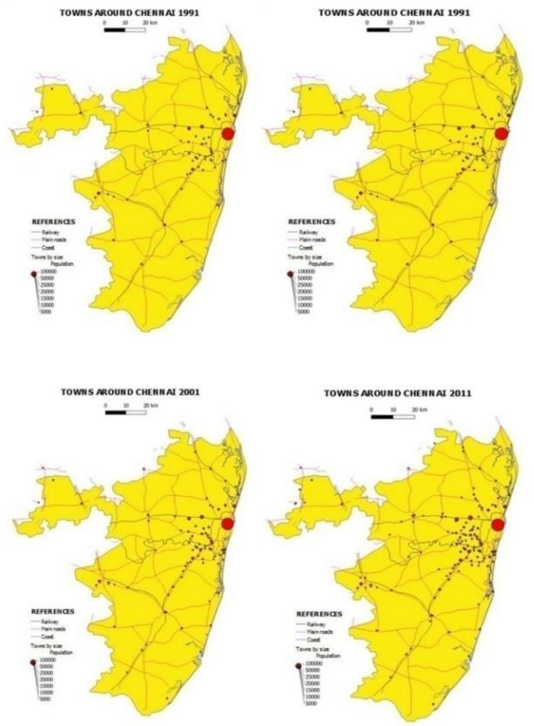
Kanchipuram, Alandur, Pallavaram, Tambaram and Madavaram. In 2011, towns were increased to 134. There were 9 Class I towns. They were Chennai, Ambattur, Avadi, Tiruvottiyur, Pallavaram, Tambaram, Alandur, Kanchipuram and Madavaram.

Maps showing spatial distribution and size from 1901 to 2011 are shown after the Tables. Towns classification and Class wise towns and their numbers from 1901 to 2011 are given in the following Tables

All classes	Population size
I	1,00,000 and more
II	50,000–99,999
III	20,000–49,999
IV	10,000–19,999
V	5,000–9,999
VI	Less than 5,000







Above map shows concentration of towns around Chennai as per Census 2011

Conclusion

In 1901, Chennai had a population of 5, 41,167 with 12 towns around. By 2011, number of towns has increased to 132 around Chennai. Population of the city has increased to 46, 46,732. In the initial stages it had grown along the main roads and railways. Later infilling took place. Towns have increased after 1961. After 1970s vertical growth and also there was an increase of towns around Chennai. The trend, size and spatial distribution are an important aspect of urbanisation. Numbers of towns have increased towards south western side of Chennai Corporation. The growth of towns in the north and west are less compared to the south west. When it is explained with spatio-temporal maps, many things can be inferred and it is useful for the future planning.

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Mapping of Urban Amenities and Land Use Land Cover Change of Rohru Municipal Committee in Himachal Pradesh

Ajay Chanjta and D.D Sharma

Abstract

Mapping is essential and of vital importance for the developmental planning of any area. This is a priority of the development of any nation and therefore certainly requires availability of accurate and up to date data. In India, bulk of tabular data is being generated by census of India but very less mapping on high resolution is being done. In this paper, an attempt has been made to map the amenities and changing Land use and Land cover of Rohru Municipal Committee of Himachal Pradesh during 2008-2018 on higher resolution data. The objective of this paper is to prepare spatial data that are relevant for planners and policy makers, with detailed and up to date status of overall availability and distribution of amenities in the municipal committee area. The mapping of all amenities in the Rohru Municipal Committee has been done through G.P.S. Land use and land cover mapping and change have been mapped with the help of LANDSAT- 6 data of 2008 and RapidEye-3 data of 2018 using supervised classification and being superimposed on High resolution Google Earth Imageries to have a high resolution mapping using remote sensing and geographical information system. The mapping methodology is novel and effective for recording qualitative status, analysing their spatial distribution and prioritization. The future research integrating these spatial data with more qualitative research can provide a holistic view for overall development of the Rohru Municipal Committee.

Key words: Mapping, Amenities, Land use and land cover, Google Earth Imageries, Satellite Imagery.

Introduction

Development of any region is based on the extent to which the basic need of humans are satisfied and to satisfied those needs some certain facilities such as market, housing, water supply, electricity and adequate transportation are required (Adekunle et al, 2011). These facilities are pre requested and integral part of urban as well as rural society because urban system is a compound complex system of human and environment with highly dense population, abandoned of resources and rich socio-economic strata (Borana and Yadav, 2017; Das and Begum, 2019). Access to basic amenities is important for well-being and a sensible standard of living people as all these aspects demarcate the quality of life availed by the local in any society (Kumar, 2015). The need for this access has been recognized internationally and nationally, as it forms the dividing line for various other forms of deprivations. There is a need for planning urban amenities to provide equitable and adequate service to all groups (Jahangeeret al., 2012).

The land use/ land cover represents the overall man-environment relationship. The pattern of land use/land cover reveals the potential rate of resource degradation. Land has multi-dimensional uses and have a very important place among natural resource of any area. It provides space for all economic activity and fulfil many human ecological needs (Yadav, 2013). Attention towards land use and land cover studies was first observed during mid-1970s observing its direct impact on global climate change which was noticed by many researcher all over the world (Lambin et al., 2003; ICSU, 1992). To maintain harmony among sustainable resources and socio-economic needs the land use analysis become imperative.

Both the public amenity and changing land use and land cover of any urban region demarcate the status of development and need to be addressed. In order to bring out this spatial distribution of amenities and for future planning purposes, the cartographic techniques play a vital role. Thus, with the help of GIS and suitable cartographic approach present research article tries to bring out the spatial pattern of amenities and changing land use land cover pattern of Rohru Municipal committee of Rohru community development block in Himachal Pradesh.

Objectives

The study is focused to achieve the following major objectives:

1. To map the amenities of Rohru Municipal Committee,
2. To generate land use and land cover change of Rohru Municipal Committee.

Study Area

The study area constitutes Municipal committee area of Rohru C.D. Block, Shimla district, Himachal Pradesh. Study area is situated in the central-east part of the Rohru C.D. Block. The study area lies between 31º 12′ 54.392″ and 31º 12′ 48.936″ N and 77º 44′ 26.3″ and 77º 45′ 43.004″ E(Figure. 1).The eastern parts of the study area share the boundary with Rantari panchayat. On the southern part Rohru municipal committee area share the boundary with Beraseli and Karalash. Panchayats. The study area consist of seven wards. The total geographical area is 2.13 sq. km with the total population of 6,875 persons out of which 3,759was male population and 3,116was female population in 2011 census. Sex ration of the study area was 828 female per thousand male in 2011 and 79.47 persons of the total population was literate according to 2011 census.

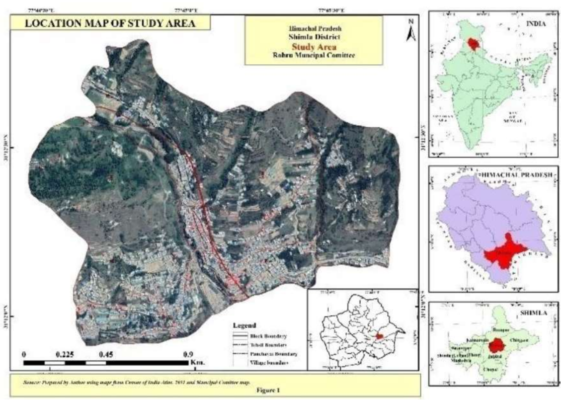

Figure 1

Methodology

In order to accomplish the objectives taken for the study, the methodology has been divided

into two branches. First the base map have been generated by geo-referencing it and made compatible for making further maps. Both primary GPS based survey data and secondary sources of data have been used for the study. The base map is prepared using Survey of India Topographic sheet (53E-11 and 53E-12 geo-coded on 1:50,000 scale).Mapping of urban amenities have been done using GPS base field survey. To develop land use and land cover map of 2010 and 2018, satellite images of LANDSAT 7 (ETM+) image path 147 row 38 of October 2010 and RapidEye-3 image (5 meter MSS, May 17th 2018) have been usedrespectively. Image processing software ERDAS is used for geo-referencing and enhancement of satellite data. Raster layer generated from supervised classification which further converted to vector using conversion tool in ArcGIS platform. These sources of data provide a low resolution land use land cover so to improve the spatial resolution of the output land use and land cover generated land use land cover map layer have been superimposed on geo-referenced google earth images (rectified on UTM projection and datum WGS 1984).

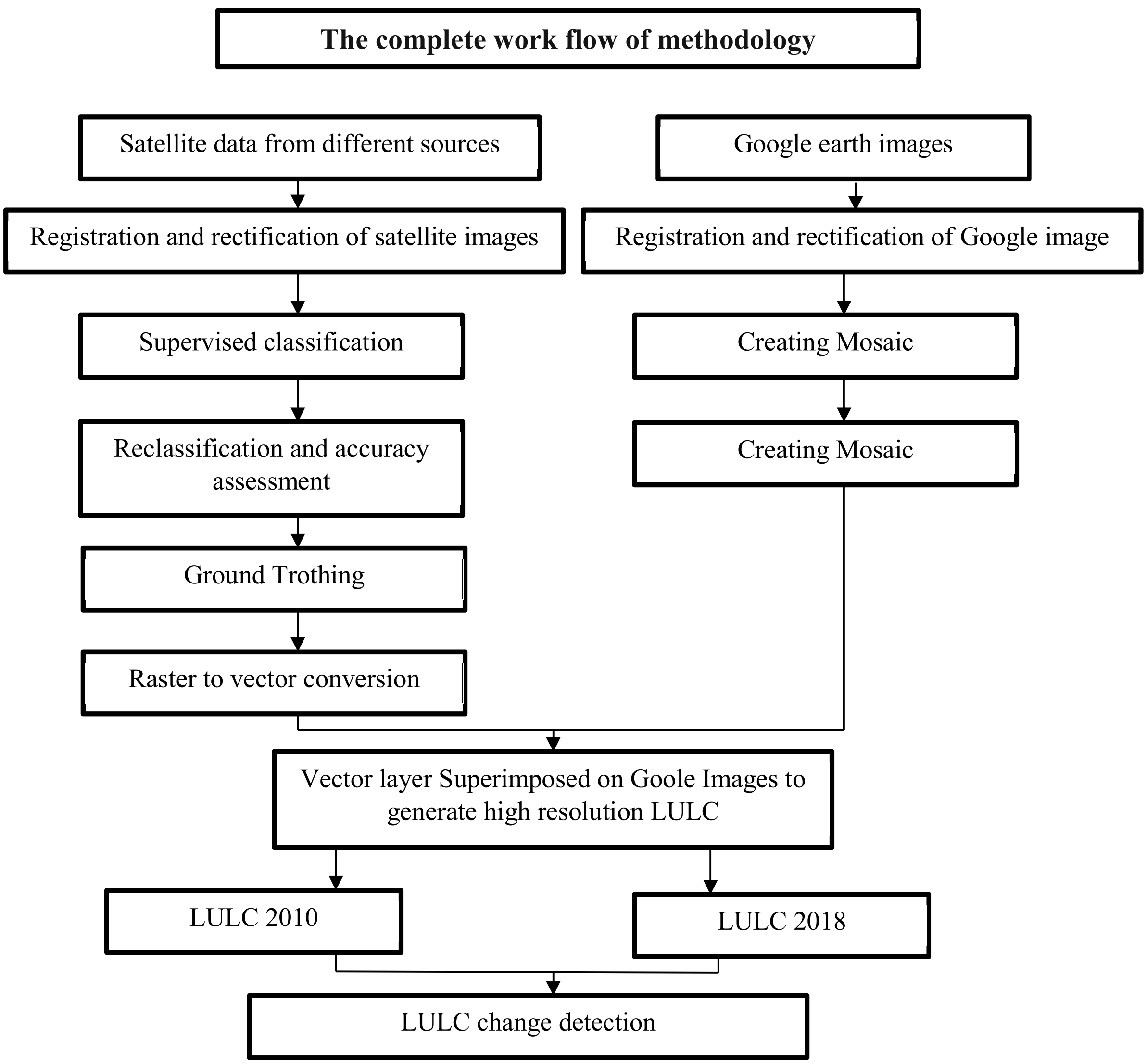

Figure 2

Results and Discussion

Ward wise amenities in Municipal Committee Rohru

Ward wise availability of public amenities have been discussed in the following paragraphs of Rohru municipal committee comprising of health, education, banking, sanitation, drinking water facilities and other facilities in the study area. Table 1 depict the number of different public amenities in the different wards of Rohru municipal committee area.

Ward No. 1.

The ward comprised of 0.349 Km^2 of the total geographical area with a total population of 1261 persons. Dashalani village falls under this ward. Two educational institutes namely Government Primary school and Government senior secondary girl's school, Rohru are part of this ward (Figure 3).

Ward No. 2.

Total Geographical Area of ward 2 is 0.154 Km^2 with total population of 651 persons. The ward have two educational institutes' i.e. Saraswati Vidya Mandir and Saint Joseph School. Two offices namely Patwari office of Karalash Panchayat and Patwari office for MC are present here (Figure 3).

Ward No. 3.

Ward number 3 has total geographical area of 0.1206 Km^2 with Total Population of 1608. In terms of basic amenities there are three educational institutes namely Aradhna Public School Rohru Blue Bells school Rohru and Silver Bells School Rohru. Offices in the ward are MC office, IPH office, Fire station and Banking Facility such as HP state cooperative bank alongwith ATM State cooperative bank and ATM SBI. Health Institution (include Civil Hospital Rohru) and HP police Chowki (Figure 3).

Ward No. 4.

Ward number 4 comprised of total 0.6634 $Km^2$with total population of 1285. In terms of basic amenities there are two educational institute namely Seventh Day Advenist Mission School and Govt. Girls Sr. Sec. School Rohru. This ward include H. R. T. C. workshop office and one health institution namely Shanti Clinic situated near Samala village. Banking facility in the ward includes Camara bank and ICICI bank. This ward has one water storage and supply tank (Figure 3).

Ward No. 5.

Total Geographical Area of ward 2 is 0.0197 Km^2 with total population of 651 persons. This ward in situated near the central business district area that's why include mostly market area. There is no educational facility in this ward. Banking facility of the ward include UCO Bank, ATM UCO Bank and ATM ICICI Bank (Figure 3).

Ward No. 6

Ward number 6 comprised of total 0.6201 $Km^2$with total population of 1285. Total population of this ward is 992 persons. Two educational institutes namely Government Primary school Dashlani and Government senior secondary girl's school Rohru are part of this ward.Offices in the ward areBSNL Exchange, BDO office, SDM office, Court Complex Rohru and Post office Rohru. There are two ATM in the ward namely ATM Indian Post and ATM SBI. There is one private hospital (Roy Hospital Rohru) and two water storage and supply tanks in this ward (Figure 3).

Ward No. 7.

Ward number 7 has total geographical area of 0.2004 Km^2 with Total Population of

719. In terms of basic amenities there are three educational institutes namely Himalayan Public School, Glory International Public School and Govt. Polytechnic College. Offices in the ward are HPPWD office, HPPWD rest house, Patwari office (Barasli Panchayat) and Horticulture office Rohruand Banking Facility such as Axis bank, HDFC bank, PNB bank, ATM ICICI, ATM HDFC, ATM PNB, ATM Axis Bank. There is one ACC amusement park and also include ISBT Rohru (Figure 3).

Table 1

Number of Amenities in different wards of Rohru Municipal Committee

Wards	Primary School	High School/	Sr. sec. schools	College	Public water tap	Public sanitation	Hospital	Petrol Pump	Gas station	Park Play	Offices	Banking facility
Ward No 1	1	1	1	0	0	0	0	0	0	1	0	0
Ward No 2	0	1	2	0	1	1	0	0	0	1	2	0
Ward No 3	2	2	0	0	1	1	1	0	0	1	1	3
Ward No 4	1	2	1	1	1	0	1	1	0	1	4	0
Ward No 5	0	0	0	0	1	1	0	0	0	0	0	3
Ward No 6	1	1	1	0	0	0	0	0	0	1	5	2
Ward No 7	3	3	0	2	1	1	0	0	1	1	4	8
Surrounding areas	4	2	0	0	0	0	2	2	0	0	0	0
Total	12	12	5	3	5	4	4	3	1	6	16	16

Source: Compiled by authors using field survey.

Spatial Concentration

An idea about the extent of concentration of public facilities in different parts ofthe Municipal committee can be obtained if we consider thedistribution of population in our analysis. In this context the use of location quotient method could be helpful. This method can be used to measure the extent to which the public facilities in different wards in Municipal committee are in balance.

This quotient does not require extensive data collection and processing. It is a device for comparing a ward's percentage share of a particular facility with its percentage share of its population. The location quotient of different wards in Rohru Municipal Committee with respect to a particular facility will provide knowledge about the level of concentration of that facility in those wards.

For calculating the location quotient(L.Q.) for a particular facility i in a particular ward, the following formula has been used.

Table 2.

Percentage Distribution of Wards by Levels of Concentration of Public Facilities

Facilities	Level of Concentration			
	Above Average	Average	Below Average	Nill
Primary School	28.6	28.6	14.3	28.6
High School	28.6	28.6	0.0	42.9
Senior secondary schools	28.6	28.6	0.0	42.9
College	28.6	0.0	0.0	71.4
Public water tap	57.1	14.3	0.0	28.6
Public sanitation	42.9	14.3	0.0	42.9
Hospital	28.6	0.0	0.0	71.4
Petrol Pump	14.3	0.0	0.0	85.7
Gas station	14.3	0.0	0.0	85.7
Park Play	28.6	42.9	14.3	14.3
Government Offices	57.1	0.0	14.3	28.6
Banking facility	28.6	28.6	0.0	42.9

Source: Calculated by authors.

L.Q. = (n**i** / p) / (N**i** / P)
Where,
n**i** = number offacility i in a given ward,
p = population of the concerned ward,
N**i** = number of facility i in Municipal Committee Rohru,
P = total population of Municipal Committee Rohru.

The analysis indicates that proportion of wards with above average concentration is much higher for public tap and sanitation facility to other facilities. On the other hand, proportion of wards with below average or no concentration is much higher hospitals, parks, playgrounds, colleges, banking and other public amenities. This means that quite a large number of wards are highly deficient in these facilities.

Firstly Composite score (C.S.) for the amenities in the study area have been calculated using following formula:

$$\boldsymbol{C.S.} = \frac{\sum Zij}{N}$$

Where, $\sum Z_{ij}$ = Z scores of all indicators in ward j.
N = Number of Indicators.

Secondly on the basis of composite score, Z-score has also been calculated and used in the present study.

Zij = $Xij - \bar{x}$ $.d.$

Where,

Zij = Standard value of the indicator i in ward j.

xij = Actual value of indicator i in ward j.

$\overline{x}$ = Mean value of indicator i in all ward.

s.d = Standard deviation of indicator i in all ward

Table 3 represent the overall ward wise status of public amenity facility in the Rohru Municipal Committee area. Table shows that ward number 7 avail high levels of public amenity facility.Ward number 3, 4 and 6 witnessed moderate levels of public amenities while ward no 1,2 and 5 have registered low level of public facilities in the municipal committee Rohru.

Ward wise Urban Amenities and Land Use Land Cover

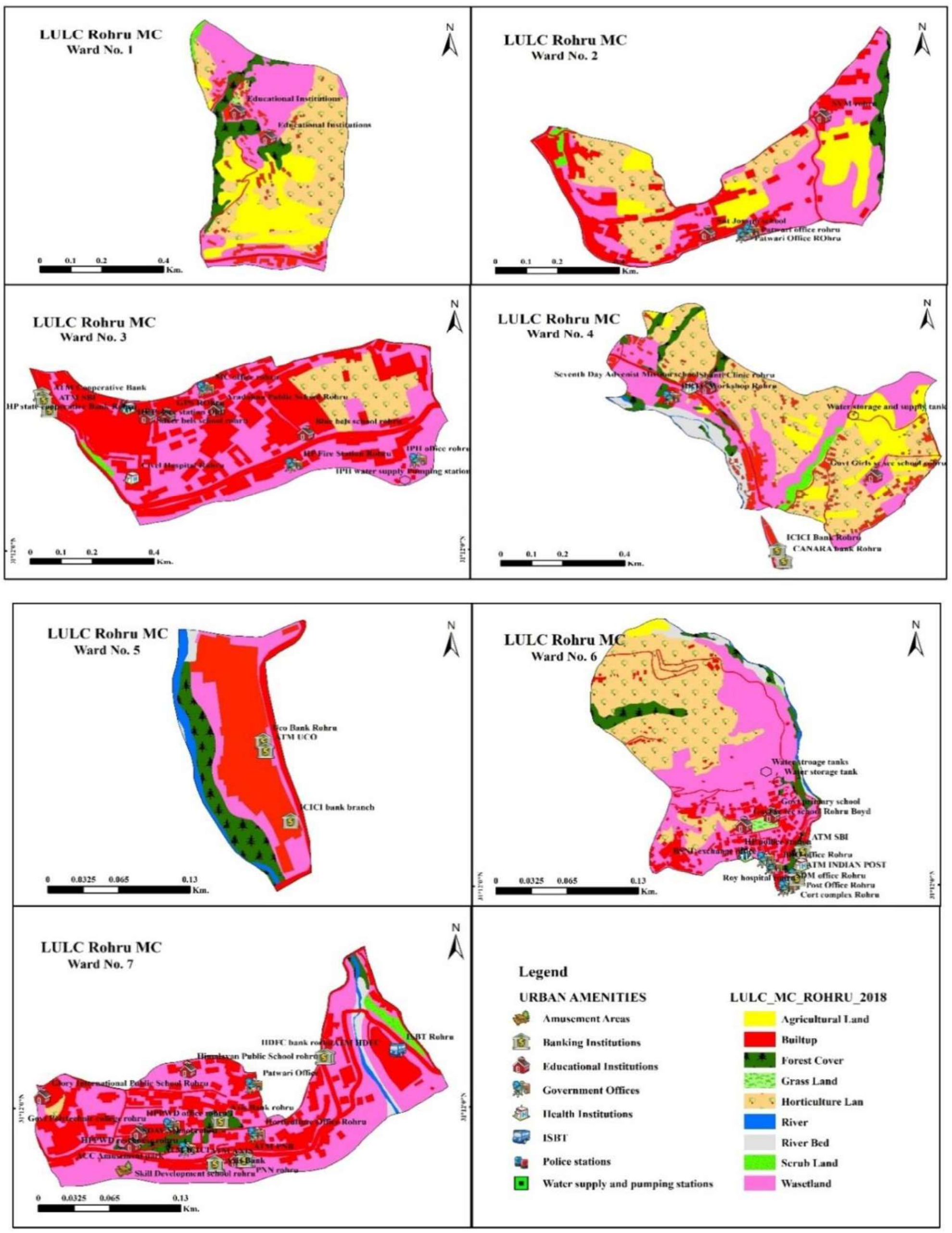

Figure 3

Table 3

Comparative analysis of wards with respect to public amenities

Ward number	Z-score	Overall Status
Ward No 1	-1.04738	Low
Ward No 2	-0.44888	Low
Ward No 3	0.14963	Moderate
Ward No 4	0.29925	Moderate
Ward No 5	-0.89776	Low
Ward No 6	0	Moderate
Ward No 7	1.94514	High

Source: Calculated by authors.

Land Use and Land Cover Change in Rohru Municipal Committee

Rohru Municipal Committee is located on the central-eastern part of the Rohru block. The total geographical area of this municipal corporation is 2.13 Km^2. Municipal corporation have seven wards.

Figures 4 portrays the spatial distribution of land use land cover pattern and the change occurred in land use land cover during 2010-2018 period of municipal committee. Figure and figure poetry the spatial distribution of land use land cover and change in the land cover during the 2010-2018 period. Land under net cultivated area recorded total of 40.38 per cent of the geographical area of municipal committee, out of which horticultural plantation land covers 26.29 per cent of the total cultivated area and 14.08 per cent of the area have been under agriculture in 2010. This figure decreased to 39.44 per cent in 2018 covering 30.52 percent of horticultural land and only 8.92 per cent of agriculture land. Land under horticulture recorded addition of 9 hector land during 2010-2018 period while agricultural land recorded decrease of 0.11hectare of land due because of agricultural land have been brought under plantation. Areas on the northern, western, central, eastern and small patches on western parts of the panchayat have observed area under net cultivation. Apple is the most grown fruit in the study area. Other than apple cultivation peoples are also cultivate Apricot, Pear, Peach, Plum etc. Multi-cropping farming methods is also prevailed in which Peas, Mustard, Potato, Cabbage, Corn Tomato, Coriander, *Joo*, etc. are also being cultivated along with the Apple plantation.

Settlements, roads and other permanent construction that is not available for cultivation account for 16.90 per cent of the area of study area in 2010. This figure increased to 20.19 per cent in 2018. Major settlements cluster have been observed on the central part along the Shikdi Khad and on the old river terraces of Pubber River on the southern half of the Municipal committee other than that there have random and dispersed settlements distribution.

Barren and uncultivated land including wasteland recorded total of 35.68 per cent share in the total area of Rohru Municipal committee in 2010 which decreased to only 34.27 per cent in 2018. Two hectare of wasteland have been brought under cultivation and other uses in eight year period from 2010 to 2018. Most of the wasteland have been observed on southern half, north-western and north eastern parts of the study area.

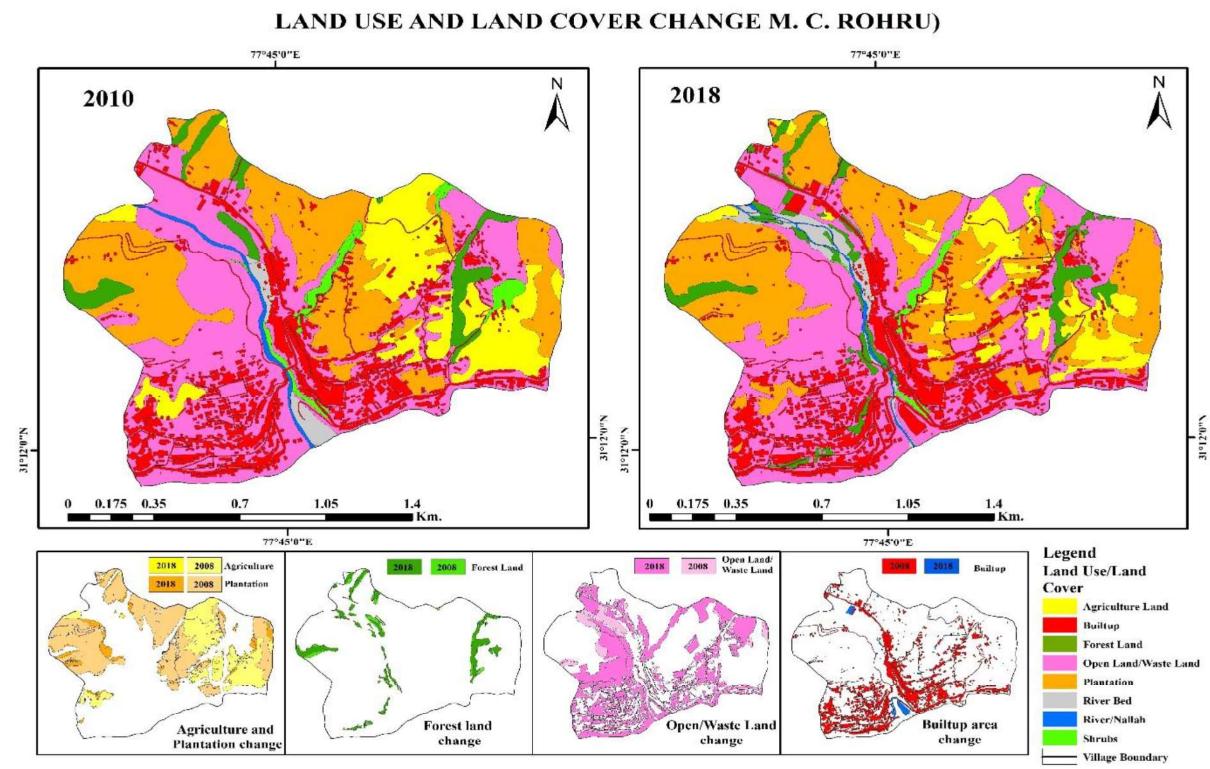

Figure 4

Table 1

Land and Use and Land Cover Change of Municipal committee

(2010 -2018) (Area in Sq. Km.)

Sr. No	Year	Total Geo Area	Land Not Use For Cultivation (Waste land)	Net cultivated area		Permanent Pasture and Grazing land		Area under forest Cover		Built up area
				Horticulture	Agriculture	Grass land	Scrub land	Dense forest	Open forest	
1	**2018**	2.13	0.73	0.65	0.19	0	0.02	0.11	0	0.43
2	**2010**	2.13	0.76	0.56	0.30	0	0.05	0.09	0	0.36

Source: Compiled by authors using LULC layer generated using Satellite images and google earth images.

The permanent pasture and grazing land including scrubland recorded only 0.94 per cent of the total geographical area in 2010 which decreased to 0.35 per cent in 2018. A very small proportion of grazing and pasture land have been witnessed on the central part of the study area covering sloppy areas of Didi Gad area. Area under permanent forest cover have witnessed a little increase in the Rohru Municipal committee. In 2010 near about 4.23 per cent of total geographical area the study area have been witnessed under permanent forest cover. This figure increased to 5.16 per cent in 2018. Total of 2 hectare of dense forest have added during the eight year period in the Municipal committee area.

Conclusions

The study contributed toward an efficient mapping of urban amenities of Rohru Municipal Committee using primary GPS base field survey. Spatial Concentrationof the public amenities have been calculated using location quotient and it shows that public drinking water facility and publicsanitation facility have much higher concentration than other amenities. In terms of the overall amenities facility ward number 7 avail high levels of public amenities while ward number 3, 4 and 6 witnessed moderate levels of public amenities.Land use and land cover map of Rohru Municipal Committee based on high resolution satellite based images and google based imageries have been extracted for two time period i.e. 2010 and 2018 which shows changing pattern within the small time period i.e. eight years. The study analysed that people are shifting from traditional agricultural practices towards commercial crops (Apple orchard plantation). Forest cover within the municipal committee area have witnessed an increase during the study period. New construction of houses have been observed in the study area but people are shifting from the core city area to the peripheral areas of Rohru municipal committee.

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Spatial Data Infrastructure and Standards

Karabi Mukherjee, Vivek Saxena, Vipin Kumar and Sneha Bagde

Abstract

An approach for creation of a Spatial Data Infrastructure (SDI) for defence specific functionalities are presented in this paper. This paper introduced a way to implement SDI for the specific use of Defence Personnel/ stakeholders. Its web based architecture solely based on open geospatial standards. Data management, discovery, delivery, analysis and processing are the key functionalities of this SDI.

Spatial Data Infrastructure (SDI) is a conglomeration of geospatial data, software, hardware, networking, standards, various units/sub units of different organizations and their people. Its architecture and design facilitate people to capture, store, discover, publish, visualize, analyse the geographic data. Its software components are Geographic Information System (GIS) application server, backend spatial/geo database, a frontend application which will work in a client server mode or in web environment over Internet or Intranet. SDI can be established by using Free and Open Source for Geo-spatial (FOSS4G) software or Commercial of the Shelf (COTS) software.

There are two types of geospatial data namely raster file like image, DEM, slope map etc. presented as regular grid and vector file like road, river, land use, land cover, spot height which are presented as point, line and polygon.

Standards play an important role in SDI. Standards should be open and interoperable for free exchange of data between different clients. The SDI which serves spatial data through web works on Open Geospatial Consortium (OGC) standards. Data exchange formats through web can be XML, GeoJSON, CSV, GML, KML. Input vector data can be any OGR format and raster data can be any GDAL format.

Application GIS software can be Arc GIS server, Geo server, Map server while spatial database can be Oracle spatial, PostgreSQL with PostGIS. Front end application can be QGIS, GRASS, UDIG, customized application developed in OpenLayers or Leaflet. For 3D visualisation & analysis; Cesium globe, Terra Explorer can be utilized.

There are many different SDI existing in the world for varied uses and applications like defence, government, agricultural, forestry, location based services. Depending on the application of SDI, network security should be implemented and various components of this are physical security (NIPS, Firewall) and software level security like multi factor authentication, encryption of data, session management, authorization and data integrity. At DGRE, we are working to develop SDI which will serve the Geospatial data to all the stake holders of the organisation.

Keywords: GIS, interoperable, FOSS, SDI, OGC.

I. **Introduction**

In recent years, with the rapid development of low cost hardware (computer, mobile, PDA, Workstation, Server), network technology and availability of Internet to common users; web services has been applied in all the fields of computer automation application and so is the case of Geographic Information System (GIS). More and more GIS application change from Client/Server (C/S) architecture to Browser/Server to become WebGIS systems [1]. Using web services, now days GIS connects multiple data sources and shares heterogeneous spatial data among all users. Data services can be seen as a kind of spatial databases' middleware extension [2]. A number of open source or proprietary technologies/software are available for publishing and processing geospatial data online but using them together for building various SDI blocks, often requires either to pre-process geo-spatial data or to adopt a loosely coupled approach which may lead to develop custom source code [3].

II. **Literature Survey**

Relevant Technologies and Knowledge

A. GIS technology

GIS is an Information System for creating, maintaining, managing and using Geographic knowledge. GIS is a complete platform for working (editing, data management, mapping, spatial analysis and visualization) with Geographic Information. Development of a GIS requires amalgamation of many disciplines like computer science, geography, mathematics and domain knowledge of GIS application area. GIS was a tool for individual projects and departments in the past but in recent years GIS has moved very swiftly from being a tool to become the framework for sharing information among organization and across society [4].

B. SDI

An organization typically develops some, but not all, of its own spatial data content. At least some of the layers will be from external sources. Thus GIS data management, by its very nature, is distributed among many users (ESRI. March 2003). GIS requires a distributed information system concept to manage and share spatial data. Because GIS users are hungry for quality geographic information, there is a fundamental need for users to share their data.

A spatial data infrastructure (SDI) is a data infrastructure implementing a framework of geographic data, metadata, users and tools that are interactively connected in order to use spatial data in an efficient and flexible way. Another definition of SDI is "the technology, policies, standards, human resources and related activities necessary to acquire, process, distribute, use, maintain, and preserve spatial data" [5].

"An SDI is a coordinated series of agreements on technology standards, institutional arrangements, and policies that enable the discovery and use of geospatial information by users and for purposes other than those it was created for" [6].

C. Geospatial Data

Geographic data and information is defined in the ISO/TC 211 series of standards as data and information having an implicit or explicit association with a location relative to Earth. It is also called geospatial data and information, georeferenced data and information, as well as geodata and geoinformation [9]. The ISO 19157 standard can be used to assure the geo-spatial data quality.

D. Web Services

Web Services are software applications with URI (Universal Resource Identifier), its interface and binding can be defined, described and discovered by XML documents [2]. It uses XML based message to interact with other software directly through Internet protocols.

E. Web GIS

As a combination of traditional technology and Internet technology(WWW), relying on the Internet, integrating World Wide Web network function, Web GIS realizes global GIS services and data sharing and truly becomes a popular and practical tool[2]. Protocols and standards associated with the web services mainly include SOAP (Simple Object based Protocol), WSDL (Web Service Description Language), UDDI (Universal Description Discovery and Integration) etc.

F. Metadata

Metadata is defined as data about data. Metadata is very important in a SDI for sharing of geospatial data/information. The metadata is used to describe geographic data set's content, quality, representation, spatial reference, management methods as well as other characteristics of data sets which is the core criteria to achieve geospatial information sharing [2]. The ISO 19115 standard defines the attributes kept for maintaining the meta data.

G. Geospatial Database

Spatial database sits at the backend of a SDI which stores the raster, vector and meta data. Its internal structure and complexity have been hided from the application users.

H. Open Source Technologies

Open source geospatial software are very useful components to build a SDI. These software can be used to customize for building an integrated application GIS tool which is the core component of a SDI. There are many software like Geoserver, Mapserver as GIS application server. QGIS, GRASS, uDIG and Mapwindow GIS etc. can act like client application. Openlayer and Leaflet can be used for developing browser based client application. PostgreSQL with spatial extension (Post GIS) is an open source DBMS application which can manages the geospatial data in a SDI. Apache Tomcat can be used as an open source web server software.

I. Service Oriented Architecture (SOA)

SOA is a paradigm for application development. SOA approach helps to make applications flexible as well as scalable. SOA philosophy maintains flexibility in large distributed systems by supporting the application's heterogenity and the the scope of decentralization [8].

Interaction among services in SOA paradigm works in this manner

i. A service provider registers its services in the service registry managed by the broker.

ii. The service is registered accordingly in registry as per its category.

Iii. Service requestor looks up for services in the registry

iv. Service consumer binds itself to the service provider and uses the service.

Geospatial interaction among interoperable distributed application functionalities in SDI is best presented by SOA paradigm.

J. Geospatial Standards

A standard is a documented agreement between providers and consumers, established by consensus, that provides rules, guidelines, or characteristics ensuring materials, products, and services are fit for purpose [7].

There are three key international organizations which have the objective of developing standards for geospatial information:

- The International Organization for Standardization (ISO) Technical Committee 211 Geographic information/Geomatics;
- The Open Geospatial Consortium (OGC);
- The International Hydrographic Organization (IHO).

There are two key types of geospatial standards: information (or content) standards and technology (interface, API standards.

The following modified definitions of these two key types of standards are from the GeoConnections website of the Government of Canada [7].

- “Geospatial information standards provide a digital encoding to locate and describe features on, above or below the Earth’s surface. Geographically-related features can be naturally occurring (for example: rivers, rock formations, coastlines), man-made (for example: dams, buildings, radio towers, roads) or intrinsic, implied and transient information (for example: political boundaries, electoral districts, weather systems, distribution of population ethnicity) [7].

- Technology standards allow different systems and services to work together through standard interfaces [7]. Ideally, when the standards are implemented in products or online services independently, the resulting components ‘plug-and-play’, that is, they work together seamlessly.”

III. **SDI Architecture**

At DGRE, there is an initiative to create a SDI for specific military functionalities deployed over closed intranet environment.

A web application provides the personnel of a services formations access to defined products. The application provides it’s logged in clients, to access the geospatial data. Depending on the rights and roles assigned; clients can visualize, edit, download, publish, and view graphical summary of geospatial data. The application supports the spatial query as well as attribute query, image processing (change detection, image enhancement, pan sharpening), shortest path finding(both on road and off road). The application has a spatial database for hosting raster and vector data at the backend to support. SDI enables the users of an organization to discover, analyse, visualise and terrain fly through over/using geospatial data on a single platform of web browser running on desktop/handheld device or any other computing device capable of supporting WWW over browser. The development of software is based upon OGC standards (WMS, WFS, WPS, CSW etc.). This application is being developed using free and open sources geospatial (FOOS4G) technology and the web based architecture is solely based on open geospatial standards.

Software development Stack: It is a 4 Tier Web application.

- Database – PostgreSQL
- Spatial Extension – PostGIS
- LDAP – Open LDAP/ Apache DS
- GIS Application Server – Geoserver
- Frontend – OpenLayers, Leaflet
- Webserver – Apache Webserver
- Web Services – Java/J2EE
- Cache – GWC
- Desktop GIS Client – QGIS
- Cesium Globe- For 3D GIS
- Server OS -CentOS
- Programming Language – Java
- Browser- Mozilla, Google Chrome
- Scripting Language- JavaScript
- Data Exchange Format – XML, GeoJSON, CSV, GML, KML, text

The Architecture diagram depicted in figure 1 shows the logical view of data flow among the various blocks of the SDI.

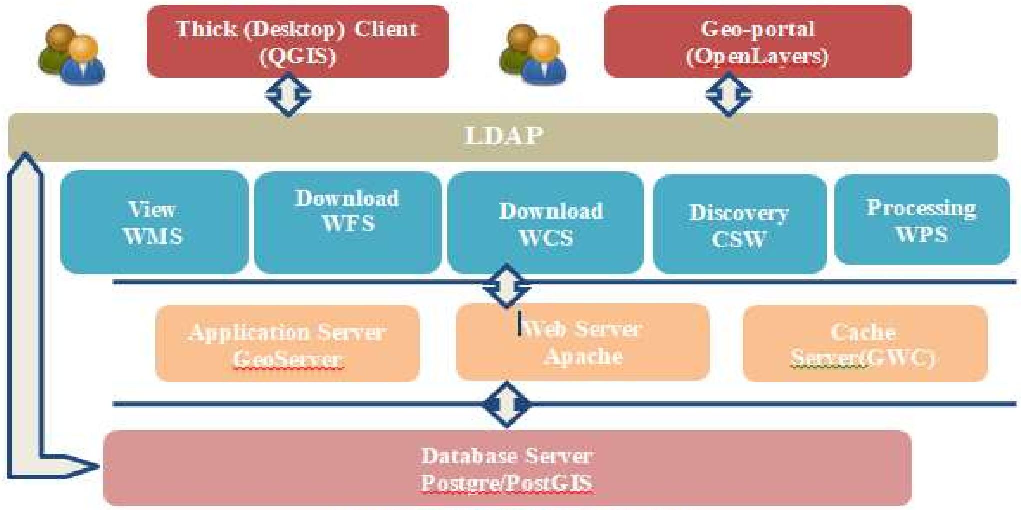
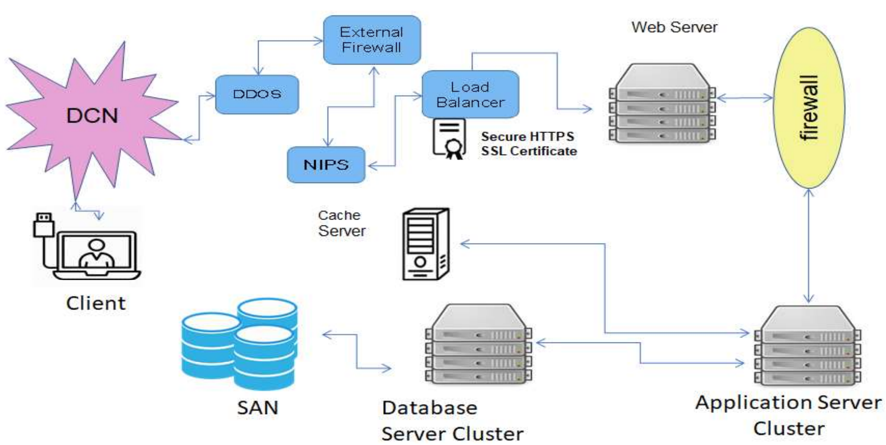


Figure 1 Architecture Diagram

The Infrastructure is composed of Web Server, Application Server, Cache Server and Database Server. Clints can remotely access the services through a web browser. Depending on their authentication and authorization clients can use the portal for publishing, visualization and analysis of spatial data.

Hardware configuration for deployment:



Figutre 2: Deployment of the SDI

High reliability, fast processing of queries, spatial operations, batch actions, and easy control for the end user are to be ensured for all simultaneous users. Various security features like User Identity, Authentication, Session Management, Interpreter Injection, Authorization, Exchange of Sensitive Data, User Attribute Definition, Verification of Secrets, Data Integrity, Data Validation are also been taken care and integrated. Figure 2 depicts a schematic for hardware configuration of deployed scenario.

As security of the data and system is great concern of the management of the SDI, software security is applied to the most of the SDI resources by providing a user management system according which users can read, write and execute at many different levels. For preventing attacks through network, network security stack is placed in the deployment of the SDI by providing firewall, Network Intrusion Protection System (NIPS).

Conclusion: Geographically distributed large organisation which deals with various kind of geo-spatial data and consumed by different applications(terrain visualisation, spatial/attribute query, descriptive summary, predictive analysis etc) of their deptt./ units/ sub units of various cluster of the organisation needs a solution based on SDI.

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History and Development of Cartography

Ashwani Kumar and Seema

Abstract

Cartography is the study of maps and map-making. Cartography can be concisely and classically defined as "the art, science and technology of making maps". The popular associations of the word, with techniques of map making are a reflection of its lexical routes in cart (French for map) and graffiti (Greek for writing). Cartography is thus a science and art of designing, constructing and producing maps. It includes almost every operation from original field-work to collect data to final printing and marketing of maps. A map, as defined by the International Cartographic Association (2009), is 'a symbolized image of geographical reality, representing selected features or characteristics, resulting from the creative effort of its author's execution of choices, and is designed for use when spatial relationships are of primary relevance'.

Cartography, or map-making, has been an integral part of the human history, possibly up to 8,000 years. From cave paintings to ancient maps of Babylon, Greece, and Asia, through the Age of Exploration, and on into the 21st century, people have created and used maps as essential tools to help them define, explain, and navigate their way through the world. Maps began as two-dimensional drawings but can also adopt three-dimensional shapes (globes, models) and be stored in purely numerical forms. The earliest known maps are of the heavens, not the earth. Dots dating to 16,500 BC found on the walls of the Lascaux caves map out part of the night sky, including the three bright stars Vega, Deneb, and Altair (the Summer Triangle asterism), as well as the Pleiades star cluster. In contrast, the Babylonian World Map, the earliest surviving map of the world (600 BC), is a symbolic, not a literal representation. It deliberately omits peoples such as the Persians and Egyptians, who were well known to the Babylonians. The area shown is depicted as a circular shape surrounded by water, which fits the religious image of the world in which the Babylonians believed. In classical antiquity, maps were drawn by Anaximander, Hecataeus of Miletus, Herodotus, Eratosthenes, and Ptolemy using both observations by explorers and a mathematical approach. Map construction has been the main concern of cartography since 2500 B.C. when Babylonian cuneiform clay tablets were produced. Ptolemy's book Geographia (150 A.D) helped spark European exploration of the world from about 1500 to 1700, and a new spurt in the production of maps based on the data acquired from these explorations. In cartography, technology has continually changed in order to meet the demands of new generations of mapmakers and map users. The first maps were manually constructed with brushes and parchment; therefore, varied in quality and were limited in distribution. The advent of magnetic devices, such as the compass and much later, magnetic storage devices allowed for the creation of far more accurate maps and the ability to store and manipulate them digitally. The present paper described the history and development of cartography.

Keywords: Cartography; History of Cartography; Development; Map Making; Computer Cartography

Introduction

Cartography can be easily defined as “the art, science and technology of making maps”. The popular associations of the word, with techniques of map making are a reflection of its lexical routes in cart (French for map) and graffiti (Greek for writing). Cartography is “the science of construction maps and charts. It includes the making of original surveys, the selection of suitable map projections and decisions on colors, layer tinting and other visual representations”(J. Smith, 1984).

According to the International Cartographic Association (2009), A map is ‘a symbolized image of geographical reality, representing selected features or characteristics, resulting from the creative effort of its author's execution of choices, and is designed for use when spatial relationships are of primary relevance’. Cartography is generally described as a meeting place of sciences and art. As a discipline of map making, cartography is definitely a science which has its own individuality. In fact it is a science with artistic learning. Cartography involves making of maps, globes, diagrams, charts, models etc.

Cartography, or map-making, has been an integral part of the human history, excavations of Harappa and Mohenjodaro give ample evidence of man’s ability to make and use maps of small areas. Indian scholars knew the cartographic technique some 4000 years ago. From cave paintings to ancient maps of Babylon, Greece, and Asia, through the Age of Exploration, and on into the 21st century, people have created and used maps as essential tools to help them define, explain, and navigate their way through the world. Maps began as two-dimensional drawings but can also adopt three-dimensional shapes (globes, models) and be stored in purely numerical forms. The earliest known maps are of the heavens, not the earth. Dots dating to 16,500 BC found on the walls of the Lascaux caves map out part of the night sky, including the three bright stars Vega, Deneb, and Altair (the Summer Triangle asterism), as well as the Pleiades star cluster. In contrast, the Babylonian World Map, the earliest surviving map of the world (600 BC), is a symbolic, not a literal representation. It deliberately omits peoples such as the Persians and Egyptians, who were well known to the Babylonians. The area shown is depicted as a circular shape surrounded by water, which fits the religious image of the world in which the Babylonians believed. In classical antiquity, maps were drawn by Anaximander, Hecataeus of Miletus, Herodotus, Eratosthenes, and Ptolemy using both observations by explorers and a mathematical approach. Map construction has been the main concern of cartography since 2500 B.C. when Babylonian cuneiform clay tablets were produced. Ptolemy's book Geographia (150 A.D) helped spark European exploration of the world from about 1500 to 1700, and a new spurt in the production of maps based on the data acquired from these explorations. Cartography, or mapmaking, has been an integral part of the human history for a long time, possibly up to 8,000 years. From cave paintings to ancient maps of Babylon, Greece, and Asia, through the Age of Exploration, and on into the 21st century, people have created and used maps as essential tools to help them define, explain, and navigate their way through the world. Maps began as two-dimensional drawings but can also adopt three-dimensional shapes (globes, models) and be stored in purely numerical forms. In cartography, technology has continually changed in order to meet the demands of new generations of mapmakers and map users. The first maps were manually constructed with brushes and parchment; therefore, varied in quality and were limited in distribution. The advent of magnetic devices, such as the compass and much later, magnetic storage devices allowed for the creation of far more accurate maps and the ability to store and manipulate them digitally. The rapid evolution of computer and digital technology continues to change the role of cartographers and the various processes of contemporary mapmaking.

Objectives of the Present Study

Maps can be seen as the bridge between a human user and big database. In this respect, cartography and maps plays a dominant role. Maps are most efficient in enabling human users to understand complex situations. Cartography is most relevant science for every human. **Without maps, we would be "spatially blind."** Knowledge about spatial relations and location of objects are most important for enabling economic development, for managing and administering land, for handling disasters and crisis situations, or simply to be able to make decisions on a personal scale on where and how to go to a particular place. Maps and other cartographic products are very attractive. The prime objective of the study is to understand and described the history and development of the cartography from the beginning.

History and Development of Cartography

Maps are central to the human experience and mapmaking is a major social achievement. In many ways, the history of maps and mapmaking is the history of human society (Erwin Raisz, 1962). The dynamic potential of maps to communicate perceptions, ideologies, and legends, offers a visual history of societies and cultures. Although much can be gained by viewing the figurative depictions on maps, to truly understand them one must be cognizant of the cultural context in which they were generated.

The Babylonians were the first to give a thought to the shape and size of the earth and they believed that the earth was flat and circular and was surrounded by sea and heavens. The oldest known map is Babylonian in origin and dates from about 2300 B.C. In addition, various pictorials of land features have been found with Egyptian artifacts from around the same period. It is notable that both of the areas depicted were river valleys and that knowing the intricacies of the geography would provide vital information for sustainable communities. Maps from later periods show plans for the construction of canals, roads, and places of worship. These were the predecessors of modern city planning and engineering maps.

While cosmography, the science of mapping the shape of the entire known world, was not heavily practiced until the time of the ancient Greeks, archeological studies in Iraq have uncovered a map dating from 1000 B.C. that shows Earth as a concentric circle with Babylon at the center of it, surrounded on all sides by water. However, there is little additional evidence that the Egyptians or Babylonians attempted to depict the entire planet and their place within it. Rather, their cartographic endeavors focused on pursuits of a more practical nature. They were more concerned with mapping fertile areas, regions with exceptional game, or their own boundaries. It would not be until the Greek philosopher-geographers began to speculate on the nature and shape of Earth that mapmakers attempted to map not only their surroundings, but also the entire world. On the basis of existing knowledge about the historical development of cartography, following 2 stages may roughly be marked:

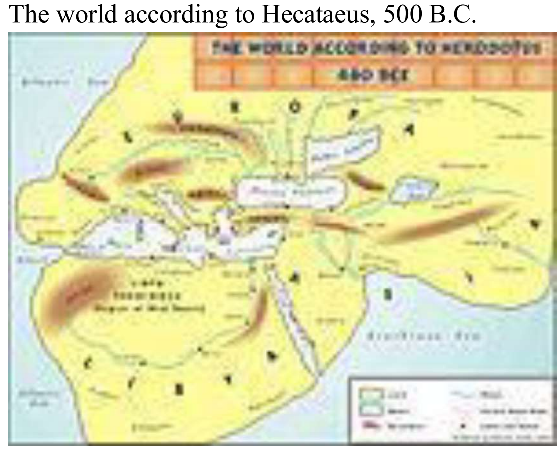
(1) Ancient Period

Contribution of European Scholars

The Greeks made the greatest early contributions to mapmaking through their systematic scientific pursuit of geography. Among the major achievements of the Greek geographers were recognition of the earth as a spheroid with its poles, equator and tropics, the division of earth into climatic zones, development of graticule and calculation of the size of the earth. They were the first to develop map projections which are so essential for making maps. Aristotle, Anaximander, Hecataeus, Herodotus, Eratosthenes, Hipparchus, Ptolomy etc. were the main architects of Greek cartography. This was somewhat motivated by need because they lacked productive soil for agriculture. This need led to colonization and the establishment of trade, primarily through navigable sea routes that needed to be charted. The city of Miletus was considered to be the center of cartographic knowledge and speculation around 600 B.C. **Anaximander**is considerd to be the first maker of the world map**. Hecataeus** (sixth-fifth century B.C.) made the first known geography book in about 500 B.C. In his book he speculated that the world was a flat disk surrounded by a great ocean. This book was later modified and expanded by the great historian Herodotus. The map drawn by Herodotus was more accurate than that drawn by Anaximander. His map included larger part of Europe adjoining the Mediterranean sea, Asia and Africa map. He added a significant amount of new information regarding the geography of the known world and even extended into the realm of the unknown by predicting the natural features of unfamiliar lands. Herodotus also questioned the idea that the Earth was a flat disk and proposed several different theories regarding its actual shape, including one that supported the theory that Pythagoras put forward that the world was a sphere. By 350 it was commonly accepted by Greek scholars that Earth was

in fact a sphere. Aristotle strongly argued this point and presented six lines of reasoning to demonstrate the world was shaped like an orb. Nearly all subsequent cartographers generally accepted this idea.

The world according to Hecataeus, 500 B.C.

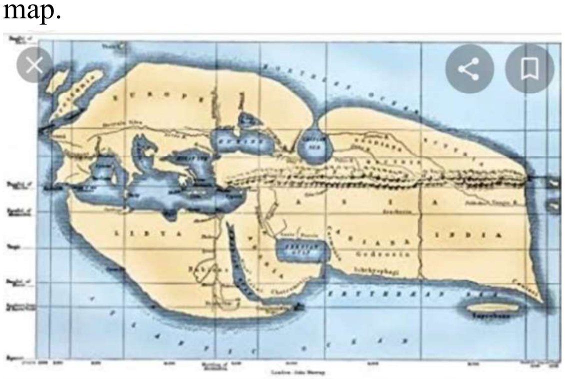


The world according to Herodotus, 440 B.C.

Dicaearchus of Messina, who was a follower of Aristotle, made significant contributions in this area. He was the first cartographer to place reference lines on world maps. He placed one running in an east-west direction and passing through Gibraltar and Rhodes. This had a significant influence on others and eventually led to the development of longitude and latitude.

The next significant Greek figure in cartography was Eratosthenes of Cyrene, the first person to reasonably estimate Earth's circumference. He realized that the Sun was very distant from Earth and that by using the angle by which the sunrays fell on two different cities of a known distance apart, he could estimate Earth's circumference. Eratosthenes made other contributions as well. He improved upon the reference lines of Dicaearchus and provided much scientific thought in other areas.

Hipparchus was a contemporary of Eratosthenes and was often quite critical of his work. The major contribution of Hipparchus was to apply rigorous mathematical principles to the field of cartography. He used trigonometry to help determine locations on Earth's surface and extended the reference lines of Dicaearchus to specify longitude and latitude as it is still used today. He attempted to measure latitude by using the ratio of the longest to shortest day for a particular area. Hipparchus was also the first person to partition the known inhabited world into climatic zones on a map.



World Map of Eratosthenes

Certainly the greatest and most important cartographer from the ancient world was **Ptolemy**. Ptolemy was a great scientist who wrote one of the most influential scientific works of all time, *The Guide to Geography*. This eight-volume work dealt with the basic principles of map and globe construction, locations of various cities, theories of mathematical geography, and instructions for preparing maps of the worlds. Interestingly enough, this work had little initial influence, as it was largely forgotten and not rediscovered until 1,400 years later. The maps and directions were often crude approximations from discussions with travelers, but they were accurate enough to show relative locations and direction. Ptolemy also contributed to the mathematical aspect of cartography as well as many other areas of science. Ptolemy revolutionized the depiction of the spherical earth on a map by using perspective projection, and suggested precise methods for fixing the position of geographic features on its surface using a coordinate system with parallels of latitude and meridians of longitude.

World Map of Ptolomy

After Ptolemy, there seems to be stagnation in the science of mapmaking.

Romans prepared maps with the primary object of serving military and administrative purposes. Their maps were dominated by locations of battle fields and road networks.

The early explorers such as Christopher Columbus (1451-1506), Ferdinand Magellan (1521), and Americus Vespucci (1454-1512) used Ptolemy's map as a guide for their voyages. While the map was as accurate as it could be for the time that it was produced, it was still grossly inadequate in many areas. For instance, it greatly exaggerated the combined size of Europe and Asia, while underestimating the size of Earth. This was a critical mistake that strengthened the idea that Columbus could reach Asia by traveling westward and actually led him to underestimate the distance to Asia as he set out across the Atlantic on his first voyage. Ptolemy's influence even extended into the Southern hemisphere, where his idea that a great southern continent existed was perpetuated for many years. It was not until 1775 and many voyages when James Cook (1728-1779) demonstrated that it did not exist. Thus, Ptolemy helped to spur the age of exploration.

In 1507, Martin Waldseemuller produced a globular world map and a large 12-panel world wall map (Universalis Cosmographia) bearing the first use of the name "America". Portuguese cartographer Diego Ribero was the author of the first known planisphere with a graduated Equator (1527). Italian cartographer Battista Agnese produced at least 71 manuscript atlases of sea charts. Due to the sheer physical difficulties inherent in cartography, map-makers frequently lifted material from earlier works without giving credit to the original cartographer. For example, one of the most famous early maps of North America is unofficially known as the "Beaver Map", published in 1715 by Herman Moll. This map is an exact reproduction of a 1698 work by Nicolas de Fer. De Fer in turn had copied images that were first printed in books by Louis Hennepin, published in 1697, and François Du Creux, in 1664.

A pre-Mercator nautical chart of 1571, from Portuguese cartographer Fernão Vaz Dourado (c. 1520–c. 1580). It belongs to the so-called plane chart model, where observed latitudes and magnetic directions are plotted directly into the plane, with a constant scale, as if the Earth were a plane (Portuguese National Archives of Torre do Tombo, Lisbon).

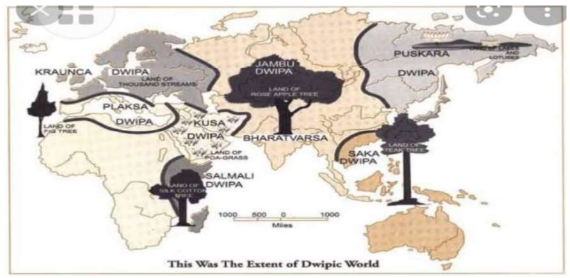
The 'Golden Age of Cartography', spanning 1570 to 1670, marked an era of successful navigation and empire expansion by the major European nation states. Much of the cartographic development during this period is attributed to the vast empire expansions to the new world and the subsequent need for more accurate navigational charts and maritime maps. Gerardus Mercator became the leading 16th century cartographer with his 1569 published world map, *Terrae Descriptio ad Usum Navigatium Emendate*. The circulation of his maps among the Portuguese, Spanish, and English was seen as one of the primary reasons for the successful navigation between Europe and the new world by prominent figures such as English privateer, Sir Francis Drake (Arthur R, 1978).

Contribution of Chinese Scholars:

In ancient China, geographical literature spans back to the 5th century B.C. Pei Hsiu (224-273 A.D.) is known as the 'father of the Chinese cartography'. He gave several basic principles of cartography such as relative locations of places, direction, distances on the maps, marking undulating land etc. The oldest extant Chinese maps come from the State of Qin, dated back to the 4th century B.C, during the Warring States period. In the book of the Xin Yi Xiang Fa Yao, published in 1092 by the Chinese scientist Su Song, a star map on the equidistant cylindrical projection. Although this method of charting seems to have existed in China even prior to this publication and scientist, the greatest significance of the star maps by Su Song is that they represent the oldest existent star maps in printed form.

Contribution of Indian Scholars:

Indian scholars had reasonably good knowledge of the earth, the sun, the moon, constellations and other heavenly bodies. The foundation of the Indian cartography was laid during the Vedic Period when general expressions of astronomical truths and cosmological revelations were made. The work of great astronomers like Arya Bhatta, Varahamihira, Bhaskara and many others added much to the astronomical knowledge and gave rise to classical treatises. Some of the discoveries by the western scholars were known to Indian scholars several hundred years before. For example, Arya Bhatta discovered the relative movement of the earth and the sun at-least thousand years before Capernicus. Bhaskara calculated the circumference of the earth to be 39,967 kms. diameter 12,722 kms. and the surface area 1,02,64,83,950 sq. kms.



Dwips of the World as known to Ancient Indians

These calculations are very accurate when compared with actual estimates. It appears that ancient Indians had a fairly good knowledge of the world. The whole of the known world, comprising Europe, Asia and Africa was divided inti 7 dwips or regions. These are: (1) Jambu Dwipa (2) Plaksa Dwipa (3) Salmali Dwipa (4) Kusa Dwipa (5) Kraucha Dwipa (6) Saka Dwipa and (7) Puskara Dwipa.

Maps from the Ain-e-Akbari, a Mughal document detailing India's history and traditions, contain references to locations indicated in earlier Indian cartographic traditions. Another map describing the kingdom of Nepal, four feet in length and about two and a half feet in breadth, was presented to Warren Hastings. In this map the mountains were elevated above the surface, and several geographical elements were indicated in different colors.

(2) Modern Period:

Cartography witnessed unprecedented progress during the 20th century, i.e. after 1900 A.D. this can be judged from the fact that the number of maps made since 1900 A.D. is greater than the production during all previous times, even if we do not count the many millions made for the military purposes. During the last few decades revolutionary changes have taken place in cartographic processes. Remote Sensing, with the help of artificial satellites equipped with powerful cameras and attendant manipulative techniques enable us to get real picture of the earth surface showing not only the location, colour and pattern of the objects focused on but also elevation and slope. Once these imageries become available, they can be used straight as a picture or converted into maps using computer programmes.

Much of cartography, especially at the data-gathering survey level, has been subsumed by Geographic Information Systems (GIS). The functionality of maps has been greatly advanced by technology simplifying the superimposition of spatially located variables onto existing geographical maps. The rapid evolution of computer and digital technology continues to change the role of cartographers and the various processes of contemporary mapmaking. With the popular emergence of programmes such as Google Earth, where a specific location anywhere in the world is quickly accessed and viewed via the internet, it is reasonable assumption that the future of GIS will also employ the technology of Global Positioning Systems (GPS). The course of any contemporary human life is now depicted through the abstraction of maps. With the development and use of modern techniques as described above we can say that modern cartography is as different from the map making of 50 years ago as is the automobile from the horse and buggy. Nowadays the concept of map becomes more and more associated in minds of people with display on a computer screen rather than something printed on paper. This applies not only to professionals in analysis of spatial information but even to ordinary public. Thus, route planners gradually substitute street atlases in planning journeys. Lots of people use numerous map-based services available in the Internet. Not only the use of computer maps increases: map creation becomes a part of professional activities of more and more specialists in different occupation areas. The traditional practice when maps are designed by expert cartographers and distributed for public use no more satisfies current needs. Analysts, planners, decision makers require rapid visualization of the most actual information in a form suited for purposes of the moment. Hence, computer technologies offer new expressive means and enhance capabilities of traditional cartographic techniques. The opportunities for mapping offered by modern computers are tremendous: practically unlimited number of available colours, very high resolution of graphical displays, software supporting generation of realistic 3-dimensional scenes, dynamic views (animation), user interaction with displays, dynamic display transformation, interlinking of multiple views, etc. All this is available even on standard personal computers while more complex and powerful equipment can further enhance some of these features. Due to these new opportunities computer maps acquire completely new properties as compared to their paper predecessors, and this necessitates development of new principles of cartography.

Conclusion:

Cartography is an art and science of map making and map is a carefully designed for recording. Calculating, displaying, analyzing and, in general understanding the interrelation of things in their spatial relationship. History of cartography is as old as history of civilization. Cartography, or map-making, has been an integral part of the human history, excavations of Harappa and Mohenjodaro give ample evidence of man's ability to make and use maps of small areas. Indian scholars knew the cartographic technique some 4000 years ago. From cave paintings to ancient maps of Babylon, Greece, and Asia, through the Age of Exploration, and on into the 21st century, people have created and used maps as essential tools to help them define, explain, and navigate their way through the world. Nowadays the concept of map becomes more and more associated in minds of people with display on a computer screen rather than something printed on paper. This applies not only to professionals in analysis of spatial information but even to ordinary public. Not only the use of computer maps increases: map creation becomes a part of professional activities of more and more specialists in different occupation areas. The traditional practice when maps are designed by expert cartographers and distributed for public use no more satisfies current needs. Analysts, planners, decision makers require rapid visualization of the most actual information in a form suited for purposes of the moment. The opportunities for mapping offered by modern computers are tremendous: practically unlimited number of available colours, very

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Geographic Information System (GIS) Based Decision Making Tool Development for the Spatio-Temporal Analysis of COVID-19 Hotspots

S. Vigneshwaran, Yeddula Bharath Simha Reddy and S. Praburanganathan

Abstract

In India, an outbreak of COVID-19 disease started in early 2020. The disease was observed to spread spatially and was caused by a novel acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The entire world is still working on eradicating the COVID-19 virus and in India, the nature of spread is spatially unpredictable. Government and Health organisations need to have a strategy that helps in monitoring and managing the rise and decline of cases every day. Remote Sensing and GIS techniques can be used effectively for Spatio-temporal analysis. COVID-19 study involves both spatial and temporal approaches i.e., the location and day-to-day monitoring of activities, these techniques can be put to use immediately. In the present study, a Geographical Information System (GIS) tool has been developed using the Model builder available in the ArcGIS software. Model builder is used in creating, editing and managing various geoprocessing tools that automate the model workflow, string together the sequences of processing and feeding the output of one tool into another as input. In this study, a COVID-19 Hotspot Mapping tool has been developed by integrating various geoprocessing tools. In this tool, the input (X, Y, β), X = Longitude, Y = Latitude and β = Number of Cases for a particular location is given as Comma Separated Values (CSV) file and the output will be produced as Spatio-Temporal map. The maps prepared will depict the hotspots in definitive circular symbology and the radii varies with the number of cases. These maps could readily be utilized by the government administrators and health agencies.

Keywords: COVID-19 Hotspots Map Tool; COVID-19 Hotspots Mapping; ArcGIS Model Builder; GIS Hotspot Tool.

Introduction

Worldwide COVID-19 pandemic caused by the SARS-CoV-2 (novel Coronavirus) has affected millions of people. Governments and various health agencies declared a state of emergency all over the world by banning international flights and visitors, restricting the movement of public transportation, lockdowns, work from home orders, etc., (Ranjit et al., 2021). In India, various types of preventive measures have been followed to curb the SARS-CoV-2. Also, various strategies have been developed by state and central governments to cater to the pandemic efficiently on a day-to-day basis (Kanga et al., 2020). Urban areas have reported higher transmission of the virus when compared to rural areas. The affected areas are isolated and made into different clusters depending upon the severity levels. Studies have shown that the nature of transmission of the SARS-CoV-2 varies with the climate and location (Huang et al., 2021). Urban areas lack green spaces, unhygienic, have more people movements and are highly congested in nature. On the contrary, rural areas possess more green spaces which provide natural ventilation and isolated nature of settlements which has contributed in curbing the spread. India is lacking medical facilities to tackle severe pandemic situations. A precise solution is required to understand the present pandemic and to create control strategies to tackle future pandemics. The number of cases every day at a particular location is essential data required by the health officials and government to control the disease (Ali et al. 2021). Cartographic representation of pandemic disease spreading was first started in 1795 by Valentine Seaman for the Yellow Fever outbreak in New York City. Various outbreaks of the pandemic had been mapped from 1795 to understand the severity of the outbreak (Mocnik et al., 2020). In the present scenario, Remote Sensing and Geographical Information System (GIS) based tools have been effectively used to study the spatial pattern of epidemic illness, these tools are being used in studying COVID-19 pandemic spatial distribution and factors which causes the spread of illness (Yalcin, 2020). In this study, ArcGIS 10.8 software has been used to prepare the COVID-19 Hotspot Map tool using Model Builder. Model Builder in ArcGIS is a visual modelling tool, this tool visualizes the provided data and spatial analysis can be done. Spatial analysis workflow tools can be connected by arrows in a hierarchical manner (Zhu et al., 2021). Location-based details are provided as inputs in the ArcGIS model builder to prepare spatial maps. The main objective of the present study is to develop a decision-making tool to identify the potential COVID-19 hotspots. The results are discussed in section 4, followed by concluding remarks in section 5.

Study Area

The study area selected for the present work is Tamil Nadu, India as shown in Fig. 1. Tamil Nadu, the southernmost state of India, covers the coastal line on the eastern side and the state is rich in mixed biodiversity. It comprises flat plains along the Eastern coastal side and hilly regions surrounded along the north and west. The climate of Tamil Nadu is tropical, the months of May and June are regarded as the hottest, winter starts from August and reach the coldest days in December. Average annual precipitation ranges from 630 to 1900 mm a year and mainly rainfall occurs between October and December. The population of Tamil Nadu as per census 2011 is 72 million and the literacy rate of the state is as high as 80.09 per cent. Chennai formerly called Madras is the capital of the state situated in the northeastern part surrounded by the Indian Ocean. Administrative units of the state comprise 38 districts, 87 Revenue Divisions, 310 Taluks, 1349 Firkas, 17,680 villages, 15 Municipal Corporations, 385 Panchayat Unions, 528 Town Panchayats, 12618 Village Panchayats, 39 Lok Sabha Constituencies and 234 Assembly Constituencies. The state is headed by the Chief Minister and his cabinet of ministers. The Governor is the executive head of the state.

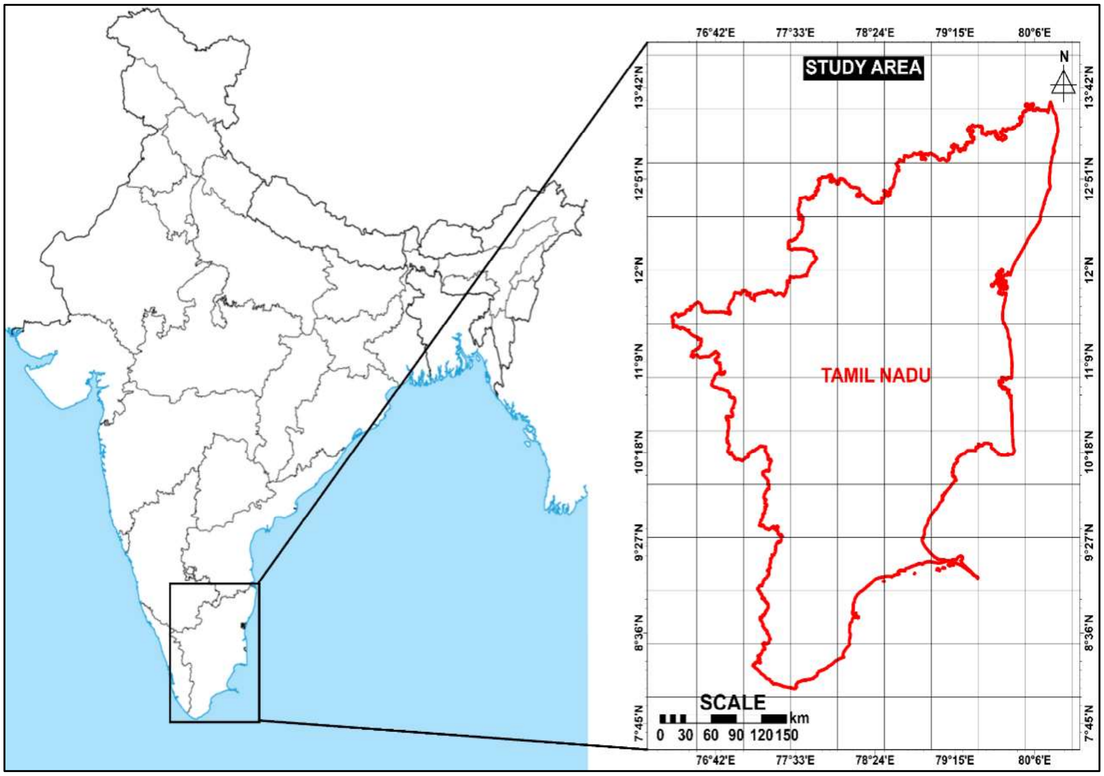

Fig. 1 Map Showing the Study Area Tamil Nadu

Materials and Methods

Geoprocessing tools involved in COVID-19 Hotspot Map tool development are as follows, (i). An input folder / File Geodatabase, (ii). XY event layer, (iii). Copy Features, (iv). Define Projection, (v). Project, (vi). Make Feature Layer and (vii). Symbology Layer. The study area is divided into several clusters having a uniform size of 15 km x 15 km. The centroid of each cluster is taken as the location reference point for that cluster. Each square cluster covers 225 sq. km (15 km X 15 km). The affected cases in numbers are given as input in the CSV format using the Make XY Event Layer tool. The table layer was converted into a point feature, the projection will be performed using the Define Projection tool to spatially register in the WGS1984 datum. Then the point features in Geographical Coordinate System (GCS) are reprojected into Pseudo Mercator Projection. Multiple symbology layers could be created and applied to prepare the final COVID 19 Hotspots Map. In ArcGIS, the geoprocessing tools were organised hierarchically inside the model builder and the model parameter (P) was assigned for the required tool. The final model was converted into an ArcGIS tool. Input will be given as the CSV file and the final output will be the COVID-19 Hotspot Map. The flowchart showing the methodology for the COVID-19 Hotspot Map tool is shown in Fig. 2. The model is further converted into the tool as shown in Fig. 3.

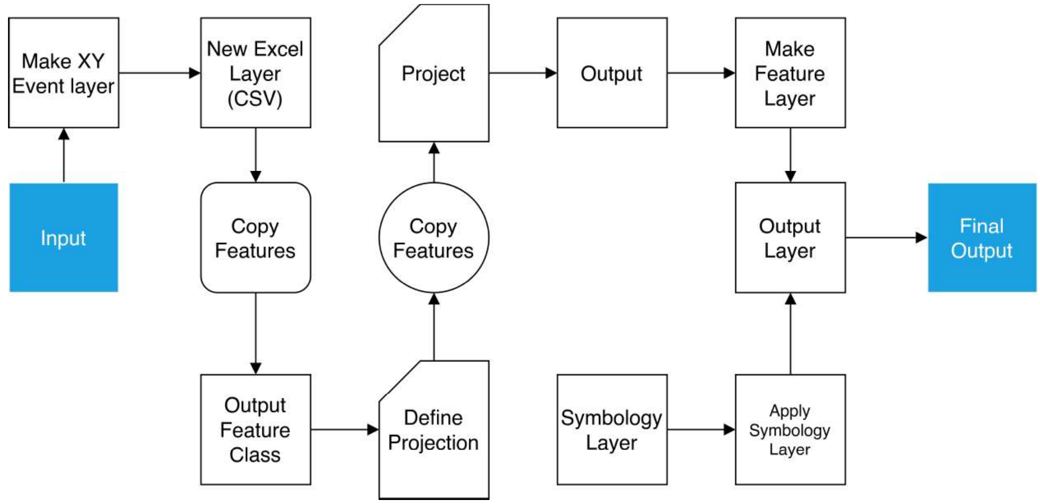

Fig. 2 Flowchart showing the methodology for the preparation of COVID-19 Hotspot Map tool

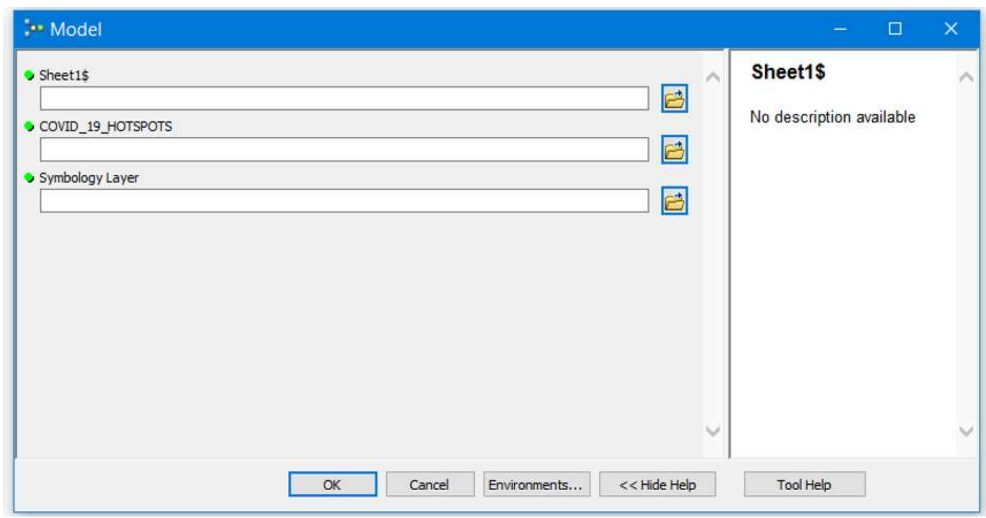

Fig. 3 COVID-19 Hotspot Map Tool

Results and Discussion

The map showing the location of clusters created using Grid Index Feature in ArcGIS Pro is shown in Fig. 3a. For preparing the location cluster, the entire study area was divided into 15 km x 15 km square clusters. The centroid of the square cluster was created and it is taken as the location of reference. The X ordinate (Longitude) and Y ordinate (Latitude) fields are created in the attribute table and locations have been exported as Comma Separated Values (CSV) file. The representative sample has been used since the study involves only the creation of a proper framework to cater to the COVID-19 pandemic. The number of cases assumed for different locations and given as input in the CSV. The CSV file is given as input (X, Y, β, X = Longitude, Y = Latitude and β = Number of Cases) in the COVID-19 Hotspot Map Tool resulting in the generation of a COVID-19 Hotspot Map as shown in Fig. 3b. As seen in Fig. 3b, the graduated symbology layer has been created, the circular radius varies with the number of cases at a particular location. Multiple symbology layers can be created based on the requirement. The number of cases affected cluster has been dived into five classes viz., very low, low, medium, high and very high. The final map can be customised with the addition of a suitable base map.

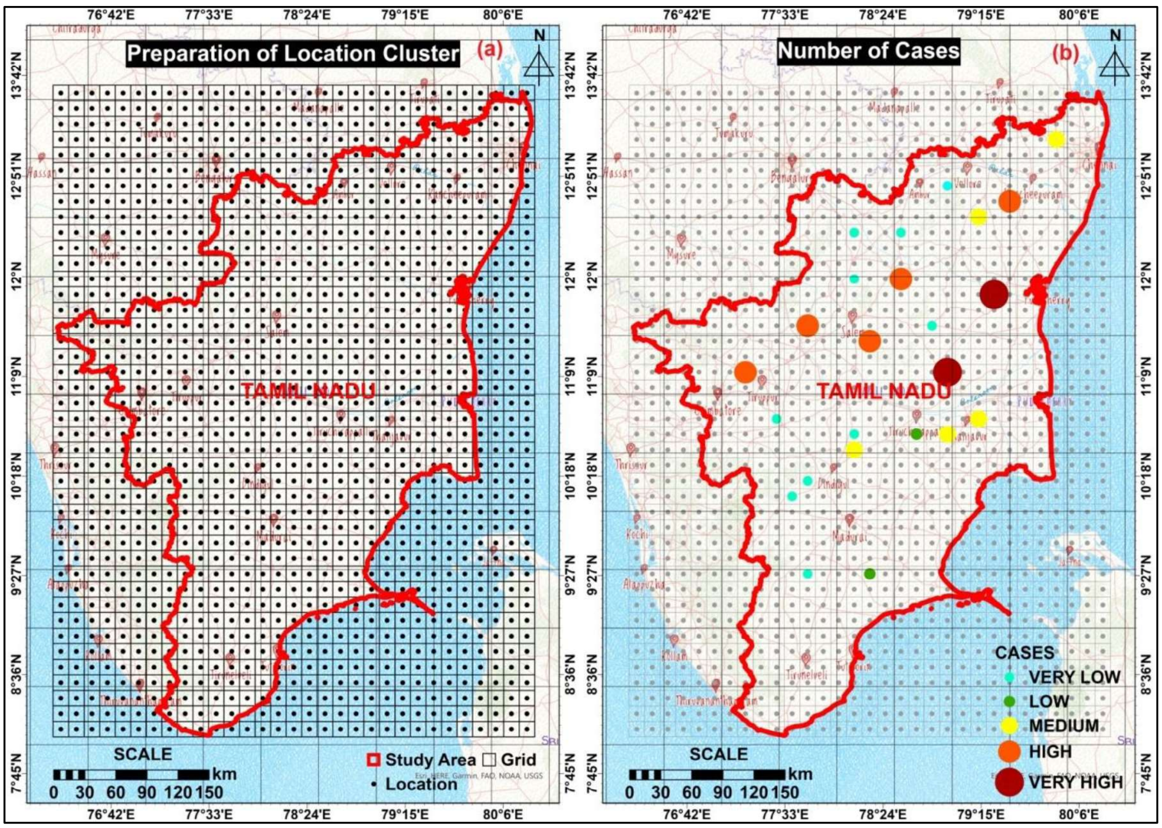

Fig. 3 (a). Map Showing the Location Clusters and (b). Output of COVID-19 Hotspot Map

Conclusion

COVID-19 pandemic has caused a social, economic fuss and the entire world is struggling to eradicate it. Cartographic representation of pandemics will help in understanding, monitoring and managing the problem effectively. Remote sensing and GIS techniques are effectively utilised in the spatial and temporal study of the COVID-19 pandemic. ArcGIS 10.8 and ArcGIS Pro software can be used effectively in solving complex GIS-related problems as utilised in the current study. In the present study, a COVID-19 Hotspot Map tool has been developed, that can be utilised in the quick generation of COVID-

19 hotspot maps. These maps can be readily used in managing the pandemic situation.

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Fusion of Earth Observation Dataset for distinguishing Impervious and PerviousStructures in Urban Environment, Bathinda, Punjab

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Abstract

Evolution in space-based technology over last 40 years has demonstrated numerous capabilities for monitoring Earth surface accurately. Fusion of optical and synthetic aperture radar (SAR) datasets give unique opportunity to monitor urban environment throughout the year because SAR has exclusive capabilities to penetrate through cloud cover and bring out information necessary for monitoring. Increasing availability of open-source SAR andoptical satellite datasets like Sentinal-1 and Sentinel-2 has helped to bring out synergized uses. Growing population pressure is continuously leading to urban sprawl which in turn is introducing impervious structures over earth's surface. But the challenge super exceeds over heterogeneous landscape which describes the peri- urban zone because spectral differentiation is difficult between pervious and impervious land cover. This study therefore aims to build an algorithm to identify impervious and pervious surface using different band combinations of optical and SAR data. Temporal behaviour of fused datasets has been observed over Bathinda city of Punjab. Data processing and geo-statistical analysis in geospatial platform illustrate the effectiveness of using Sentinal-1 SAR data infused with optical datasets. Since seasonal effect in India is a major challenge that affects change in land cover and often magnifies the factor in the peri-urban regions so therefore this study has taken three season Rabi, Zaid and Kharif. Misinterpretation of pervious and non-pervious structure rises due to increase in fallow land therefore this study focuses to find a method which can distinguish distinctly the difference. The potential of SAR to penetrate in cloudy atmospheric conditions have helped to compliment the optical datasets for being interpreted over three seasons Rabi, Kharif and Zaid. Further SAR datasets attribute well in the texture quantisation in conjunction to optical datasets when fused. This study optimally finds out inference for three types of land cover impervious semi pervious and non-pervious. The study brings out potential benefits of pixel to pixel fusion of SAR data in a complicated peri-urban environment like Bathinda.

This study proposes a geospatial technique to classify pixel-based data fusion of SAR and optical datasets to spatially quantify the area which is under urban agglomeration. The technique developed has been divided into three levels (i) Pixel-based data fusion (2) Feature Fusion and (3) Decision Fusion. The accuracy level over three seasons is respectively 0.75 in Kharif, 0.75 in Rabi and 0.79 in Zaid. Therefore, this classification technique based on open-source Sentinel-1 and Sentinel-2 developed can be used by the planners to manage areas of urban agglomeration well without affecting the general balance of the environment.

Keywords: Optical; SAR, Peri Urban; Pervious; Non-Pervious

Introduction

Urban agglomeration is a highly developed spatial form of integrated cities (Fang et al., 2017) these are currently regarded as alarming hotspots because they are zones of co-operation and compaction for global economic development. Researchers around the world are continuously focusing to understand urban agglomeration patterns in recent decades. In the research community, space science has contributed a lot toward understanding of urban agglomeration and its delineation in geographic space using remote sensing data, space technology has been used in laying out combating action plans to protect the space in a planned way. Across the globe several researchers have reported rapid growth of urban agglomerations by continuous increase of impervious surface (Adams et al., 1986) thus understanding this term is important. Impervious surfaces are concert surfaces like building rooftops, driveways, sidewalks, parking lots pavement etc that significantly refers to anthropogenic features through which water cannot penetrate into soil. The knowledge of impervious surfaces, especially the magnitude, location, geometry, spatial pattern etc is requisite for range of issues, which address environmental science and human environment interactions. Thus, understanding these structures are extremely important for urban planning and environmental and resources management (Arnold et al., 1996). Increase of impervious surface has several negative factors that could increase volume, duration, and intensity of urban runoff (Weng,2001). Large amounts of impervious cover may experience an overall decrease of groundwater recharge and base flow; it may influence an increase of storm flow and flood frequency over time (Brun& Band, 2000). Furthermore, imperviousness is related to the water quality of a drainage basin also indirectly because interrupts water receipt to streams, lakes, and ponds therefore monitoring it impervious structure is important. Increase in impervious cover and runoff directly impact the transport of on-point source pollutants including pathogens, nutrients, toxic contaminants, and sediment (Hurd&Civco, 2004). However field survey with GPS is a very expensive and time-consuming technique it can provide reliable information on both impervious and pervious surfaces but is very labour intensive therefore need ofthe hour is remote sensing technique to differentiate between pervious and impervious structure (Weng , 2012). There are several remote sensing techniques to extract impervious surface like manual digitization from hard-copy maps or remote sensing imagery for mapping imperviousness structures. Previous studies typically differentiated impervious surfaces from other land cover types based on the spectral and spatial characteristics of land covers. However, for regional level impervious surface estimation, using only spectral and spatial characteristics was considered ineffective due to the limited spectral and spatial resolutions of optical data (Li et al., 2013; Weng and Hu, 2008; Zhang and Weng,2016).

However, the major gap stands in understanding a structure, which lies between pervious and impervious structure because urban environments are challenged by spatial and spectral heterogeneity. Optical and Synthetic Aperture Radar (SAR) imagery seems to be suitable sources of reliable information about the multiple facets of urban environments because impervious structures are difficult to identify from optical remote sensing data because its information is usually missing in simple optical data. Fusion of SAR and optical data has proved to be promising in understanding structural differences because the transition zone of urban agglomeration is well understood in this regard.

An urban agglomeration that can be broadly considered to be made up of three types of surfaces(Boyd et al., 1993):

Impervious areas which are directly connected to the drainage system, typically roads, parking lots and in some cases roofs

Semi Impervious areas which are not directly connected, runoff from which flows over pervious surfaces before reaching the drainage system. Both 1 and 2nd together make up the total Impervious area

Pervious consisting of lawns, gardens and parklands

. Over the time advent of third generation very high spatial resolution (<20m) SAR datasets of Sentinal-1 has stimulated the development of urban remote sensing still further. The data produced by these satellites facilitate improved detection of subtle urban changes and rapid expanding agglomerations and 'edge cities' of many developing countries like India. It can also allow easier discrimination of the typology of urban landscapes especially in dense and heterogeneous cities. Finding simple yet effective operational approaches for urban extent extraction in optical and SAR images constitutes one of the main needs of urban practitioners and local governments. In the last decade, there have been a number of important methodological developments that attempted to fulfil these requirements. Some of the already available, computationally simple, semi-automatic procedures rely on morphological transformations, others on wavelet transform or on textural analysis of SAR and/or optical data. In the line of these approaches, an attempt was made to study and implement an original approach for the analysis and classification of SAR and optical data. It is entirely automatic and properly designed for fast information extraction for the purpose of rapid urban mapping. Based on straightforward theoretical considerations, the methodology consists complete unsupervised procedure that can be applied on a pair of co-registered SAR/optical images for operational urban areas extraction.

Objectives

The research was aimed to develop a geospatial based technique to identify pervious, semi-pervious and impervious structures over a typical semi urban environment of India were clear boundary identification of Urban and Peri urban is very difficult to be demarcated. This technique will help to manage and plan areas under over exploitation due to urban agglomeration. Since urban agglomeration has led to land degradation over various areas as per United Nations (UN) therefore this study can be crucial contribution towards Land degradation neutrality.

The objective of the study therefore can be divided into two basic parts:

Development of Pixel to Pixel based fusion technique for SAR and Optical based Datasets

Understanding effect of seasonal variation (Rabi, Kharif and Zaid) on semi pervious structures by using different band combinations of Optical and SAR data.

Supervised classification of fused datasets for characterizing pervious, semi pervious andimpervious structures

Accuracy assessment of the classified product generated from fused SAR and Optical bands.

Study Area

This study was focused around Bathinda city, Punjab because it is one of the growing cities suffering from urban agglomeration over the

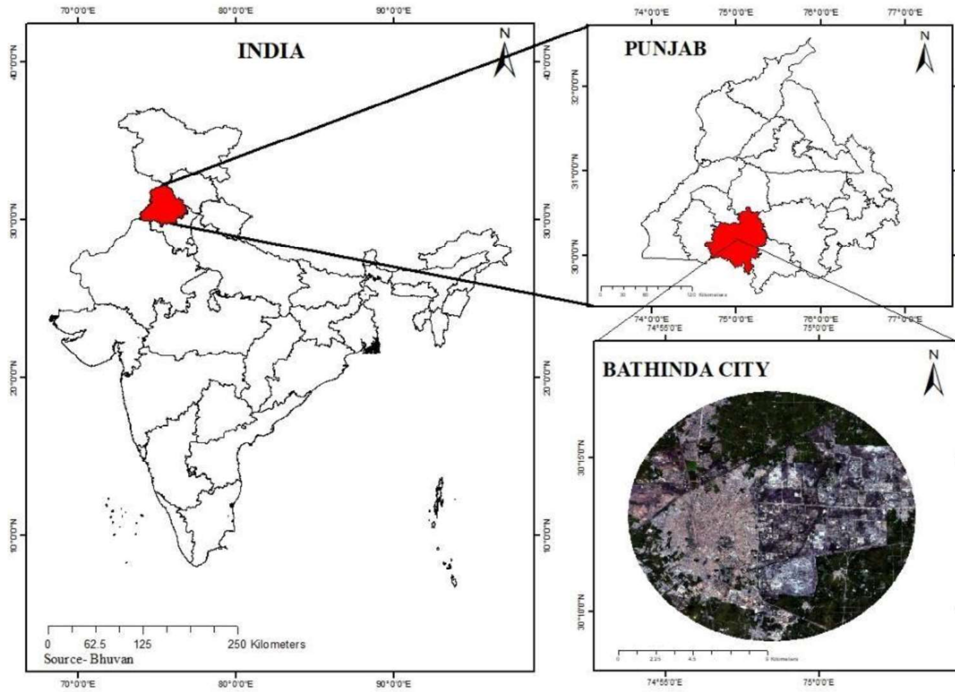

Figure1: Study area of Bathinda, Punjab, India.

years. It is one of the oldest cities in Punjab therefore core of the city has compact structures. Geographically it is located in India's North-western part over Malwa Region. It is 227 km west of the capital city of Chandigarh and regarded as the fifth largest city of Punjab with the population of around 1388525(Census, 2011). Bathinda's is known as the 'City of Lakes', because of the artificial lakes in the city. The city has two well built modern thermal power plants, Guru Nanak Dev Thermal Plant and Guru Har Gobind Thermal Plant at Lehra Mohabbat. Apart from this the city has a fertilizer plant, two cement plants (Ambuja Cements and Ultra Tech Cement Limited), and a large cantonment area, an air force station, a zoo, and a historic Qila Mubarakfort. It is evident by the infrastructure facility of Bathinda that it's a growing modernised city which may suffer from several issues due to urban agglomeration therefore monitoring this region is important for proper urban planning.

Climatic condition is a very important aspect of any area. Bathinda city lies in the south-western part of Punjab therefore shares a typicalhot summer and bracing cold in winters.In summer season (March- June) temperature rises around 47°C, as it's close to the vicinity of Thar Desert of Rajasthan; therefore it experiences extreme heat, followed by lots of precipitation in monsoon. The average rainfall is around 421 mm which lasts till middle of September. When the monsoon withdraws temperatures begin to decrease, and winter season in Bathinda starts from November and extends till February. January is the coldest month, with mean daily temperature of about 21°C and minimum 4

°C. Nearly 70% of the total rainfall is received during the monsoon period (July to September). This region is very perspective in terms of agricultural growth because nearly 87 per cent area of the district is under irrigation facility, of which canal irrigated area is 62.8 per cent while tube well irrigated area is 24.2 per cent.

The main land use land cover is agriculture in Bathinda district; Agriculturally Bathinda is very progressive as it is hub of cash crop like cotton in Punjab. Bathinda takes three season crops Kharif, Rabi and Zaid every year. There exhibits a large crop diversity in the region.

Material and Methods

Data used

This study uses Sentinel-1 (SAR) and Sentinel-2 (Optical) scene for analysis. Date of satellite image acquisition is 20.10.2019, 22.02.2019, 05.05.2019 for Kharif, Rabi and Zaid season respectively. These are open source data from Earth Observational Datasets which is freely available and therefore can be readily used for analysis.

Sentinel-1 Satellite Image

The Sentinel-1 mission comprises a constellation of two polar-orbiting satellites, operating day and night performing C-band synthetic aperture radar imaging, enabling them to acquire imagery regardless of the weather (Sentinel-1 Handbook, 2013). The Sentinel-1 mission includes C-band imaging operating in four exclusive imaging modes with different resolution (down to 5 m) and coverage (up to 400 km). It provides dual polarization capability, very short revisit times and rapid product delivery. Sentinel-1 was launched on 3 April 2014, its acquisitions using the Interferometric Wide swath mode polarization over land with a 250 km swath width was a unique achievement. Two images were captured in VV (vertical receive and vertical transmit) and VH (vertical receive and horizontal transmit). Sentinel-1 is designed to work in a pre-programmed, conflict-free operation mode, imaging all global landmasses at high resolution.

Table1: Showing Characteristics of Sentinel 1 and Sentinel-2 Datasets

Properties	Sentinel-1A	Sentinel-2A			
		Sentinel-2	Data description		
Spatial Resolution	20m	• 10m • 20m • 60m	(four visible and near-infrared bands) (six red edge and shortwave infraredbands) (three atmosphericcorrection bands).		
Radiometric	12 bits	12 bits	Spectral band		
			10m	B2B3B4B8	Blue Green Red NIR
Temporal	6-day repeat cycle at the equator.	5 days at the equator.	20m	B5 B6 B7 B11 B12	RERERE Cirrus B13- SWIR
Spectral	2 SAR Bands	13 Optical, NIR, SWIR			
Swath	250 km- Upto 400km	290 km	60m	B1 B9 B10	Coastal Veg.RE WaterVapor
Launch date	1A (3 April, 2014) 1B (25 April, 2016)	2A (23 June 2015) 2B (7 March 2017)			

Sentinel-2 Satellite Imagery

Sentinel-2 is European Space Agency's (ESA) wide-swath, high-resolution, multispectral imaging mission. This mission includes twin satellites flying in the same orbit but phased at 180°, it is designed to give a high revisit frequency of 5 days at the Equator. Sentinal-2 carries an optical instrument payload that samples 13 spectral bands. Among which four bands are at spatial resolution of 10 m, six bands at 20 m and three bands at 60 m spatial resolution. The orbital swath width is 290 km. The main objective of this mission is systematic global acquisitions of high-resolution, multispectral satellite images therefore it is allied to a high revisit frequency, continuity of multispectral imagery provided by the SPOT series of satellites and the USGS Landsat Thematic Mapper instrument and observation data for the next generation of operational products, such as land- cover maps, land-change detection maps and geophysical variables.

Methodology

The data processing technique followed in the study is presented in the flowchart illustrated in Figure 2 and involves three major stages:(i) Data processing (product segmentation and classification), and

(ii) accuracy assessment.

Computation of Vegetation Index from Optical data

Remote sensing of vegetation is mainly performed by obtaining the electromagnetic wave reflectance information from canopies using passive sensors. It is well known that the reflectance of light spectra from plants changes with plant type, water content within tissues, and other intrinsic factors (Xue et al., 2017) Therefore to measure the greenness cover optical

products are commonly used. The reason for using vegetation index is to highlight vegetation cover detail in the image. Sentinel-2 multi- spectral instrument (MSI) with a refined spatial resolution (10 m and 20 m) allows improved and accurate monitoring vegetation cover. Furthermore, the presence of three red-edge bands, centered at 705 (band 5), 740 (band 6) and 783 nm (band 7), which are not present in freely available multispectral sensors, widens the spectral windows for vegetation stress discrimination at broader scales (Somvanshi et al., 2020). Normalized Difference Vegetation Index (NDVI) is a very popular Index which has been used in the study:

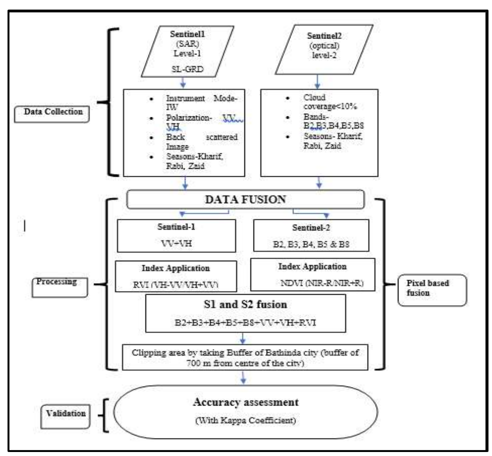

Figure 2: Methodology

NDVI = **NIR−R/ NIR+R**.................... (1)

These indexes enhance the contrast between soil and vegetation but minimize the effects of illumination conditions because NIR (which reflects vegetation strongly) and Red light (which absorbs vegetation reflectance) bands are used to estimate the density of green on area of land. Therefore B4 and B8 of Sentinel-2 were used to compute NDVI using ARCGIS 10.6.

Computation of backscatter from SAR data

Computation of vegetation index from SAR data

SAR datasets can penetrate the clouds thus it has the potential to monitor the crop growth in all seasons. This point is very important in the context of Punjab because North western disturbance often hinders satellite enabled monitoring. The study explores the possibility of Radar Vegetation Index (RVI) for vegetation monitoring in fields as an alternative source of monitoring vegetation apart from optical datasets. RVI is computed by VV and VH polarisation of SAR. RVI is the measure randomness of scattering has been proposed as a method for monitoring the level of vegetation growth, particularly when time series of data are available (Mandal et al., 2020).

RVI = VH−VV/VH+VV…………….. (3)

Image Fusion Technique

Methods of image fusion can be grouped into three categories depending on the level at which the integration is performed. The first category refers to the combination of the original image pixels, while the second is based on combining features extracted from the individual datasets. In contrast, decision fusion requires preliminary analysis of the different datasets, e.g., the separate classifications of optical and SAR data as a method for monitoring the different features, over a time series. Here are three methods that can be used for fusion of SAR and Optical datasets

a) Pixel-level Fusion (data fusion)

b) Feature Fusion

c) Decision fusion

Accuracy assessment

Accuracy assessment is done for the individually processed images of fused SAR and optical images with respect to optical data derived classification product. The classification accuracy was also assessed by using the producer's accuracy (PA), the user's accuracy (UA), the overall accuracy (OA) and the Kappa coefficient based on the confusion matrix. The confusion matrix is calculated by comparing classification derived from the image against ground truth data. Each column of the confusion matrix represents a ground truth class, and the values in the column correspond to the image's labelling of the ground truth pixels. The Kappa coefficient, a statistical measure of inter reliability, is calculated as follows (Stehman et al., 1997):

k = Po−Pe/1−Pe………………………(4)

Cohen's Kappa coefficient where (Po- P observed, Pe- P chance).

Producer's accuracy (PA) is the probability that a pixel is correctly classified to a land cover type, representing the errors of omission. User's accuracy (UA) is the proportion of pixels that are correctly classified within the image, representing the errors of commission. The overall accuracy is calculated as the ratio between the number of correctly classified pixels and the total number of pixels used for accuracy assessment.

Currently, fusion between optical and SAR data for mapping impervious surfaces is mainly performed at the pixel and feature levels. The decision-level fusion in this study refers to integration of classification results that come from different data sources (optical or SAR data) for making a final decision on a pixel. Thus, the fusion of classification results from different data sources has shown superiority for image classification over traditional Bayesian approaches. Therefore, in this study we have used three Fusion methods to derive our results.

Results

Analysis from Optical dataset

Using the Sentinel-2 bands Vegetation indexes was calculated as described in methodology. The entire work was done at a scale of 20meter. The NDVI values ranged between -1 to +1. These values were distinctly characterized to estimate spatial spread of Impervious, Pervious, and Water bodies. The target year for classification was 2019. For the optical time series analysis approach, three seasons were taken Kharif, Rabi and Zaid respectively shown on figure. Three season images were considered for the results because semi impervious zones which are often identified as the zone of agglomeration are often affected by seasonal phenomenon since they are not part of total concrete structures usually observed in the urban regions. Vegetation Index computed using optical images can be clearly used to classify water, Impervious and pervious. Seasonal variation is prominent in Bathinda not only it gives the insight of agriculture crops in different season but also helps in identification of the pervious and especially impervious areas. It is observed that water bodies in Rabi season occupies maximum area it is around 120.37ha were as in Kharif it is around 100.06ha and 100.50ha in Zaid. The reason may be because of heavy north western disturbance causing high level of rainfall in Rabi season in and around Bathinda. Impervious region is identified by Kharif season is 9491.56ha, Rabi season is 10410.90ha, and Zaid season is 7590.12ha were as pervious surface in Kharif season is 8082.88ha, Rabi is 7143.19ha and Zaid season is 9984ha. Figure 3 illustrates the spatial spread of Water bodies, Pervious and Impervious layer in and around 10km from the Bathinda city and Table 2 explains the areal spread in hectares of Water bodies, Pervious and Impervious classes.

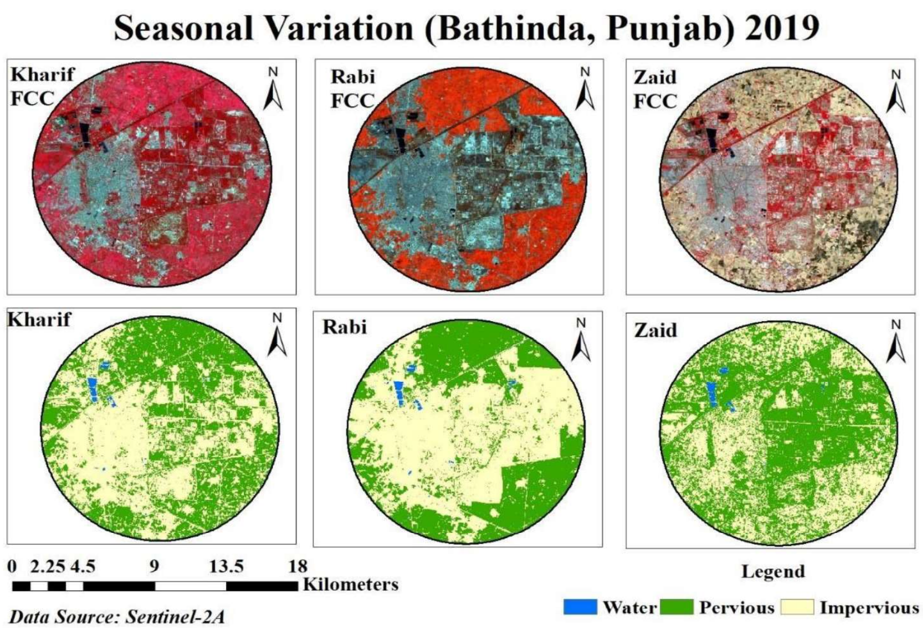

Figure2: Seasonal variation map including FCC and NDVI Image of three seasons.

Table: 2 Classification of Study Area using optical datasets

Categories	Kharif (ha)	Rabi(ha)	Zaid(ha)
Water	100.06	120.37	100.50
Impervious	9491.56	10410.9	7590.12
Pervious	8082.88	7143.19	9984.00

5.1 Analysis from Fused Dataset (SAR and Optical) - SAR has a unique complimentary feature; it can penetrate even in cloudy days to give attribute of several unique features in a region. Therefore, fusion of SAR and Optical data can eliminate cloud problems during monsoon disturbance as well as north western disturbance in winter. Different band combinations have been used to identify spectral feature s of several structures in the region. Each combination represents unique feature therefore this technique was very helpful to identify each single entity at 20m resolution. Image stacking has been carried out of nine distinct layers five optical images, 2 SAR bands, 1 NDVI layer and RVI layer. Combinations of these 9 layers has attributed to the researchers understanding of the spatial spread in different distinct features. In Figure 4, 5 and 6 representations of six distinct combinations has been used to segment each identifiable spatial feature like agricultural area, core urban structures city composed of concrete features like building, pavement, parks etc, urban agglomerated areas were urban and peri-urban meets, semi impervious structures like barren land, water logged areas which is clearly identifiable for three seasons over the selected study area. Further these datasets has been used to set the decision rule for the classification obtained from the SAR and Optical fused based classification classes for identification of pervious, semi-pervious and impervious classification system.

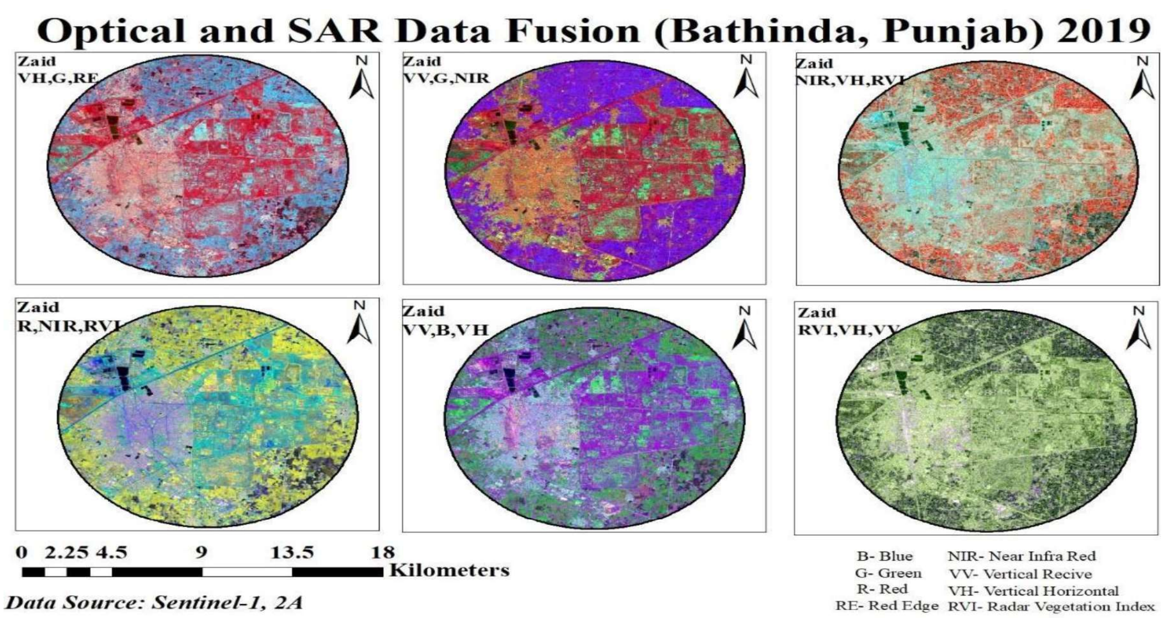

Figure 4: Optical and SAR fused datasets in Kharif

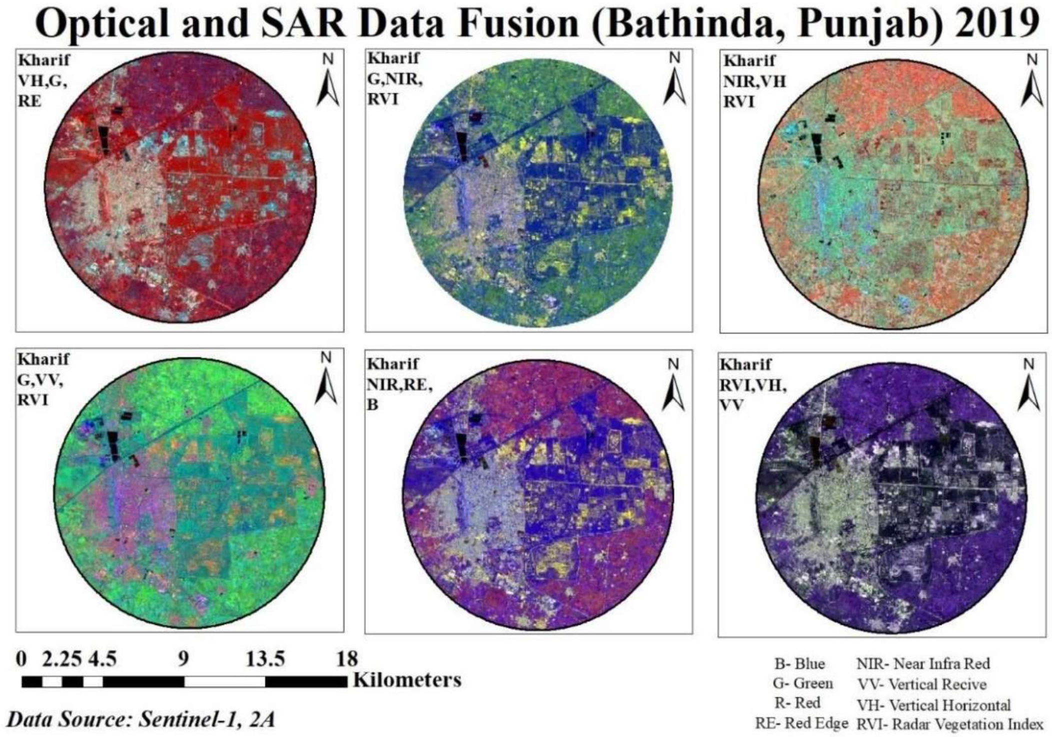

Figure 5: Optical and SAR fused datasets in Rabi

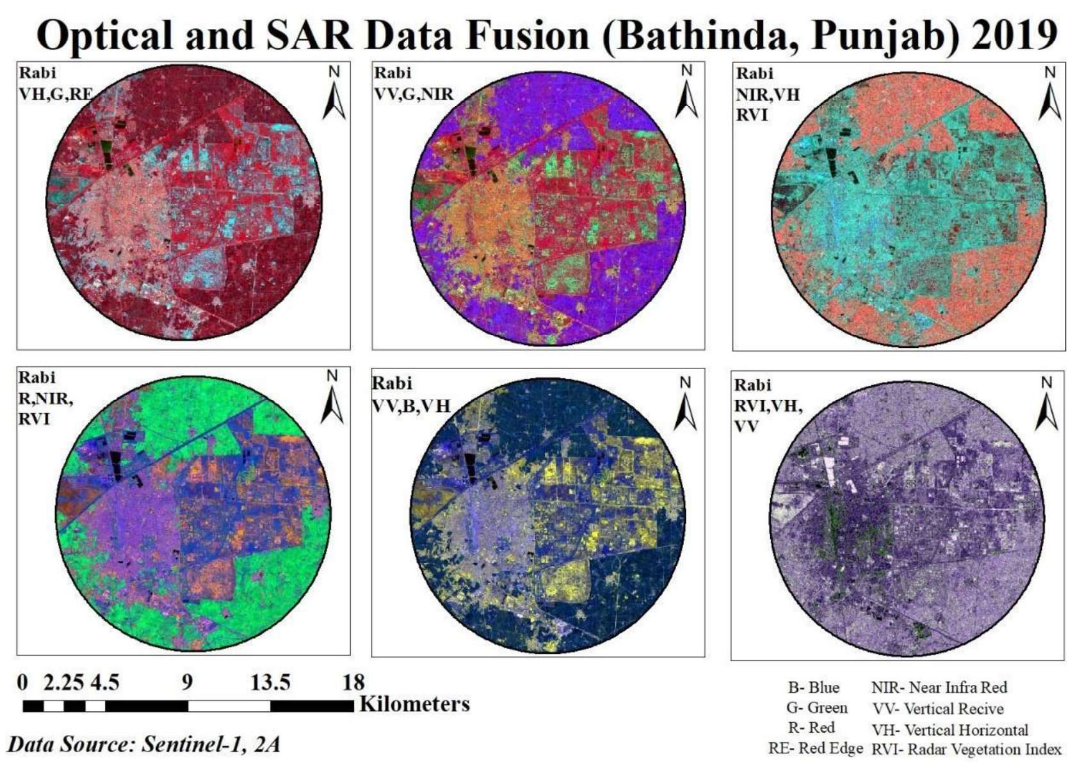

Figure 6: Optical and SAR fused datasets in Zaid

Classified Fused Image

The above technique helped to estimate and set decision rules for classification of each image in the three seasons. The SAR and optical based fused image helped to classify an extra class named the Semi-pervious class which was not distinctly identified in optical classification system. It is observed that water bodies in Zaid season occupies maximum area it is around 1062.6875ha were as in Rabi it is around 282.6875ha and 171.0625ha in Kharif. The reason may be because of Roni is done in Zaid season to make land fertile and ready for next season because in the month of May and June extensive heat and up the ground and moisture level of ground falls down so local people practices **roni** system in which they fill the agriculture land with water in Bathinda. Impervious region is identified by Kharif season is 5794.875ha, Rabi season is 6831.0625ha, and Zaid season is 7670.4375ha were as pervious surface in Kharif season is 7479.5ha, Rabi is 6147.5ha and Zaid season is 6137.126ha and additional semi-pervious area is also calculated Kharif season is 4325.5ha, Rabi is 4508.8125ha and Zaid season is 2900.25ha . Figure 3 illustrates the spatial spread of Water bodies, Pervious, Semipervious and Impervious layer in and around 10km from the Bathinda city and Table 3 explains the areal spread in hectares of Water bodies, Pervious, Semi-Pervious and Impervious classes.

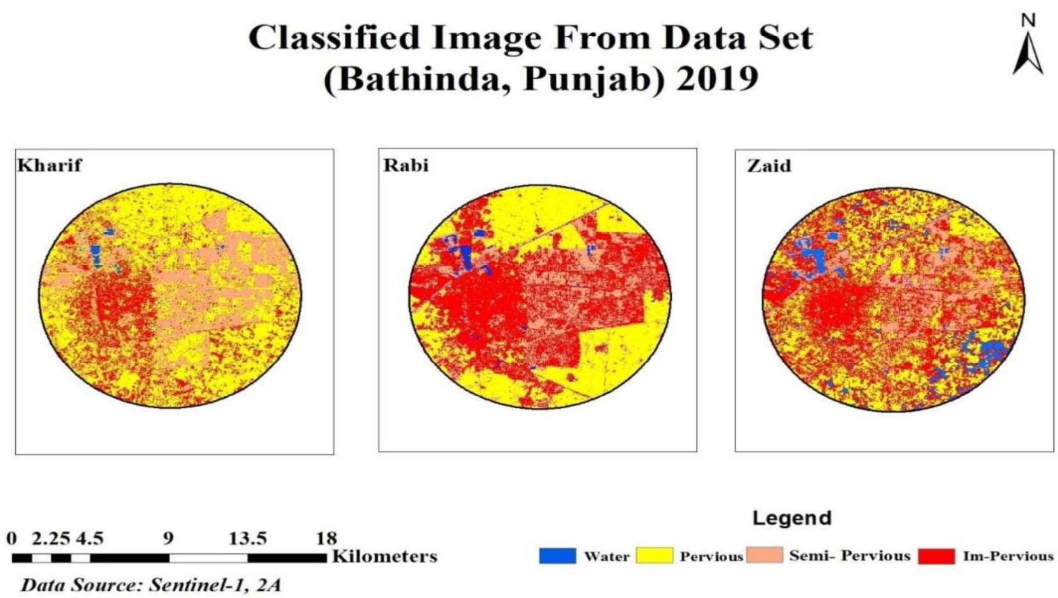

Figure 7: Classification based on Fused SAR and Optical Datasets

Table: 3 Classification of Study Area using optical datasets

Categories	Kharif (ha)	Rabi(ha)	Zaid(ha)
Water	171.0625	282.6875	1062.6875
Impervious	5794.875	6831.0625	7670.4375
Semi-pervious	4325.5	4508.8125	2900.25
Pervious	7479.5	6147.5	6137.126

1. **Accuracy Assessment**

Sample locations were selected randomly over the study area from the four identified classes A totalof 151 points were selected as training samples, i.e., 65 points from Impervious, 60 pixels from Pervious, 10 pixels from Semi-Pervious, 18 pixels from water bodies. The classification accuracy was also assessed by using the producer's accuracy (PA), the user 's accuracy (UA), the overall accuracy (OA) and the Kappa coefficient based on the confusion matrix generated. The confusion matrix is calculated by comparing land covers derived from optical datasets which has been considered as the ground truth class (this has been considered as the ground validated product because optical standards of NDVI are quite common in recent times). Each column of the confusion matrix represents a ground truth class, and the values in the column correspond to the image's labelling of the ground truth pixels. Producer's accuracy (PA) is the probability that a pixel is correctly classified to a land cover type, representing the errors of omission. User's accuracy (UA) is the proportion of pixels that are correctly classified within the image, representing the errors of commission. The overall accuracy is calculated as the ratio between the number of correctly classified pixels and the total number of pixels used for accuracy assessment. Our results clearly shows that the classified image from the SAR and optical based fused image has high accuracy in ranging between 87% to 92% producers accuracy and 85% to 89% over all three seasons. The Kappa coefficient recorded is 0.75 in Kharif, 0.75in Rabi and

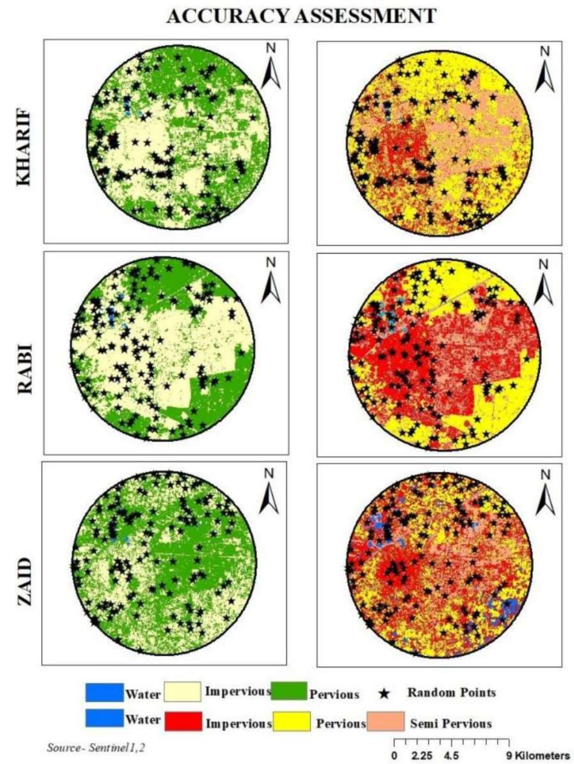

Figure 8: Randomly selected accuracy assessment points

0.79 in Zaid , these values indicate that the fused product is highly valuable and can infer high level of information. Figure 8: Show randomly selected accuracy assessment points. Table 4,5,6 shows Accuracy assessment table for Kharif, Rabi and Zaid and Table 7: Shows accuracy assessment table for Kappa Coefficient in three seasons.

Table 4: Accuracy assessment table for Kharif

Categories	**Impervious**	**Pervious**	**Semi-Pervious**	**Water**	**Total**
Impervious	56	3	0	1	60
Pervious	6	59	0	0	65
Semi-Pervious	3	7	0	0	10
Water	3	0	0	13	16
Total	68	69	0	14	151

Table 5: Accuracy assessment table for Rabi

Categories	Impervious	Pervious	Semi-Pervious	Water	Total
Impervious	58	2	0	0	60
Pervious	6	59	0	0	65
Semi-Pervious	3	7	0	0	10
Water	5	0	0	11	16
Total	67	66	0	11	151

Table 6: Accuracy assessment table for Rabi

Categories	Impervious	Pervious	Semi-Pervious	Water	Total
Impervious	59	1	0	0	61
Pervious	4	61	0	0	65
Semi-Pervious	5	5	0	0	10
Water	4	1	0	11	16
Total	72	67	0	11	151

Conclusion

This study proposes a geospatial technique to classify pixel-based data fusion of SAR and optical datasets to spatially quantify the area which is under urban agglomeration. The technique developed can be divided into three levels (i) pixel-based data fusion (2) Feature Fusion and (3) Decision Fusion. This technique has provided high accuracy level over three seasons 0.75 in Kharif, 0.75 in Rabi and 0.79 in Zaid. Therefore, this classification technique based on open source Sentinel-1 and Sentinel-2 developed can be used by the planners to manage areas of urban agglomeration well without effecting the general balance of the environment.

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Mapping Topographic Wetness Index (TWI) and Land Forms in Kannur District, Kerala State

B. Sukumar and Ahalya Sukumar

Abstract

The Topographic Wetness Index (TWI) is one of the most widely used topography-based indications of soil moisture. It is commonly used to quantify topographic control on hydrological processes. The index is a function of both the slope and the upstream contributing area. The TWI's importance is due to topography being a major factor in water distribution, and thus it is able to explain and predict soil moisture. It was introduced by Beven and Kirkby (1979). It is commonly used to quantify topographic control on hydrological processes. This index is used in various ecological studies and flood prone areas in urban areas. Since it is related to topography and slope used to predict soil moisture in an area.In this paper, an attempt is made to study the soil moisture distribution pattern through TWI in Kannur district, Kerala. Kannur district is situated in the northern part of Kerala state. SRTM data, SAGA GIS and QGIS are used for the study. TWI is classified into five classes as very low, low, moderate, high and very high for understanding the spatial distribution over the district. TWI is overlaid on Land form map of the district prepared based on contour and slope. Land for map is intersected with five classes of TWI and maps were prepared. TWI area is calculated over each land form units viz., Coastal plain, valley fill, undulating denudation upland, low dissected plateau/pediment, high mountain and hill/ridge areas.From the study it found that very low index has 577.21 sq.km, low with 788.38 sq.km moderate with 289.95 sq.km, high with 701.51 sq.km and very high with 721.72 sq.km in the district. Very low and low TWI is found in the mountainous areas in the east. Among the five classes low is the predominant with 25.61 per cent to the total area, followed by very high and high classes. Moderate TWI is found mostly in the undulating denudation upland region in the mid areas of the district. Very high and high TWI is found in the coastal plain and valley fill region of the district. It is very useful to know the soil moisture in different terrain condition and land forms of the district.

Keywords: Topographic Wetness Index, SRTM, Topography, Slope

Introduction

The Topographic Wetness Index (TWI) is one of the most widely used topography-based indications of soil moisture. It is commonly used to quantify topographic control on hydrological processes. The index is a function of both the slope and the upstream contributing area. The TWI's importance is due to topography being a major factor in water distribution, and thus it is able to explain and predict soil moisture. It was introduced by Beven and Kirkby (1979). It is commonly used to quantify topographic control on hydrological processes. This index is used in various ecological studies and flood prone areas in urban areas. Since it is related to topography and slope used to predict soil moisture in an area.

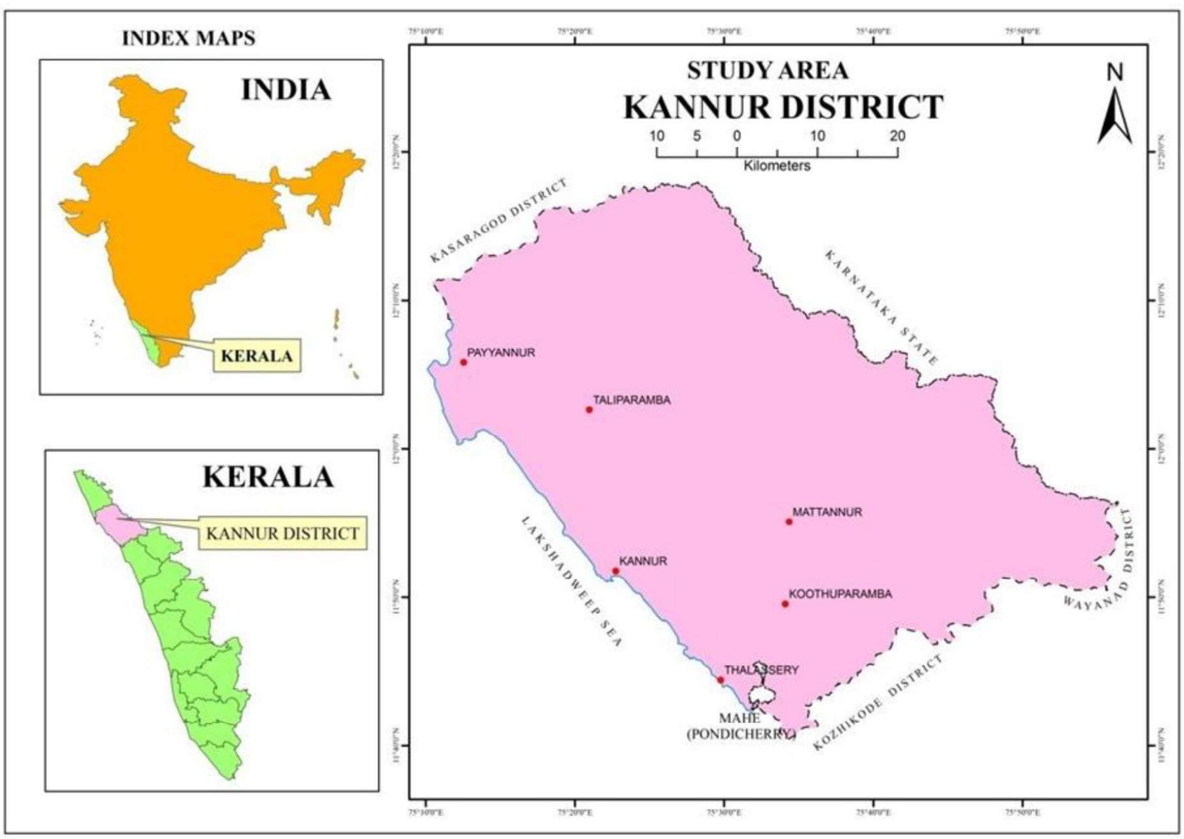
Objectives

In this paper, an attempt is made to study the soil moisture distribution pattern through TWI in Kannur district, Kerala.

Study Area

Kannur district is situated in the northern part of Kerala state in India (Fig.1). It is one of the 14 districts in the state of Kerala. The district lies between latitudes 11° 40' to 12° 48' North and longitudes 74° 52' to 75° 56' East. Kannur district is bounded by the Western Ghats in the east (Coorg District of Karnataka state), Kozhikode and Wayanad districts in the south, the Lakshadweep Sea in the west and Kasaragod district in the North (Fig.1). The total area of the district is 2966 sq.km. It ranks 6th position in area among the 14 districts of Kerala. The district has three taluks, viz., Kannur, Taliparamba and Thalassery. There are nine development blocks comprising 81 panchayats.

Relief of the district vary from mean sea level in the west to more than 1200 meters in the east. There are 9 main river basins in the district. Most of the rivers originate from the Western Ghats in the east and drains into the Lakshadweep Sea in the west. The district has a humid climate with hot season from March to the end of May. This is followed by the South-West monsoon which continues till the end of September. October and November form the post-monsoon or retreating monsoon season. The average annual rainfall in the district is 3438 mm, of which 80 per cent is received during the period June to September. July is the



rainiest month and also a month of heavy rainfall occurrence. During the months of April and May, the mean daily maximum temperature is about 35 °C. Temperature is low in December and January and the minimum temperature is about 20 °C.

Based on Physiography the district is divisible into three units; the coastal plains, the Midland Fig.1: Study Areaand the high lands. The coastal plain is a narrow region of depositional landforms. The midland region a relatively wide zone representing undulating denudational landforms exhibiting laterite duricrust capped flat regions, ridges, spurs, laterite interfluves and narrow alluvial valleys. The high land region in the east consists of structural cum denudational landforms.

The soil types in the district includes, coastal alluvium along the coast, riverine alluvium in the valley portions, laterite in the midland regions and forest loam in the east along the western Ghats.

Materials Used and Methodology

Digital Elevation data from SRTM is used for the study. SAGA GIS and QGIS were used for the study. TWI is classified into five classes as very low, low, moderate, high and very high for understanding the spatial distribution over the district. Topographic maps of the Survey of India on 1: 50,000 scale were referred. TWI was overlaid on Land form map of the district prepared based on contour and slope. Land form maps were intersected with five classes of TWI and maps. TWI area was calculated over each land form units viz., Coastal plain, valley fill, undulating denudation upland, low dissected plateau/pediment, high mountain and hill/ridge areas after intersection.

Analysis and Discussion

Among the land forms, undulating denudation uplands occupy about 53.46 per cent of the total area of the district (Fig.2). It is composed of laterite and occupy middle portion of the district. Land forms and their percentage to the total area is given in Table.1. The Topographic Wetness Index (TWI) prepared from SRTM data using SAGA GIS, was reclassified into five classes as very low, low, moderate, high and very high (Fig.3). Of which, low represents 26 per cent of the total area. Table.2 shows the area covered by the topographic wetness index and their percentage to the total area of the district.From the study it is found out that low index value is predominant and occupy 759.50 sq.km, followed by moderate with 695.28 sq.km, high with 675.81 sq.km, very lowwith 556.07 sq.km and very high with 279.33 sq.km.

Table.1

Kannur district- Land forms and their percentage

Sl.No	Land form	Area in sq.km	Percentage
1	Coastal Plain	314.14	10.59
2	Valley fill	410.19	13.83
3	Undulating denudation upland	1585.64	53.46
4	Low dissected plateau/pediment	575.25	19.39
5	Hill/ridge	80.78	2.72
	Total	2966.00	100.00

Table.2
Kannur district – Topographic Wetness Index Area and percentage to the total area

Sl.No	Topographic Wetness Index	Area in sq.km	Percentage
1	Very low	556.07	18.75
2	Low	759.50	25.61
3	Moderate	695.28	23.44
4	High	675.81	22.79
5	Very High	279.33	9.42
	2966.00		100.00

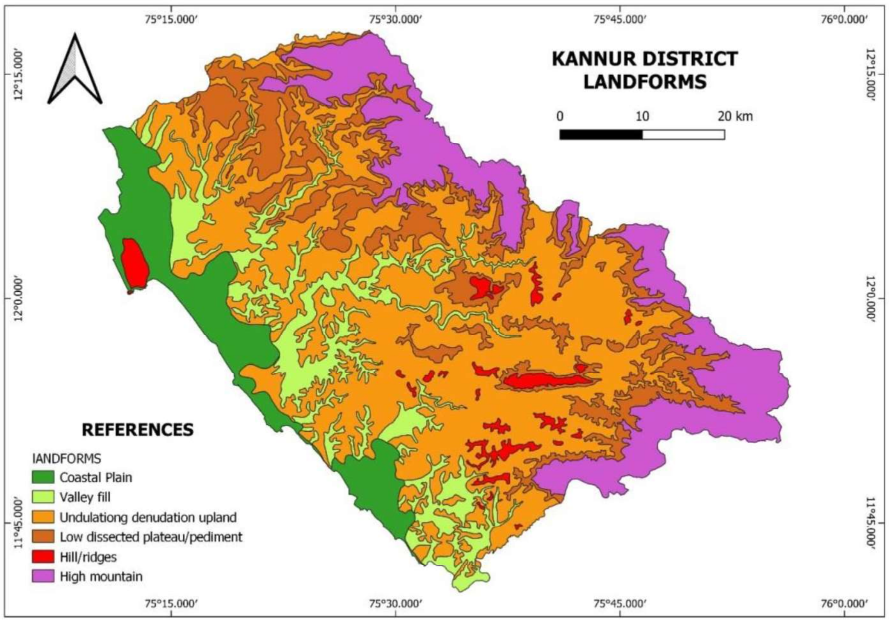


Fig.2

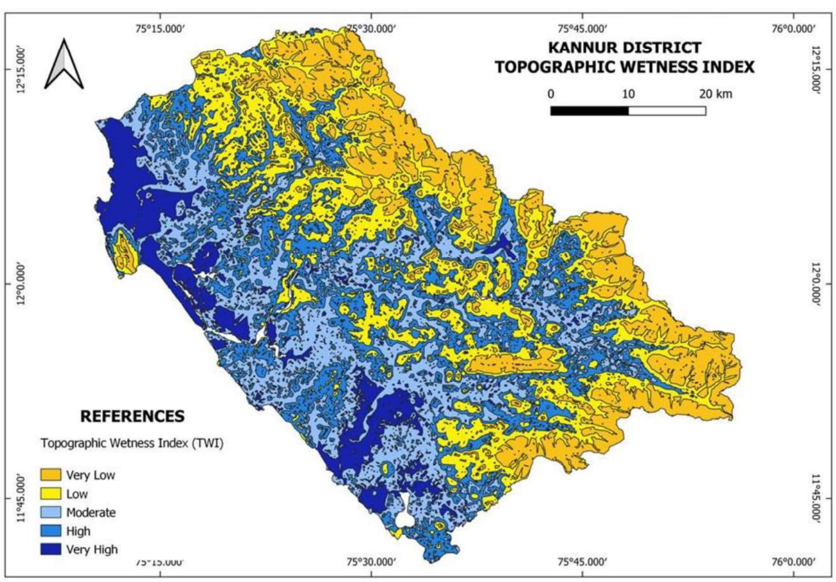


Fig.3

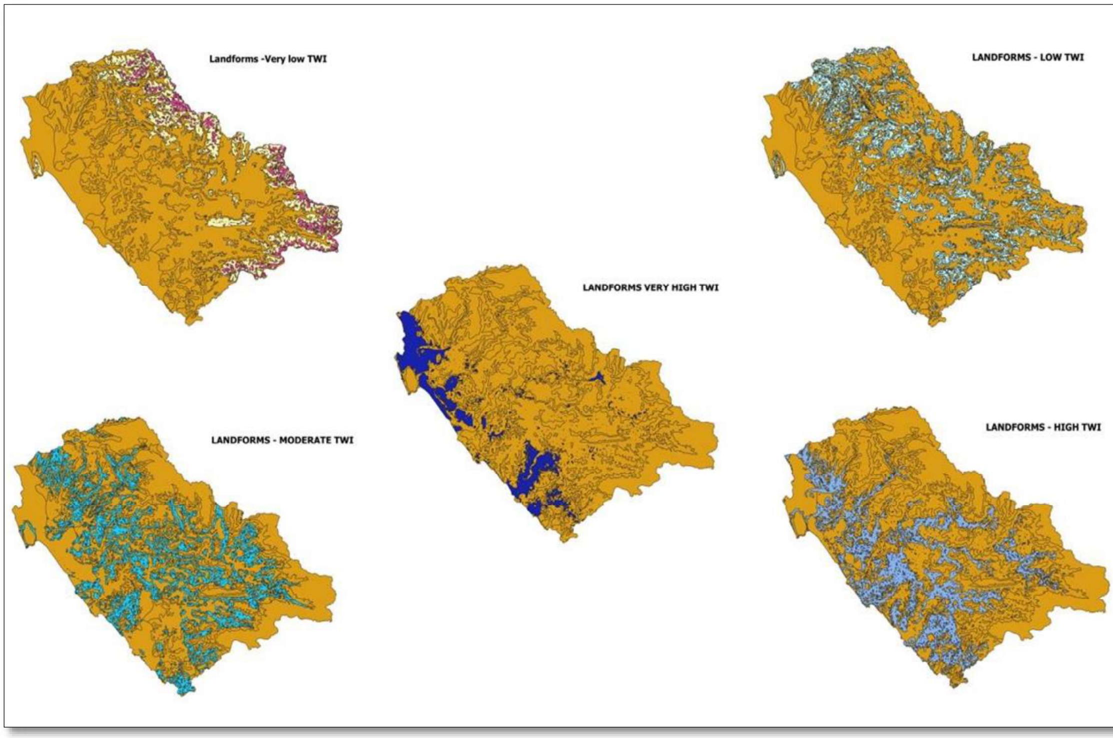


Fig.4

When the TWI is compared with the land form map, mostly steep slope areas and convex slope areas in the east shows low to very low index value. High and very high index values are found in the coastal plain in the west and valley fill areas along the main rivers of the district. Moderate index value found in the undulating denudation uplands of midland. The intersected maps of TWI and land forms are shown in Fig.4.

Conclusion

It is a very useful result to know that there is a correlation between the soil moisture in different terrain condition and the land forms of the district. The area under high and very high index value is vulnerable for flooding during rainy season. Agricultural practices can follow TWI in future for cropping pattern and crop rotation in the district. There is scope for intensive studies in future using this index for agricultural and urban flooding in the district.

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Mapping Child Friendly Public Spaces In Urban Environments: A Case of Chandigarh

Gareema and Ravinder Kaur

Abstract

A child friendly public space (CFPS) is a place that enhances the mobility and freedom of children by providing them with opportunities to develop, play, learn and interact. These largely include recreational and play spaces. With the growing population and with the realisation of great importance of CFPS in a child's life it has become very crucial to focus on the creation of new CFPS as well as on the development and maintenance of existing CFPS in cities. An analysis of CFPS in a planned city is done by taking the case of Chandigarh city by creating a database and mapping these spaces. In the present study, the CFPS are classified into two categories, namely, (i) recreational and play spaces, and (ii) cycling and walking spaces. These two categories are mapped and analysed on the basis of two parameters i.e., child safety and accessibility to these spaces, using geoinformatics. The data is acquired in the form of both, spatial data (e.g., sector map, road map) and attribute data (e.g., population data, crime data). The spatial data is converted into layers using the ArcGIS software whereas the attributed data is sorted in a meaningful manner. These two types of data are then linked and integrated together to create a database. The CFPS are then mapped and analysed using various tools like overlay, buffer etc. The study revealed that the safety and security concerns of the children in the CFPS are the major issues that need to be given attention in the city so that children can have equal, independent and safe access to these places for their growth and development.

Keywords- Child friendly public spaces, Geoinformatics, Database, Mapping

Introduction

A *public space* is a place that is generally open and accessible to all for different purposes like recreation, socialisation, commerce etc. However, *a child friendly public space* (CFPS) is a place that enhances the mobility and freedom of children by providing them with opportunities to develop, play, learn and interact. For example, recreational and play spaces.In this study, the word 'child' denotes someone under the age of 18, in keeping with the United Nations Convention on the Rights of the Child. In urban areas, child friendly spaces give children an opportunity to escape the crowded living conditions. The term 'child friendly space' has been in use since 1999 when UNICEF introduced it as a strategy to ensure children's rights to survival, development, participation, and protection, particularly during times of crisis or instability.(*Child Friendly Spaces - Wikipedia,* n.d.) Now, child friendly spaces are known by different names including Child Centered Spaces (CCS), Safe Spaces, Safe Play Areas, and Child Friendly Spaces/Environments (CFS/E).

City living can have negative impacts on children's development from early childhood through adolescence and beyond because of less physical activity.(Sugar, n.d.) A plethora of scientific research suggests that CFPS have a significantly positive effect on a child's physical, mental, and social well-being as they aid kids in reaching their full potential. Hence, access to these spaces contributes to the fulfillment of children's rights.

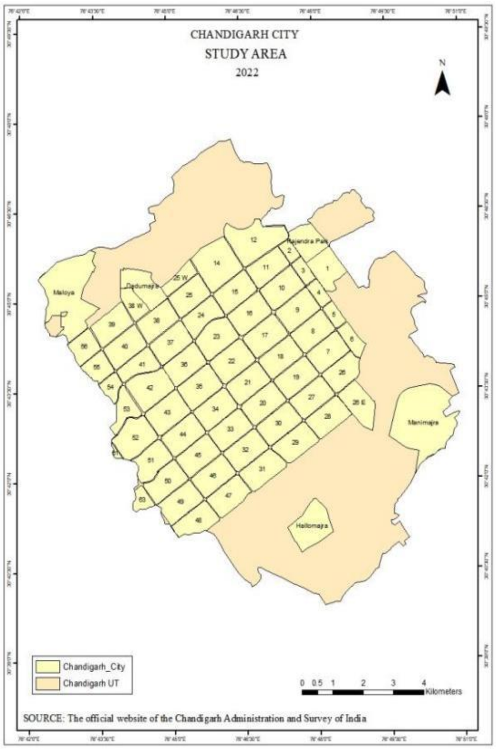
The UN Conference in 1996 declared that the wellbeing of children is the ultimate indicator of a healthy habitat, a democratic society and of good governance. Moreover, various international conventions are also inclined towards giving children the access to secure green spaces including the Convention on the Rights of the Child, the Sustainable Development Goals, the Convention on the Rights of Persons with Disabilities, the Rio Declaration on Environment and Development, the United Nations Declaration on the Rights of Indigenous Peoples, and others.(Sugar, n.d.) Each child, no matter where they live in the city, should be in easy walking distance from a safe and welcoming recreation area like a public green space. In order to attain this objective, it is crucial to take into account obstacles to children's accessibility to green space as well as the safety of such spaces altogether when promoting, developing, or creating such spaces.

So, with the growing population and with the realisation of great importance of CFPS in a child's life it has become very crucial to focus on the creation of new CFPS as well as on the development and maintenance of existing CFPS in cities. In achieving the same, Geoinformatics can play a very vital role in creating and maintaining inventories, mapping the spatial data and analysing the data to ultimately help in decision making for the stakeholders.

Objectives

1) Creation of spatial and attribute database of child friendly public spaces in Chandigarh
2) Mapping child friendly public spaces using geoinformatics
3) Analysing child security and accessibility of these spaces using Geoinformatics

Study Area



Map 1 : Study area

Chandigarh (30.74°N 76.79°E) is a city, district and union territory in India. It is also the capital of two states i.e., Punjab and Haryana. For the present study, Chandigarh city under Municipal Corporation Chandigarh is considered as the study area as shown in Map 1. It includes Sectors 1-56, 61, 63, Manimajra, Hallomajra, Maloya and Dadumajra.

In Chandigarh's original layout plan, the city features a precise hierarchy of open spaces, landscaped areas, recreational places, and tree-lined roadways.(*1. OPEN SPACES AND LANDSCAPING OF CHANDIGARH*, n.d.) Also, there are comfortable vehicular and pedestrian access right to the door step of the houses.

The city has been organised into a cellular system of sectors based on the concept of a neighbourhood unit. Sectors- 1 to 6, 12, 14, 17, and 26 are exceptions to this concept.

Chandigarh was planned as an Administrative Town for a population of 5 lakhs by Le Corbusier and built in two phases: sectors 1 to 30 (First Phase), and sectors 31 to 47 (Second Phase) and then later due to population growth, Third Phase (sectors 48 to 56) was formed.(*CHANDIGARH MASTER PLAN 2031 | Chandigarh, The Official Website of the Chandigarh Administration*, n.d.) These three phases are categorised based on the morphology of the sectors. The southern sectors have the maximum concentration of population. The northern part of the city consists of the main government buildings and in the southeast are the industrial areas, separated from the residential sectors by a greenbelt planted with mango trees.

Hence, it can be said that Chandigarh is a planned city with exemplary architecture and urban design with great emphasis on family life and community living while the planning this city. However, initially it was not planned with the motive of making it a child friendly city. At present, the population of Chandigarh is more than 10 lakhs and children comprise of approximately one third of the total population of the city. The growing population is leading to crowded living spaces in many sectors of Chandigarh causing unequal access of CFPS to the children. Moreover, factors like maintenance of play spaces, crimes against children, road safety, presence of stray animals etc. impact the freedom and mobility of children to access CFPS in the city because these factors have led to unequal and unsafe access to CFPS and ultimately resulting in hindrance to the holistic growth and development of children. Therefore, these issues need to be addressed because needs and requirements of one third of the population can't just be neglected. Hence, it is vital to create a database and map the child friendly public spaces in the city.

In the present study, the child friendly public spaces are classified into two categories, namely, 1-recreational and play spaces, which include open spaces like gardens and parks, and 2-cycling and walking spaces, which include the cycle tracks and pedestrian paths. These two categories were mapped in this study using Geoinformatics. Since, child safety and accessibility to these spaces are the key components of any child friendly space, these two parameters were analysed using Geoinformatics.

Framework Followed

The framework of present study is depicted through a flowchart in figure below. The data is acquired in the form of both, spatial data (e.g., sector map, road map) and attribute data (e.g., population data, crime data). The spatial data is converted into layers using the ArcGIS software whereas the attributed data is sorted in a meaningful manner. These two types of data are then linked and integrated together to create a database. Once the database is created, the CFPS are then mapped and are analysed using various tools like overlay, buffer, query etc.

Database creation involves 2 steps:

1) Database Acquisition
2) Data Processing

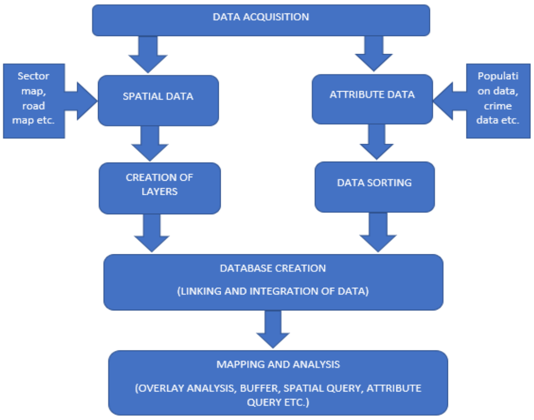


Figure 1 The flowchart depicts the framework followed

Table 1 Database Creation

SR.NO.	DATABASE	ACQUISITION
1	Study area layer	Survey of India, official website of Chandigarh Administration and ArcGIS in-built feature of Bas emap (Streets) also used.
2	Road network layer	Acquired from https://extract.bbbike.org/ website
3	Cycle tracks layer	(Map of 'Plan showing cycle tracks') Acquired from Department of Urban Planning, Chandigarh Administration official website. ArcGIS in-built feature of Basemap (Streets) also used.
4	Public green spaces layer	(Layout plan of each sector to map neighbourhood parks) Acquired from Department of Urban Planning, Chandigarh Administration official website (Map of 'Green spaces and forest areas') Acquired from Department of Urban Planning, Chandigarh Administration official website.
5	Road accident layer	(Road accidents in 5 years i.e., 2016-2020) Acquired from Traffic Police Office, Sector-23, Chandigarh. (List of Critical Points in Chandigarh) Acquired from Chandigarh Traffic Police official website.
6	Population density of children data	(Sector-wise population in 2020) Acquired from Chandigarh Education Department official website. And https://geoiq.io/ website also used.
8	Crime data	(Sector-wise total crimes and crimes against children, 2020) Acquired from Chandigarh Police HQ, Sector-9, Chandigarh
9	Dog bites data	(Jan, 2020- Dec, 2020) Acquired from Government Multi Specialty Hospital, Sector-16, Chandigarh and (Jan,2019- Dec,2020) Acquired from Civil Dispensary-cum-Anti Rabies Clinic, Sector-19, Chandigarh

Table 2 Data Processing

SR.NO.	DATABASE	PROCESSING
1	Study area layer	Digitisation done in ArcGIS to prepare Thematic map
2	Road network layer	Clipped data downloaded from the website using study area layer
3	Cycle tracks layer	Digitisation done in ArcGIS
4	Open green spaces layer	Digitisation of gardens and playgrounds in Google Earth Pro software as polygons Neighbourhood parks digitised in ArcGIS by first georeferencing the layout plan of each sector with the boundary using shapefile method
6	Road accident Layer	Hardcopy data converted into Excel table to sort the locations according to frequency of road accidents Then, accident prone points and roads digitised
7	Population data	Excel table made "Join and Relate" option used in ArcGIS with the study area layer Choropleth map prepared
8	Crime data	Hardcopy data converted into Excel table "Join and Relate" option used in ArcGIS with the study area layer Choropleth map prepared
9	Dog bites data	Hardcopy data converted into Excel table Bar graph and table prepared

Results and Discussion

Spatial Distribution of CFPS in The City

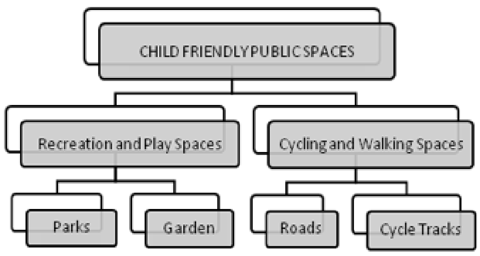
The CFPS in the city are classified as recreation and play spaces, and cycling and walking spaces in the present study as shown in the flowchart in Figure 2.

Recreation and Play Spaces

Recreation and play spaces are those places where children play and do recreational activities—making new friends, sharing, taking turns, and interacting with other children. For example, parks and gardens.

These spaces are shown in Map 2 (a).

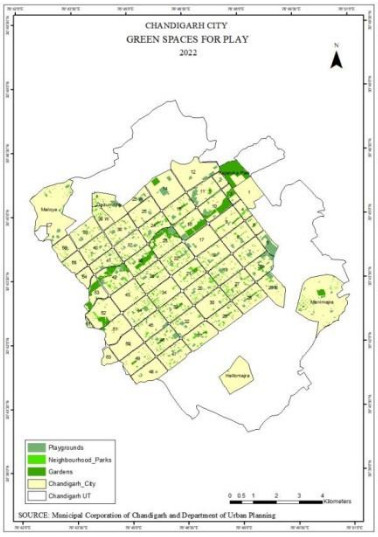
Figure 2 Classification of Child Friendly Public Spaces



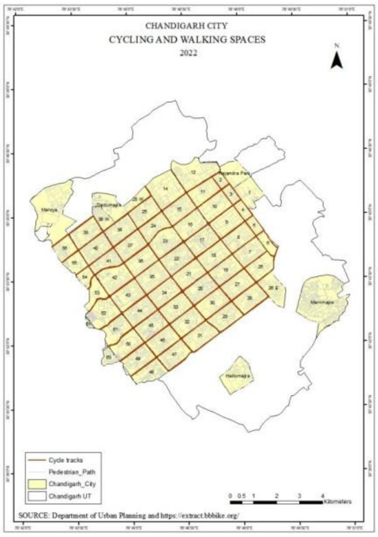
Cycling and Walking Spaces

Cycling and walking spaces are considered as CFPS and include cycle tracks, pedestrian paths, residential area streets, shopping street roads and sector circulation roads in Chandigarh.

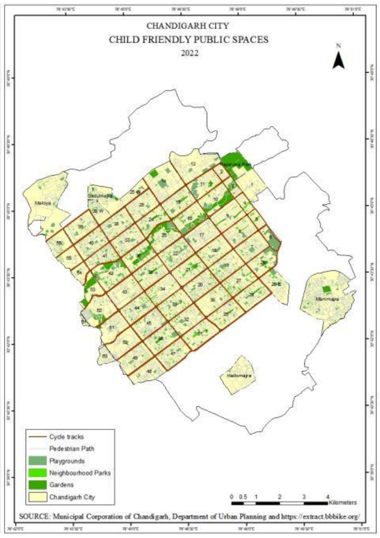
In Chandigarh, the cycle tracks are around each sector but not around peripheral areas like Manimajra, Hallomajra, Maloya and Dadumajra and walking spaces are present in all the areas of the city.



Map 3 : (a) Green Spaces for Play (2022)



Map 2: (b) Cycling and Walking Spaces (2022)



Map 2 Child Friendly Public Spaces (2020)

Distribution of CFPS in the City

Overlay tool in ArcGIS software is used to study the distribution of CFPS in the city.

The spatial distribution of CFPS in Chandigarh is shown in Map 3. It is quite visible on the map that all the sectors in Chandigarh city have recreation and play spaces as well as cycling and walking spaces.

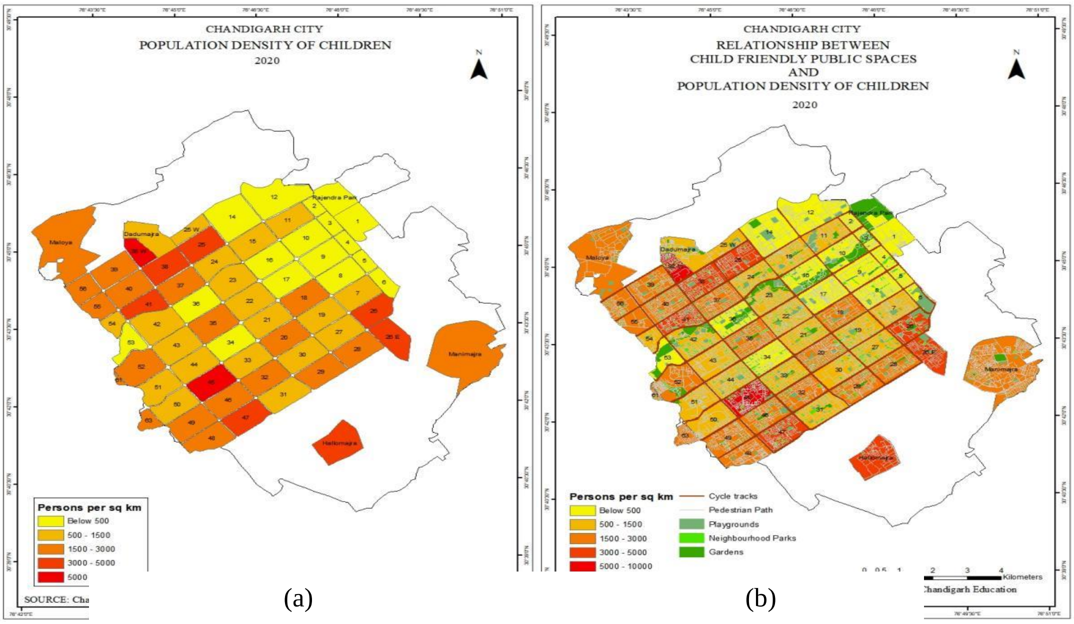
Assessing the Availability and Accessibility of CFPS

Cycling and walking spaces are evenly distributed throughout the sectors as compared to the recreational and play spaces. The recreational and play spaces are concentrated in the central part of the city. Somehow, the peripheral areas like Sector- 50, 51, 54, 63, Maloya and Hallomajra have relatively very few recreation and play spaces along with no cycle tracks and unevenly distributed walking spaces in Manimajra, Hallomajra, Maloya and Dadumajra.

Distribution of CFPS and population density of children

ArcGIS software, an attempt has been made to understand the relationship between CFPS and the population density of children.

It can be seen in Map 4 (b) that the recreation and play spaces are concentrated more in the central part of the city whereas the population density of children is more towards the peripheral areas.

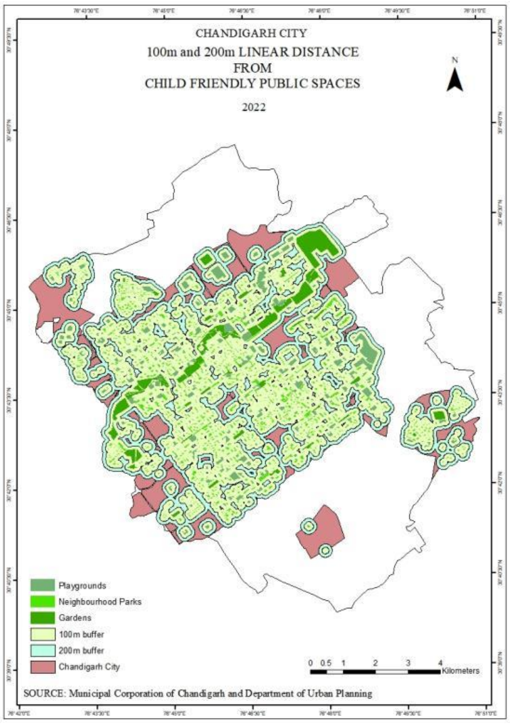


Map 4 (a) Population Density of Children (2020) (b) Relationship Between Child Friendly Public Spaces and Population Density of Children (2020)

Accessibility of CFPS

In order to analyse the accessibility of CFPS, 100m and 200m buffers were created around the recreation and play spaces. This helps to recognise the areas in the city which lack these spaces and have failed to cater to the needs of children living in those areas. Map 5 shows that children don't have easy to access to recreation and play spaces in large parts of the peripheral areas, especially in Maloya and Hallomajra.

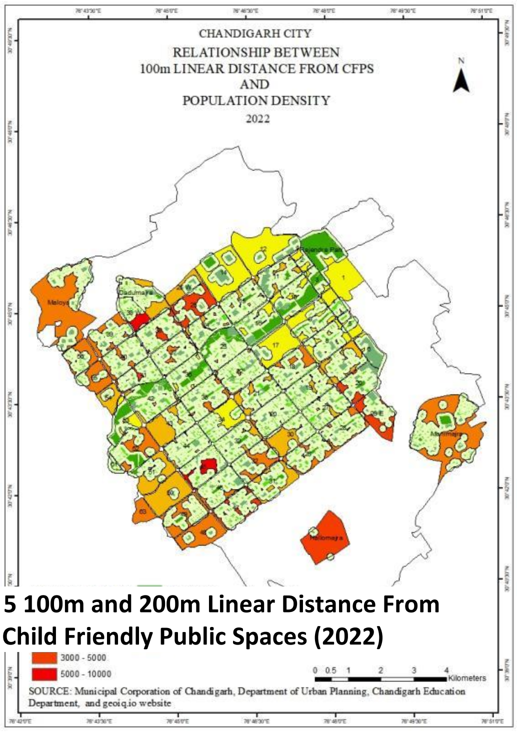
Map 6 (a) shows that areas even with high population densities of children like sectors- 45, 38 West, 38, 25, 26 and 26 East have some places which do not have any recreation or play space within 100m proximity. Map 6 (b) highlights areas with their children population densities that lack CFPS in their 200m range.



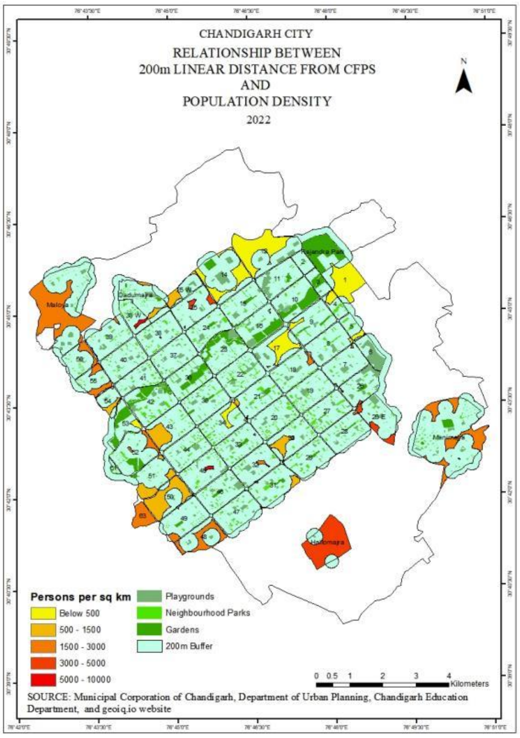
Assessing Child Safety and Security

Accident prone locations in the city

Overlay and Directional Distribution (Standard Deviational Ellipse) tools are



Map 5 100m and 200m Linear Distance From Child Friendly Public Spaces (2022)



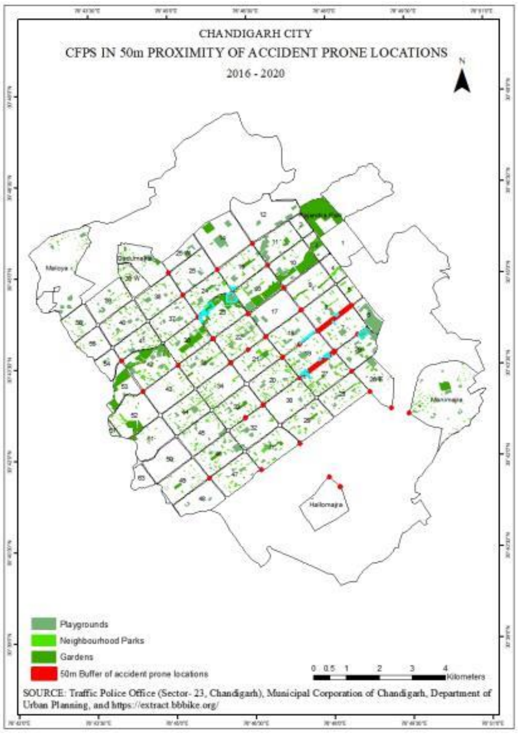
(a) (b)

Map 6 (a) Relationship Between 100m Linear Distance From CFPS and Population Density (2022)
(b) Relationship Between 200m Linear Distance From CFPS and Population Density(2022)

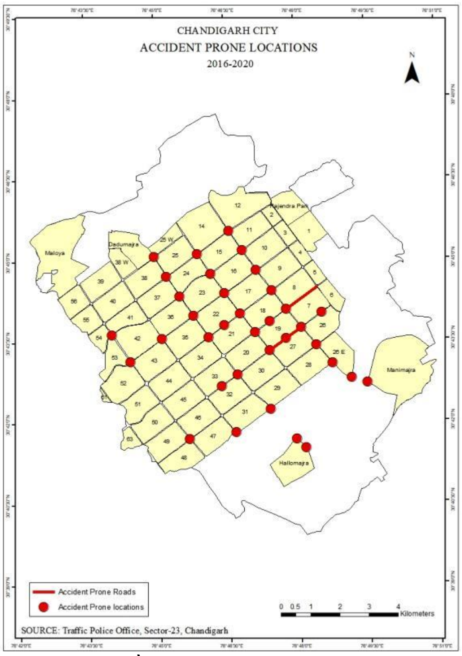
used to analyse the accident-prone locations in the city. It is highlighted in Map 7 (a) that the round-abouts on the roads running parallel to each other across sectors 15,16, 17,18 and 19, Sector- 7/8 dividing road and Sector-19/27 dividing road have been some of the most accident-prone locations in Chandigarh city in the past 5 years. The accident-prone locations are highly concentrated in the central and eastern part of the city. (Map 7 (b))

CFPS in 50m proximity of accident-prone locations

Using Overlay, Spatial Query and Buffer tools the CFPS in 50m proximity of accident-prone locations are determined.



There are a total of 24 recreation and play spaces which are in 50m proximity of the accident-prone locations as shown in Map 8. It is quite obvious from Map 8 that the CFPS in the southern and western parts as well as those within the sectors are more safe for the children from the view of traffic safety.



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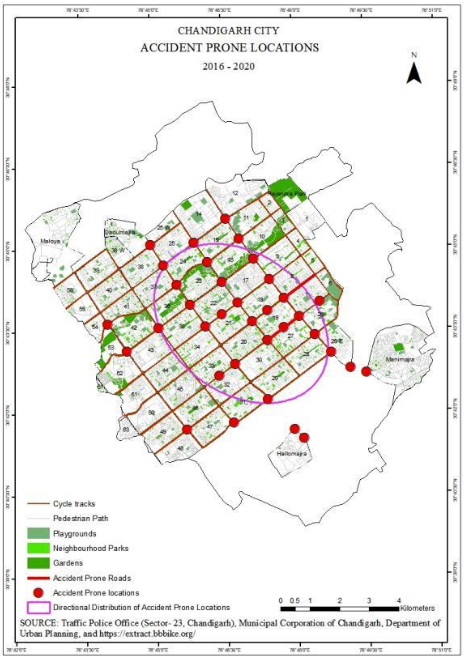
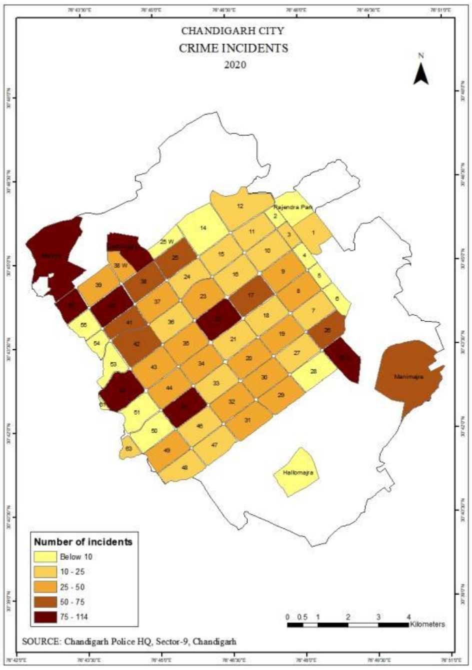
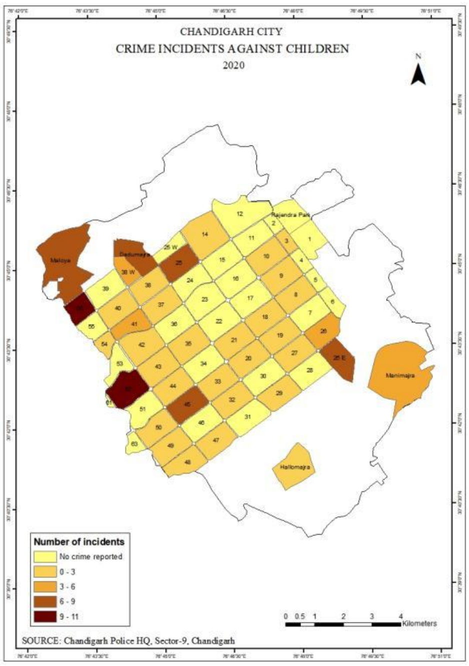


(b)

Map 8 (a) Accident Prone Locations (2016-2020) (b) Accident Prone Locations (2016-2020)





(a) (b)

Map 9 (a) Crime Incidents (2020) (b) Crime Incidents Against Children (2020)

Crime incidents in the city

Choropleth maps are prepared for total crime incidents and crime incidents against children.

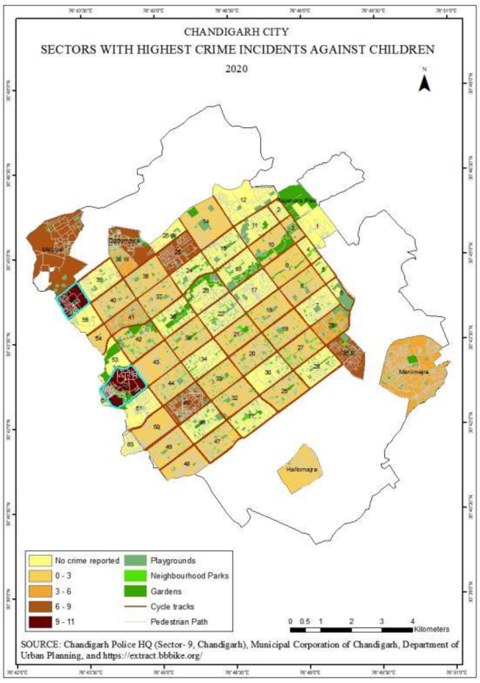
It is evident from Map 9 (a) and Map 9 (b), that the peripheral sectors especially in the west have high crime incidents as well as high crime incidents against children. Sectors- 52 and 56 have the highest incidents in both. The northern sectors have the least incidents. There are also many sectors where no crime incident against children was reported.

Sectors with highest and lowest crime incidents against children

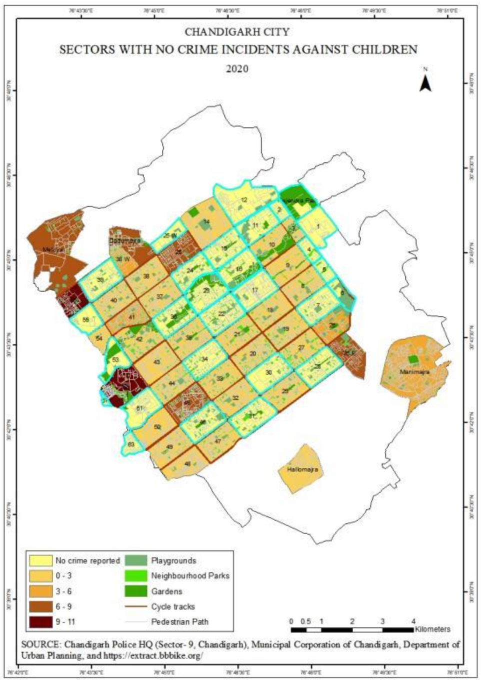
Overlay and Attribute Query Building tools are used to analyse the sectors with highest and lowest crime incidents against children.

The highest crime incidents are reported in Sectors- 52 and 56 as indicated in Map 10 (a).

28 sectors with no crime incidents are- 1, 2, 4, 5, 6, 7, 11, 12, 15, 16, 17, 21, 22, 23, 25 West, 28, 29, 31, 34, 36, 39, 46, 51, 53, 56, 61, 63 and Rajendra Park. These are highlighted in Map 10 (b).



(a)



(b)

Map 10 (a) Sectors with Highest Crime Incidents Against Children (2020) and (b) Sectors With NO Crime Incidents Against Children (2020)

Relationship between crime incidents against children and population density of children

By using Overlay tool, the relationship between crime incidents against children and population density of children is determined.

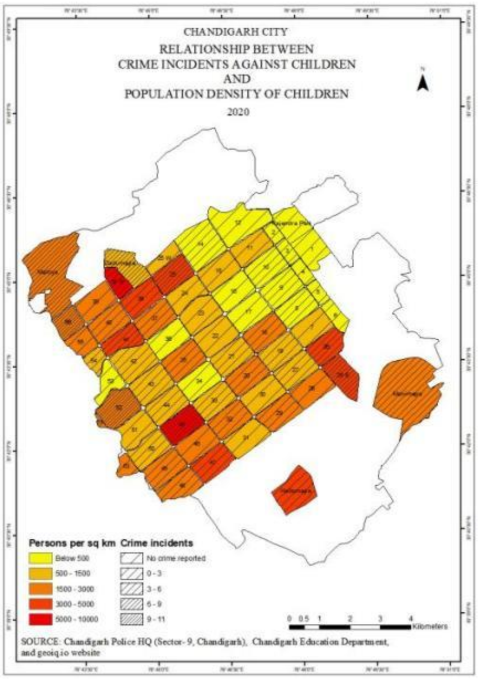
It is evident from Map 11 that both, crime incidents against children and the population density of children are mostly higher in peripheral areas of the city except northern sectors.

Dog bite incidents in children

The analysis of dog bite cases among children throughout the city is not done by using the geoinformatics tools because of non-availability of Sector-wise data.The Chandigarh city has been witnessing a rapid increase in the stray dog population, and according to the MC,

Plate 1 (a) Stray dog in a park in Sector-44

the number of dog bite cases has also gone up by 35% in the past five years.



Map 11 Crime Incidents Against Children And Population Density of Children (2020)

Plate 1 (b) A park having an improvised door to stop dogs from entering the park in Sector-41

According to the latest animal census, conducted by the UT animal husbandry and fisheries department, the number of stray dogs reached 12,900 in 2019, up from 7,847 in the last census conducted in 2012. Dog bite incidents among children reported in last 2 years i.e., Jan,2019- Dec,2020 are given below in Table 3.Every year more than 2500 cases of dog bite are reported in children. On an average every month more than 200 dog bite patients (children) are observed in Chandigarh.

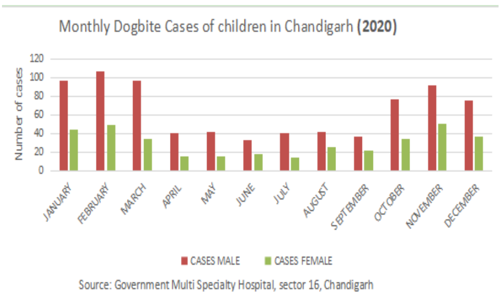
Dog bites in children are frequent and this can be seen in Figure 3 (a) that even during the lockdown months in 2020 the total number of incidents reported in Govt. Multi-Speciality Hospital, Sector-16 are more than 50.From Figure 3 (b) it is evident that dog bite cases are invariably observed in each age group.

Assessing the Most and Least Child Friendly Sectors of the City

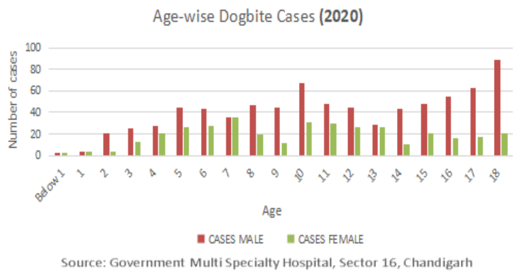
Using the previously attained results, the most and least child friendly sectors in the city are assessed. It is found that Sectors- 39, 46 and 61 are the most child

Table 3 Dog bite cases in Chandigarh (2019-2020)

YEAR	SOURCE	MALE	FEMALE	TOTAL
2019	Sec-16	-	-	-
	Sec-19	1863	640	2503
2020	Sec-16	777	360	1137
	Sec-19	1358	467	1825
TOTAL		3,998	1467	5465



(a)

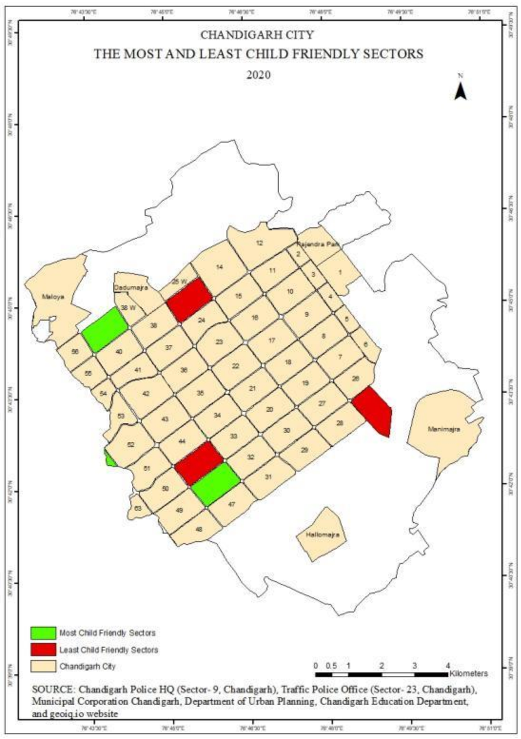


(b)

Figure 3 (a) Monthly dog bite cases of children in Chandigarh, 2020 and (b) Age-wise dog bite cases in Chandigarh, 2020

friendly sectors because these sectors have zero crime incidents against children, have population density of children more than 1500 and the recreation and play spaces are within 200m, if not 100m reach from every corner of the sector. In addition, there are no accident prone locations near these sectors, except Sector- 46 which has 1 such location nearby.

On the other hand, Sectors- 25, 26 East and 45 are the least child friendly sectors of the city. In these sectors more than 5 crime incidents against children were reported. Also, these have population density of children more than 3000 and yet there are areas in these sectors from where the recreation and play spaces are in neither 100m proximity nor 200m proximity. Moreover, there are 3 accident prone



Map 12The most and least Child Friendly Sectors of the City locations near each sector, except Sector- 45 which has no such location nearby.

Conclusion

CFPS play an important role in a child's life as it helps to develop physical, social, emotional and moral capacities. Safe and secure access to these spaces is the right of every child. With growing urbanisation in cities, it is important to maintain the mobility and freedom of children. Chandigarh is a planned city which was initially not planned to be a child friendly city and now children constitute around one-third of the city population. After analysing the existing CFPS in the city, the following conclusions have been drawn:

- CFPS Distribution in Chandigarh

1. Recreation and play spaces are unevenly distributed. They are concentrated in the central part of the city.
2. Also, there are places within areas with high population density of children which do not have CFPS in their 100m or 200m proximity . This means all children don't have equal access to these spaces.
3. Cycling and walking spaces are evenly distributed in sectors but Manimajra, Hallomajra, Maloya and Dadumajra completely lack cycle tracks.

- Safety and Security of the Children in the CFPS

1. Crime rates are higher in the peripheral areas. Therefore, child security is a major concern in these peripheral areas.
2. The accident-prone locations are higher in the central and eastern parts of the city. Hence, traffic safety is the major concern in the these parts of the city because children living in sectors with lesser CFPS have to travel through unsafe paths to access the sectors with higher concentration of CFPS.
3. Presence of street dogs makes all CFPS unsafe for all age groups of children.

- Independent and Safe Access to CFPS

1. The independent and safe access to CFPS depends upon the safety and security of the children in the CFPS. Hence safety and security of children must be the priority to enhance the mobility and freedom of children.
2. Children have comparatively safer access to CFPS within their sectors because then they do not have to traverse through accident prone locations.
3. Absence of CFPS within easily walk-able distance and presence of street dogs hinders the accessibility to CFPS throughout the city for all age groups.

To sum up, it can be said that the safety and security concerns of the children viz traffic, crime incidents against children, and dog bite incidents in the CFPS are the major issues that need to be given attention in the city so that children can have equal, independent and safe access for their growth and development.

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Mapping: Impact of Population Growth on the Dynamics of Resources: A Case Study of Kultali Block, South 24 Parganas, West Bengal

Jitendra Shukla and Kalyan Sardar

Abstract

This article deals about the impact of population growth on dynamic of resources of Kultali block. Recently rapid growth of population was recorded in the block. Since 1901 population growth has immensely affected the resources of the block. As per 2011 the total population of the block is accounted as 229053 in which 117562 male and 111491 is female population, which is 2.80% respectively to the total population of the district of south 24 parganas. The total area of the block is 3.07% of the block and 11.22% of the district to the state. The linkage between resource and dynamics of population is less documented in the selected study area. The study areas are very important because these areas are situated in transition zone of Sundarbans biosphere reserve.

A tremendous change has taken place on existing resources of the Kultali block. There are nine gram panchayat and 43 revenue villages. The administrative boundary has been continuously changing owing to ever increasing population. The impact of population growth drastically affecting the land covers such as forest, soil, and aquatic resources of the block. The present paper endeavours to map the rapidly growing population and its impact on dynamics of resources.

Key words: Population Growth, Dynamic of Resources, land cover, Transition Zone, Sundarban.

Introduction

The scientific and technological developments of the past two hundred years have brought many benefits, material and otherwise, to mankind but they have also been responsible for many serious problems. Here, in this study, attention is focused upon one, perhaps the most important, of this problem: the relationship between population and resources.

As Michael Chisholm has pointed out, the world is now faced with novel problems in relation to the environment, the problem concerning which man does not know their full nature nor their full significance; furthermore, the whole art of social management (to which one might add economic management), necessary to meet these problems, is in its infancy.

Many have long argued that man’s science and technology have raced ahead of his capacity to adjust himself ecologically, economically and socially to the new conditions he has somewhat irresponsibility and uncaringly precipitated. Few thinking people would indeed doubt this assertion. the great crucial, problem now is whether or not is too late: whether, indeed, man can rescue himself from the apocalyptic race towards doomsday.

Population dynamics examines the short- and long-term changes in the size and age composition of a population, and the biological and environmental processes

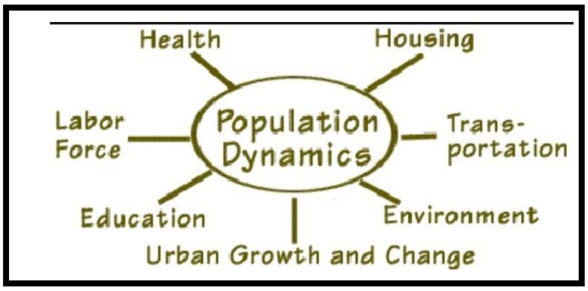


Figure1: The relationship between population dynamics and development variables.

(Source: PDRG, http://www.usc.edu/sppd/research/popdynamics) .

A scrutiny of the land use land cover change data in decadal growth reveals that while the natural resources cause like erosion, accretion, submergence due to sea level rise and corresponding geomorphic changes can accountforthe66%oflanduseandlandcoverchangeinthestudyarea.Anthropogenicforceslikepopulation growth, conversion for quick economic return, urbanization and unwise exploitation of natural resources account for the rest. (Sugata Hazra,Tuhin Ghosh,Rajashree Das and Goutam Sen, School of Oceanography Studies, Jadavpur University;kolkata70003 ;India)

The linkage between resource and dynamics of population is a less documented in the selected study area. The study areas are very important because these areas are situated transition zone of Sundarbans biosphere

influencing those changes. It deals with theway populationsareaffectedbybirthanddeathrates,andbyimmigrationandemigration,andstudiestopicssuch as ageing populations or population decline. As shown below, understanding population in detail is central for many servicesareas.

reserve.Populationincreasesintheseareasalsocausedincreasedofdemandforfoodandarableland.Moreover, agricultural expansion in the form of shrimp farming encouraged deforestation and encroachment of coastal land, which in turn contributes to micro climatic change. Population growth also associates with increased demand for energy, especially fuel wood from forest, which provides energy to virtually all rural frontier population of the studyarea.

Selected block Kultali, South 24 Parganas, West Bengal, are filled with natural resources including forest resources, water resource, soil resource and population resource. In spite of people in these areas facing different types of difficulties related to socio-economic environment like poverty, crime, gender inequality, and unemployment, lack of health facility and oppression of women. This study area is located about 120 km. away from Kolkata metropolitan, so it is not very unfortunate, In spite of location of the area at the adjacent part of Kolkata metropolitan. There is extreme inequality of resources among the people in this area.

Objectives of theStudy

The main aim of this research is to find out the answer of the question through scientific procedure. The following are the main objectives of this research work.

1. To analyze the relationship between people and resources in the study area.
2. To find out the problem and mitigating process for population growth and its impact on the resources.
3. To examine the impact of resources.

Methodologies and database

The study relies heavily on secondary and primary data gathered from a variety of sources. The 2011 census provided population data, while the district statistical handbook provided a wealth of information. The household survey and people's perceptions in this area were used to acquire primary data. Following the data collection, various approaches were used to analyze the data and prove the study's hypothesis, which is detailed below.

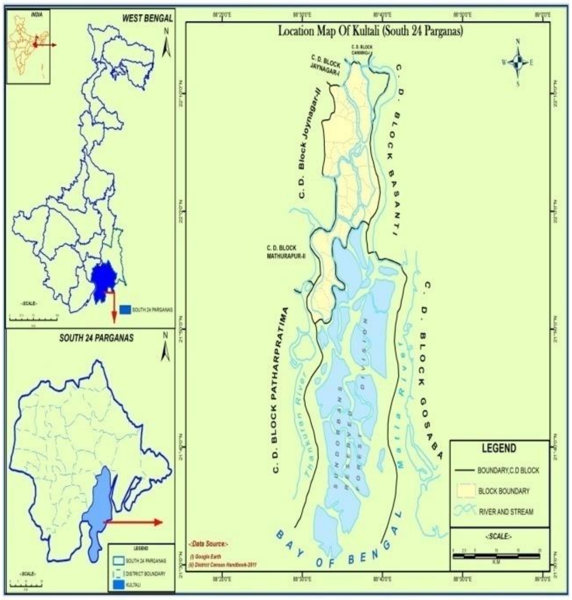
The data collected from the field will be included and unnecessary data will be cleaned. Then the data will be transcribed, classified and grouped and analyse to derive narrative from various informants. The survey data will be coded and the EXCEL and SPSS programmed, QGIS, ARC GIS will be used to generate table of frequency, mapping, cross tabulation to check the validity of the data and then the result will be described in the later section.

1) **Data processing and analysis**

The data collected from the field will be included and unnecessary data will be cleaned. Then the data will be transcribed, classified and grouped and analyze to derive narrative from various informants. The survey data will be coded and the EXCEL and SPSS programmed, QGIS, ARC GIS will be used to generate table of frequency, mapping, cross tabulation to check the validity of the data and then the result will be described in the later section.

Some formula and methodology to represents the population dynamics are mentioned below:

Population growth rate:
Population(time-1) - Population (time 2) /



Population (time1) * 100
Population density: Number of people / land area.
Population doubling time: 70 / Percentage of growth per until time.
Exponential population projection formula:

$$Pt=Poek^{\Delta t}$$

Where, Pt- Population at time T
P_{O}- population at time zero
K- Growth rate
$^{\Delta t}$:Elapsed time in years from time zero
E = Euler's numbers.

Basic equation of population dynamics:

dN /dt =r.N

Where dN /dt = instances rate of change N With time "t"

R= average individual; contribution to [population growth.
N= the population size.

The Study Area

Kultali is a community development block in the South 24 Parganas district of West Bengal, India. it is situated 22°05′12″ N and 88°35′37″ E, and average elevation 7 meters (23 feet) above sea level. The Kultali CD block is bordered by 4 different blocks which are Jaynagar I and Canning I CD blocks in the north, the Basanti CD block in the east, and the Jaynagar II CD block in the west. The total area covered by the kultali block is 870 km^2 (335.909 square miles). There are

Year	Density per Sq Km
1961	220
1971	350
1981	400
1991	600
2001	613.82
2011	750

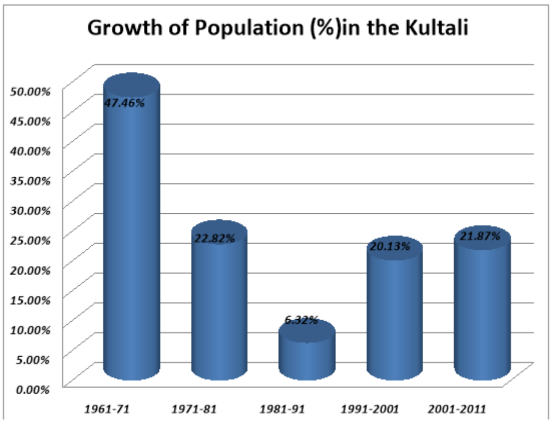
nine-gram panchayats, 120-gram sansads

(village councils), 46 Mouzas, and 43 inhabited villages in the panchayat samity. The two police stations service the entire block, the Maipith police station serves the coastal part of Kultali, and the Kultali police station serves the majority of the area. Jamtala is the CD Block's headquarters. Kultali is unique in that it is a component of the Indian Sundarbans. This area consists of approximately 30 large and small islands separated by numerous tidal streams and rivers. Matla and Bidyadhari are two important rivers that flow from the two sides of the Kultali Block.

Population Growth of kultali block

2017 UN projections show a continued increase in population in the future (but a steady decline in the population growth rate), with the global population expected to reach 9.8 billion in 2050 and 11.2 billion by 2100. Estimates by the UN Population Division for the year 2150 range between 3.2 and 24.8 billion; mathematical modelling supports the lower estimate. Some analysts have questioned the sustainability of further world population growth, highlighting the growing pressures on the environment, global food supplies, and energy resources. Solutions for feeding the extra billions in the future are being studied and documented.

From the figure of population growth, it is seen that the highest point of population growth in the period of 1961-1971 is 47.46% then the period of 1971 to 1981 the population growth rate was 22.82 %. Hence the present time in this area population growth is very high, 2001-2011 the Growth rate of population was around 21.87%.



From the density of population (1961-2011) shows the population density of the kultali block, South 24 Parganas. the density of population in 1961 is 220 /sq. km where in the 2011 The density of population is 750/sq. km; therefore, the growth of population density is 241% and Within 2001-2011, percentage of population density is 22%. So, population density growth rate per year is 4.82%

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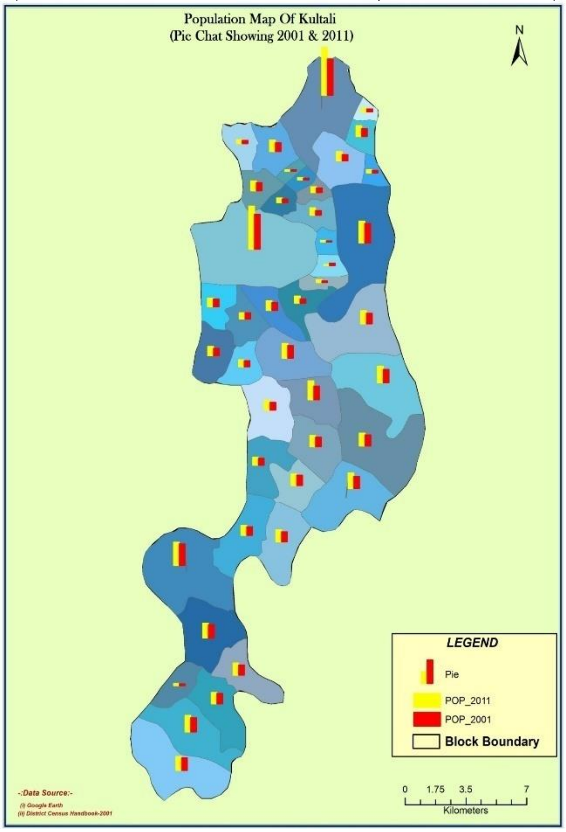
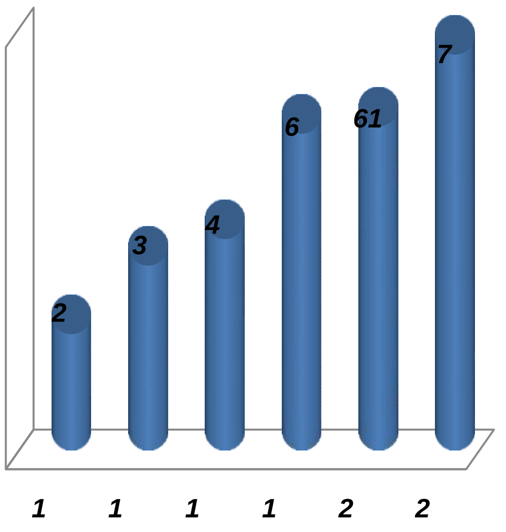
Year	% Of Growth
1961-71	47.46%
1971-81	22.82%



Density of Population (in Sq. Km) Kultali Block

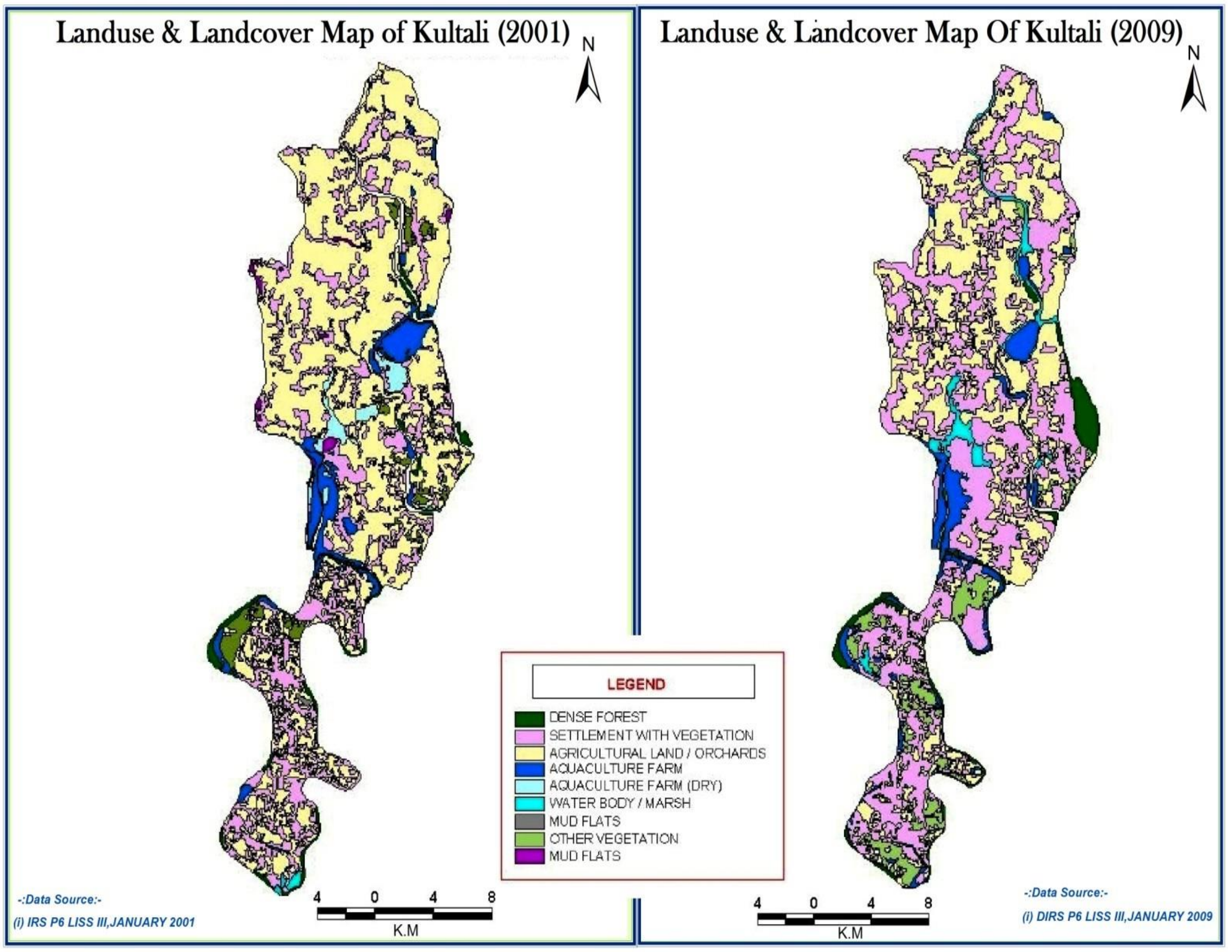


Land use And Land Cover Changes in the Study Area

Land use and land cover changes are familiar phenomena in this study area. From the satellite imagery data analysis, it isclear how land use and land cover change is occurring in the kultali area. The main reason for change in land use under land Cover through the growth of population.The above data and maps show that thekm and 2009 Man Land Ratio is 0.0004095 sq. km, with the increase of populationover a period of Time,the amount of

man land ratio (total agricultural land/population) 2001 is 0.0006922 sq. agricultural land is decreasing at double rate and how settlement is being made for more population accommodation. Not only the agricultural land is decreasing and population are increasing as well as Natural resources and ground water is decreasing at a higher rate and is likely to end in the future.

SL NO	LANDUSE CLASSES		
		2001	2009
1	**Dense Forest**	2.461	5.841
2	**Settlement with Vegetation**	45.673	77.568
3	**Agricultural Land / Orchards**	130.10	93.818
4	**Aquaculture Farm**	9.784	10.651
	Aquaculture Farm (Dry)	5.206	7.573
5	**Water Body / Marsh / Swamp**	0.128	
6	**Mud Flats**	0.585	
	Total	**195.957**	**195.451**



Conclusion

From the overall analysis of the entire region, we can conclude that population growth is very much effective on the dynamics of resources. Population increases in these areas also caused increased of demand for food and arable land. Moreover, agricultural expansion in the form of shrimp farming encouraged deforestation and encroachment of coastal land, which in turn contributes to micro climatic change. Population growth also associates with increased demand for energy, especially fuel wood from forest, which provides energy to virtually all rural frontier population of the study area.

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Pattern, Growth and Gaps in the Availability of Healthcare Infrastructure of Himachal Pradesh

Khub Ram and Seema Chaudhary

Abstract

The analysis of the study reveals that there has been increase in absolute numbers of healthcare infrastructure from 1991 to 2011 in Himachal Pradesh. However, the development of health infrastructure does not exhibit much striking spatial pattern as there exists a wide gap between the development blocks. The growth in the healthcare infrastructure also shows perceptible changes from 1991 to 2018 of the tree tier system. The number of blocks having moderate and high level of growth shows gradual increase in healthcare infrastructure. The study has also tried to analyse the gaps in existing and required health infrastructure as per the population norms set up by the Indian Public Health Standards (IPHS). The analysis brings out that almost all the blocks have shown significant development in relation to the formed population norms for the three-tier system. However, the general hospitals and dispensaries have not shown significant development in relation to population requirement and require proper attention and infrastructural development.

Keywords: Health, Infrastructure, Economic Growth, Healthcare

Introduction

Health is a vital component of the human life and the healthcare is considered as constitutive element of well-being. However, still it has been one of the most neglected aspects of development in India (Dreze and Sen, 2002). Health if considered under broad sense of "quality of life" refers to absence of disease. It therefore becomes a universal goal if cultural variations encrypt in the way. Health is not a component but is an expression of development; it is a combination of physiological development associated with reduced mortality-mobility trends and the capacity of both mentally and physically creative work (Bhasin, 1994). The health of the population in any area is determined by the availability of medical infrastructure in that particular area (Varkey, 2020). The distribution of health infrastructure is not uniform everywhere and it reflects disparities. In order to bring out these imbalances, the cartographic techniques play a vital role. Thus, with the help of suitable cartographic approach present research article tries to bring out the regional disparities in health infrastructure of Himachal Pradesh. Precisely it tries to bring out in details the changes in terms of pattern, growth and gaps in the availability of healthcare infrastructure in the state from 1991 to 2011.

Objectives

The study is focused to achieve the following major objectives:

I. To analyse the spatial pattern of healthcare infrastructure in Himachal Pradesh

II. To examine the growth and gaps in the availability of healthcare infrastructure in Himachal Pradesh.

Study Area

Himachal Pradesh is the northern-western Himalayan state of India and is primarily a hilly and mountainous in nature. It has deeply dissected topography complex geological structure and rich temperate flora. Geographically it lies between $30^0$22'40" to $33^0$12'40" North latitudes and $75^0$45'55" to $79^0$04'20" East longitude (Fig. 1.1). To the east it forms Indian border with Tibet (China), to the north of it lies the state of Jammu and Kashmir, Uttarakhand is in the south-east, Haryana and Uttar Pradesh in south and Punjab is situated in the west. It extends from the Shiwalik hills in the south to the greater Himalaya range, including a slice of trans-Himalaya in the north. It covers a geographical area of 55,673 km^2 which is 1.69 per cent of total geographical area of India. According to the Census of 2011, Population of Himachal Pradesh is 68.65 lakhs. Administratively state comprises of 12 districts 97 Tehsils, 49 Sub-Tehsils and 78 blocks (Statistical Abstract of Himachal Pradesh, 2015).

Database and Methodology

The present study has been mainly based on secondary data sources and block has been selected as the unit for analysis. The

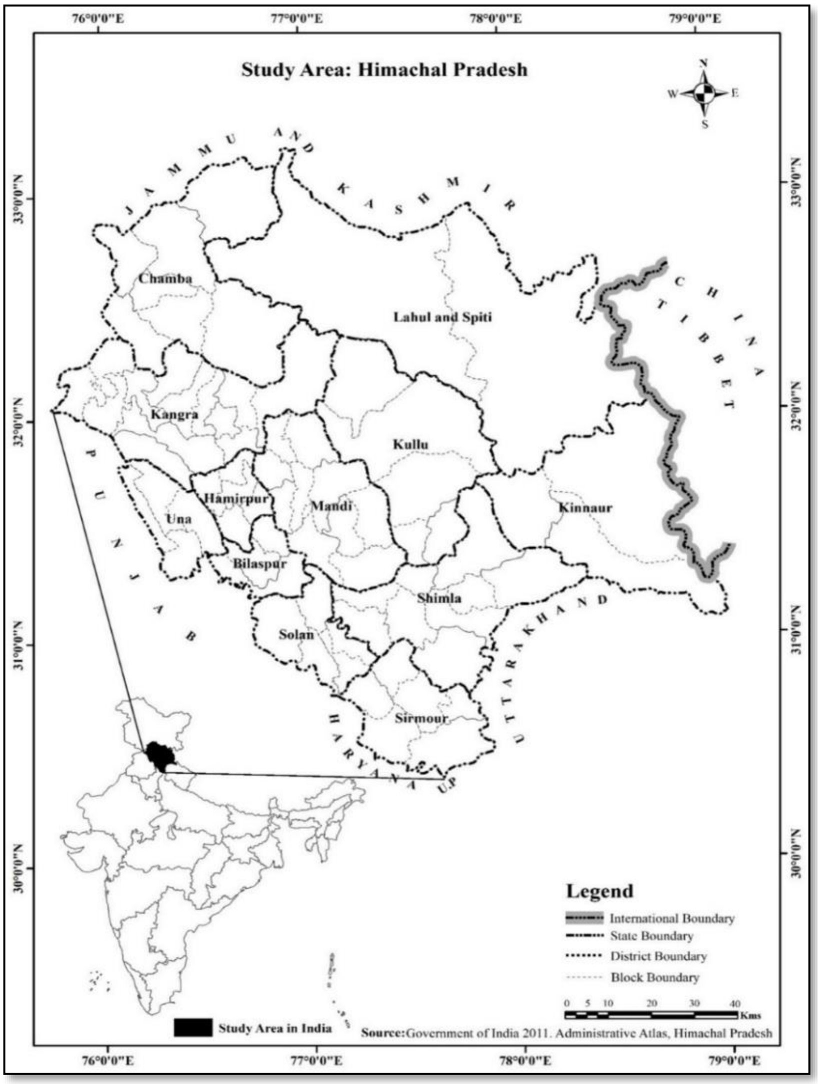

Fig. 1

collected data has been tabulated, processed, analysed and interpreted by applying suitable statistical and cartographic techniques. A composite index has been used to show the changes in the overall pattern of the healthcare infrastructure during selected period. In order to understand the growth and gaps of healthcare infrastructure, 1991 has been taken as base year for the study. In order to find the levels of gaps in healthcare infrastructure in the study area the availability of health infrastructure actually presents in terms of relation to population and the actual requirement of healthcare infrastructure in relation to population norms by IPHS (Indian Public Health Standards) has been calculated. Since no clear norm for establishing a dispensary has been obtained, the population for setting of dispensaries for present study has been assumed to be 10,000 people. In order to bring out a composite picture of gap in the health infrastructure the blocks have been analysed on the basis of the categories namely surplus, average, and deficit blocks.

Results and Discussion

Change in Spatial Pattern of Healthcare Infrastructure

The disparity exists at all levels ranging from the district, tehsil, and even at the village level. The spatial patterns of healthcare infrastructure keep on changing with time and reflect improvement in certain areas on one hand while may show gloomy results in some other areas. The Indian healthcare infrastructure exist at three tiers namely CHC, PHC, and sub-centres. Hospitals and dispensaries are also important component of the structure. In the present study overall health infrastructure has been discussed. The composite score has been calculated for all the CHCs, PHCs, sub-centres, general hospitals and dispensaries. It provides us an overall picture of the health infrastructure in the state of Himachal Pradesh. The changes in pattern have been discussed in terms of areas under five levels these are:

I. Areas with Very High Composite Score in Overall Health infrastructure (More Than 1.50)

In 1991 there was only one block namely Mashobra which performed good in overall status of the health infrastructure. It was because the Mashobra block hadthe highest number of health institutions and the highest number of sub-centres among all the blocks in 1991 (Fig. 1). The Bilaspur Sadar block moved up to the category of very high composite score of the overall status of the health infrastructure in 2011. The area of the blocks with very high status of health infrastructure was 1.44 percent in 1991 which slightly decreased to 1.29 in 2011 (Fig. 3). The decrease in the proportion of the blocks with the very high availability of health institutions has been due to the increased number of blocks during the study time period. In 1991, the areas with very high composite score were spatially distributed in the southern part of the study area but in the next decades the distribution has shifted towards the south-western part of the study area which included the Bilaspur block of Bilaspur district.

II. Areas with High Composite Score in Overall Health Infrastructure (1.00 – 1.50)

The areal coverage of the blocks with high composite score in overall health infrastructure was 5.79 percent in 1991 which includes Nalagarh, Rampur, Mandi

Sadar and Nurpur blocks. In 2011 there was an increase of only one block in this category which increased the number to 5.This category comprised of 6.49 percent area of the total number of the blocks including newly created Fatehpur block of Kangra district. In 2011, the Nurpur block again moved to the category of high composite score due to the significant increase in the availability of dispensaries and PHCs and Lambagaon and Mashobra block were added to this category in 2011. In 1991 areas of high composite score were spatially isolated in the eastern, south-western, central and western part of the area. The spatial distribution has remained almost unchanged during 1991 to 2011 with a little addition of Lambagaon block in the central part of the south-western region of the study area.

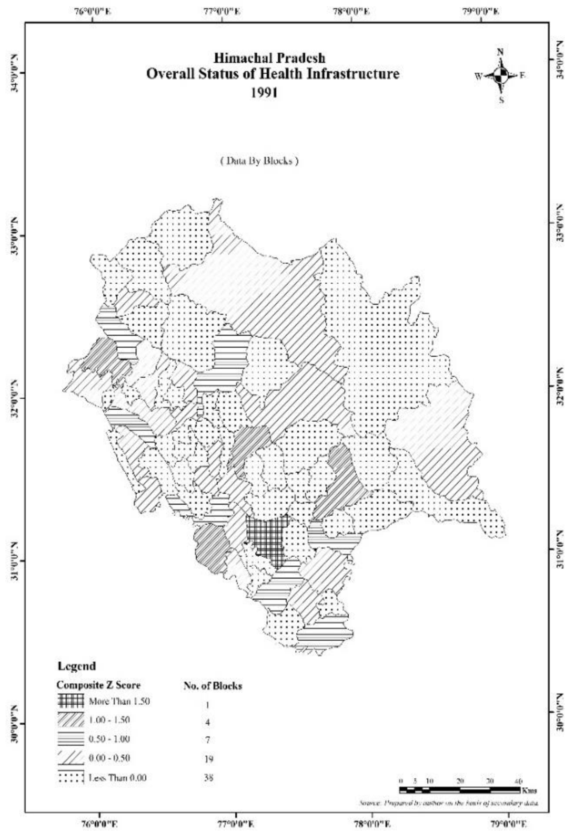

Fig. 2

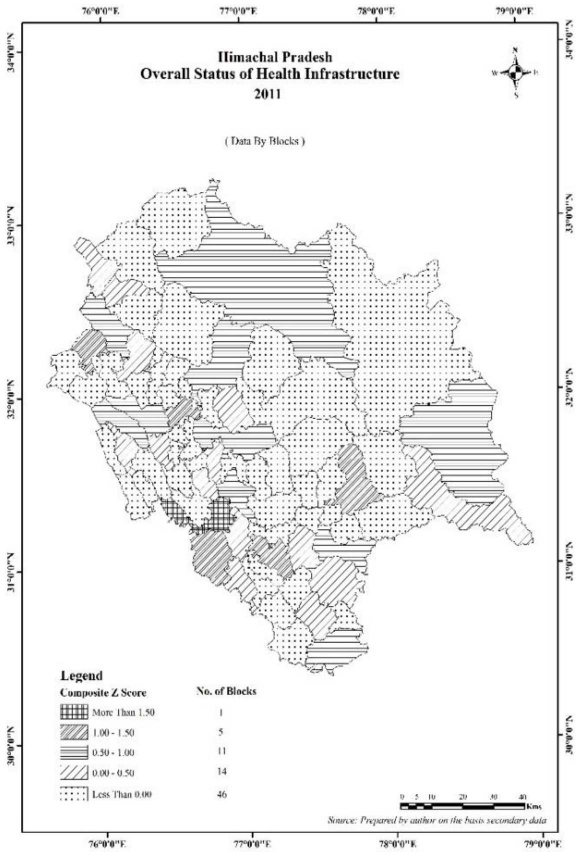

Fig. 3

III. Areas with Moderate Composite Score in Overall Health Infrastructure (0.50 – 1.00)

There were 7 blocks in 1991 with the moderate composite score in overall health infrastructure. These were spatially located in isolated patches in southern, western, northern and north-western part of the study area (Fig. 2). On an average it comprised of the 10.14 percent area of the total blocks of the study area. The number of blocks in this category increased to 11 in 2011. However, areal extent of the blocks under this category increased to 15.27 percent in 2001 but slightly decreased to 14.28 percent in 2011 on account of increase in the total numbers of the blocks. The spatial distribution has remained unchanged in 2011, and only Mandi Sadar block has been added to this category in the central part of the study area. It is due to the fact that boundaries of Mandi Sadar block were changed (Merged) with the Rewalsar (Balh) block the Mandi district between 2001 and 2011 (Fig. 3). Therefore, Mandi Sadar block has experienced significant increase in the availability of the dispensaries and primary health centres.

IV. Areas with Low Composite Score in Overall Health Infrastructure (0.00 – 0.50)

The shares of blocks with low composite score have shown decreasing trends between 1991 and 2011. It indicates the improvement in the overall status of the healthcare infrastructure in the study area between 1991 and 2011 (Fig. 2 and 3). The low composite score shares 27.54 proportion of the total blocks which decreased to 18.18 percent areal coverage in 2011. The decrease in the proportion of the areal coverage between 1991 and 2011 has been due to the moving up of the blocks with low composite score to the higher categories. In 1991, the areas with low composite score were found in patches in northern, eastern, western, south-western and southern part of the study area and covers almost the entire region of the study area. The northern part included the Lahul and Baijnath block, western part comprised Indora, Rait, Dera, Kangra, Lambagaon, and Panchrukhi blocks of the Kangra district. The south-western part included the Amb and Una blocks of the Una district and also formed a linear belt from Gopalpur block of Mandi district to the Dharampur block of the Solan district. However, in 2011 the distribution has almost remained unchanged and was found in patches in north-western, central, south-eastern and southern part of the study area.

V. Areas with Very Low Composite Score in Overall Health Infrastructure (Less Than 0.00)

The areas with very low composite score have registered an increase between 1991 and 2011 (Fig. 2 and 3). In 1991, there were 38 blocks with the very low composite score in overall health infrastructure comprising 55.07 percent proportion of the study area. The number of blocks has slightly increased to 46 in 2011 and areal coverage which slightly increased to 59.74 percent in 2011. It is due to the fact that between 1991 and 2011 some new blocks were formed and which registered very low composite score. And as a result, exhibited decreasing trends in availability of some indicators and in overall health infrastructure. In 1991 the northern and north-western part comprised of the Pangi block and Saluni, Tisa, Bharmour and Mehla blocks respectively. However, the concentration has remained almost unchanged in 2011.

Thus, it is evident from the above discussion that there has not been any significant development in overall health infrastructure during the study time period. The very high, high and moderate categories have not shown any significant development in comparison to the very low categories throughout the study time period.

Growth and Gaps in the Healthcare Infrastructure

The growth and accessibility of healthcare facilities of any region provide opportunities to basic healthcare system and universal change of health for all It also reflects country's priority with regards to the establishment of new facilities and improvement in the available infrastructure (Singh et al., 2016). The difference between the existing availability and requirement of healthcare infrastructure provides in an insight into the gaps which exist in the availability of healthcare infrastructure. The growth and gaps in health infrastructure of Himachal Pradesh indicator wise follows:

Growth and Gap in Community Health Centres

The availability and requirement of community health centre has been computed to 80,000 population of the block.It is evident from the table 1 and figure 4 that about 40 percent of the blocks did not show any growth in community health centres during 1991 to 2001. The highest growth of community health centres was registered during 1991 to 2001. The lowest growth was registered during 2001 to 2011 mainly due to the upgradation of CHCs into general hospitals. The spatial analysis reveals thatin 1991 majority of the blocks (35) have shown deficiency in the availability of the community health centres. The population of these deficient blocks did not fulfil the populations criterion as set by the IPHS (Indian Public Health Standards). However, about 43.47 (30) percent blocks of the study area had shown the better development in the availability of the community health centres. Out of these blocks six blocks (8.69 Percent) exhibited the availability of the community health centres more than required number (Table 2 and Fig. 5). In 2011 there were nine blocks which had the dire need of the community health centres as they were totally deficient of CHCs. On the whole the availability of community health has been increasing from 1991 to 2011 and the gap has been declining.

Table 4
Growth of Healthcare Infrastructure

Health Facilities	1991-2001	2001-2011	2011-2018
CHCs	31	13	24
PHCs	111	160	138
Sub-centres	221	1	121
General Hospitals	11	3	32
Dispensaries	-21	-133	4

Growth and Gaps in Primary Health Centres

The availability and requirement of primary health centre has been computed to 20,000 population of the block.During 1991 and 2001 there were 20 blocks of the study area which did not show any growth in primary health centres and the number of primary health centres of these blocks has thus remained unchanged. As table 1 and fig. 4 exhibited overall growth of primary health centres in which highest growth has registered during 2001 to 2011. The availability of primary health centres has shown significant development as per the population norms in the study area. In 1991 among six blocks the highest surplus number of primary health centre has been registered in Pooh block (3) of Kinnaur district and lowest requirement has been found in the Nichar (1) block of Kinnaur district (Table 1 and Fig. 5). There were 15 blocks in 1991 where the number of primary health centres was in average numbers and about 70 percent (48) blocks faced the shortage of the primary health centres. The highest deficit has been found in Nurpur (-5) block of Kangra district. In 2011 the highest surplus number of primary health centres has been registered in the Nichar block (6) of Kinnaur district in which there was requirement of only one primary health centre and there were 6 blocks which have the lowest requirement of only one primary health centres to fulfil the population norms.

Growth and Gaps in Sub-centres

The availability and requirement of sub-centre has been computed to 3000 populationof the block.The growth of sub-centres has reveals that in1991 availability of sub-centres hassignificant development.It is evident from the fact thatthere were about

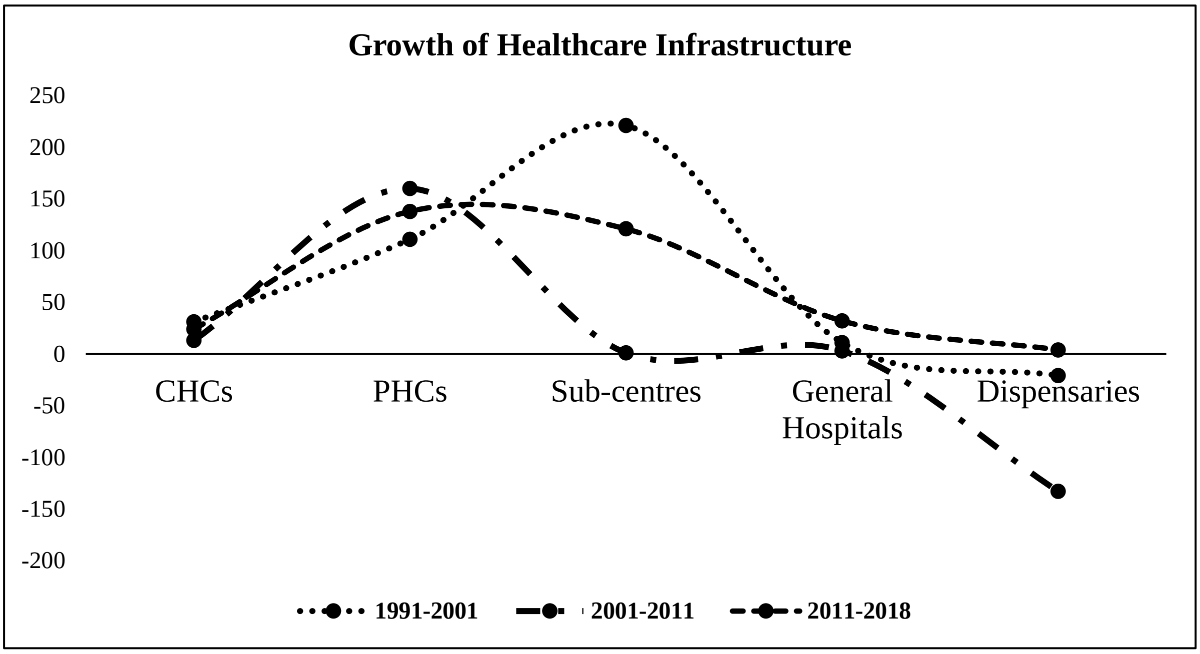

Fig. 4

Table 2
Levels and trends of Gaps in Healthcare Infrastructure

Availability of Health Infrastructure	Number of Blocks with CHCs		Number of Blocks with PHCs		Number of Blocks with Sub-Centres		Number of Blocks with Dispensaries		Number of Blocks with General Hospitals	
	1991	2011	1991	2011	1991	2011	1991	2011	1991	2011
Surplus	6	18	6	40	53	35	2	0	6	8
Average	24	30	15	10	2	4	0	0	22	28
Deficient	35	21	48	19	14	30	68	69	41	33

Source: Compiled by author on the basis of secondary data.

77 percent of blocks have registered the availability of sub-centres more than existing population norms. The highest numbers of sub-centre have been registered in Mashobra block (58) of the Shimla district (Table 1). There were only two blocks namely Nurpur block of Kangra district and Kalpa block of Kinnaur district in which the sub-centres were in balance with the national norms. However, in 1991 fourteen blocks of the study area have shown the deficiency of the sub-centres due to the larger population size of that blocks. However, the overall picture has changed in the 2011 in which the gap in the availability of the sub-centres as per the national norms has further in demand.

However, the overall picture has changed in the 2011 in which the gap in the availability of the sub-centres as per the national norms has required. It is evident from table 1 that approximately 43.47 percent blocks have shown the shortage of the availability of the sub-centres account of increase in population of these blocks as compared to the number of sub-centres. The growth of in the availability of sub-centres has registered highest during 1991 to 2001. The scenario of growth rate of the sub-centres has changed in next decade during 2001 to 2001. It is due to the fact that most of the sub-centres were upgraded to the primary health centres (Table 1 and fig. 4).

Growth and Gap in General Hospitals

The availability and requirement of general hospital has been computed to serve 1 lakh of population of the block. It is evident from the table 2 that there has gradual increase in the availability of general hospital from 1991 to 2011. There were 6 blocks in which the number of general hospitals has higher than required number. The highest surplus number has been found in Mashobra block (3) however there was requirement of only one general hospital. The development in the availability of general hospital can judged from the fact that the number of blocks deficient in general hospital has shown declining trends from 41 in 1991 and 33 in 2011. The highest surplus number of general hospitals registered again in Mashobra block (3) of the Shimla district, although according to the 2011 population size of the blocks there exists the need for one general hospital. However, it is evident from the table 1 and fig. 4 that the time period of 2001 and 2011 witnessed worst conditions in the growth of the general hospitals only 3 general hospitals has added. The growth general hospitals during 2011 to 2018 have shows the better condition as there were added 32 general hospitals in Himachal Pradesh. There were only 4 ESI dispensaries added during 2011 to 2018.

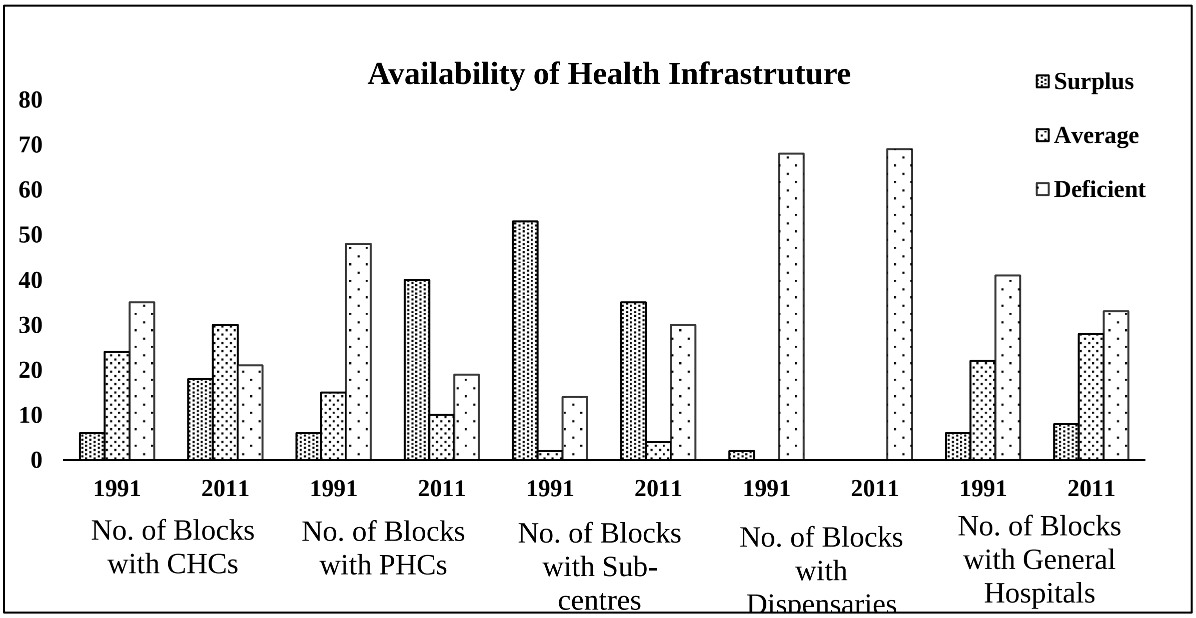

Fig. 5

Growth and Gap in Dispensaries

The requirement and availability of dispensaries has been computed in relation to 10,000 population of the block on account of lack of any clear-cut norms as per government policy. The growth of dispensaries was different during the next decade between 2001 and 2011 as the majority of the blocks have shown sudden negative growth in the availability of the dispensaries. It is clearly evident from table 1 that there were only two blocks namely Mashobra (5) and Lahul (1) of Lahul & Spiti district in 1991 in which the number of dispensaries was surplus as against to the availability. About 97.10 (67) percent blocks registered deficiency of the dispensaries among which the highest deficit has been found in Mandi Sadar (-11) and Nurpur blocks (-11) of the study area. It is also evident from the table 2 that in 1991, 98.5 (68) percent blocks have shown the deficiency of the dispensaries and further worsening situation in (100 Percent) 2011 (Table 1). It is due to the fact that after the 2003 civil dispensaries were excluded and new ESI (Employee's State Insurance) dispensaries introduced in the study area. There has not any been significant development of the ESI (Employee's State Insurance) dispensaries in the state. The highest deficiency has been registered in the Nurpur (-19) block of the Kangra district and the situation so bad that about 58 blocks of the study area even do not have the availability of ESI dispensaries. This happened as the civil dispensaries were excluded from the government records while the new ESI (Employee's State Insurance) dispensaries data was available for the next decades only and as a result the number of dispensaries suddenly declined. Therefore, after the introduction of ESI dispensaries the overall number of dispensaries did not show any significant growth and few blocks were there which had the availability of ESI dispensaries.

Conclusion

It is thus evident from the above discussion that all the indicators have shown the significant growth during 1991 and 2018 except the civil dispensaries. It becomes evident from study that almost all the blocks have shown significant development in relation to the formed population norms for the three-tier system which includes the sub-centres, primary health centres and community health centres. However, the general hospitals and dispensaries have not shown significant development in relation to population requirement and need proper attention and the availability.

The spatial distribution has clearly exhibited the poor conditions of the overall health infrastructure. However, minority blocks have shown significant development in overall health infrastructure. These are the hubs of the medical health care facilities which have exhibited good performance levels in all three points of time. Thus, on the whole it can be summed up that no doubt there has been increase in absolute numbers of healthcare infrastructure from 1991 and 2011 but the development pattern has not come up with much striking pattern and there exists a wide gap between the region for bringing the level of healthcare infrastructure at par with each other.

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Land Surface Temperature Analysis of Chandigarh and its Surrounding Areas

Jashandeep Kakkar, Abhishek Malik and Gaurav Kalotra

Abstract

The human activities had played a critical role in urban transformation. Rapid urbanisation is one of the key causes of change in local climate, and it has a significant impact on the surrounding areas.Chandigarh is one of India's first planned city. With no further scope of horizontal expansion the surrounding areas of the city are rapidly urbanising.The temperatures of the urban areas are rising as a result of use of bricks, concrete and asphalt as building material, increased emissions from industry and cars. Land Surface Temperature (LST) also increases, which cause the Urban Heat Island (UHI) phenomenon. The study uses Landsat-9 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) satellite data of June 06 2022 to find out LST of Chandigarh and its surrounding areas. Delineated LST map shows variation between 25.10 to 38.62°C. The majority value is dominated by built-up area.

Keywords: Landsat 9, Land surface temperature, Urban heat Island, Chandigarh

Introduction

The world has been experiencing rapid population growth and urbanisation. United Nations report projected that about 70 per cent of world population will reside in urban centre by 2050 (UN-HABITAT Report). The urban area tends to expand in parts of the world as the increment of population migration to an urban area. The expansion of urban area tends to alter the urban landscape. The proportion of built-up area dominates the urban space as the demand for economic activities and residential space increases. The human activities had played a critical role in urban transformation, viz. alteration of land use for various purposes that affects local climate, air movement, and ground cover change in surface energy budget, emission patterns, and thus heat transfers. The rapid construction, usage of low albedo building materials, alteration of vegetation cover, and emission/waste from various sources have been recognised as contributing factors to transform surface energy budget and hence inadvertent modification of local climate (T.R. Oke,1987). It has been observed that temperature is one of the most important parameters regarding the exchange of long-wave radiation and turbulent heat fluxes at the surface–atmosphere interface (R. Zhang, J. Tian, H. Su, X. Sun, S. Chen and J. Xia).

Identification and characterization of Urban Heat Island (UHI) is typically based on LST that varies spatially, due to the non-homogeneity of land surface cover and other atmospheric factors. LST is the key factor for calculating highest and lowest temperature of a particular location.Li Yang defines urban heat island effect as a phenomenon of accumulation of heat in an urban setting which is caused by human activities and urbanization (Yang, 2016). Urbanization often tends to change the way our land is used. Buildings, pavements, roads replace the open space and vegetation. Permeable surfaces are taken over by dry and impermeable surfaces. Rapid urbanization replaces natural surfaces with impervious surfaces, which raises Land Surface Temperature (LST) than surrounding rural areas due to their high heat absorption and retaining capacity.

Objective and Methodology

The main objectives of the present study is to

- Find out the Land Surface Temperature of Chandigarh and its surrounding areas based on Thermal Infrared band
- Analyse variation of temperatures at different spots by spatial distribution of land surface temperature (LST) and its relationship with different land use

Data and Methodology

Data Source

LST is the most important parameter to understand the surface energy balance of an area because the impact of radiation can be computed. Thermal infrared (TIR) remote sensing allows for the collection, analysis, and modelling of environmental parameters. It allows to calculate Land Surface Temperature (LST).

This study uses data from USGS Landsat 9 Collection 2 Level-1 and Level-2 that is available for download from USGS website (https://earthexplorer.usgs.gov/).
Concerning Landsat 9, the OLI consists of one panchromatic band and eight multispectral bands, with a resolution of 15 and 30 m, respectively. In the TIRS sensor, there are two thermal bands with a resolution of 100 m. Topographical sheets of Survey of India are used to digitise the administrative boundaries.

Table 1 - List of satellite data and topographical map with their specifications

Topographical Map-Survey of India	No. 53B/9, 10,13,14	Surveyed - 1995-1995 Updated - 2005-2006	1:50000 Scale	-	-
Data used	Path/Row	Date of acquisition	Spectral resolution (μm)	Spatial resolution(m)	Swath (km)
Landsat-9 OLI/TIRS Collection 2 Level-1 Scene ID = LC91470392022157 LGN00 Cloud Cover = 0.47	147/39	2022-06-06	Band 1 = 0.43 - 0.45	30	185
			Band 2 = 0.450 - 0.51	30	
			Band 3 = 0.53 - 0.59	30	
			Band 4 = 0.64 - 0.67	30	
			Band 5 = 0.85 - 0.88	30	
			Band 6 = 1.57 - 1.65	30	
			Band 7 = 2.11 - 2.29	30	
			Band 8 = 0.50 - 0.68	15	
			Band 9 = 1.36 - 1.38	30	
			Band 10 = 10.6 - 11.19	100	
			Band 11 = 11.5 - 12.51	100	

Table 2 - Metadata of Landsat-9 TIR satellite data

Variable	Description	Value
K_1 K_2	Thermal constants, Band 10 (Band_Specific thermal conversion from the metadata)	774.8853 1321.0789
M_L	Band-specific multiplicative rescaling factor from the metadata	3.3420E-04
A_L	Band-specific additive rescaling factor from the metadata	0.10000

Methodology

The approach to the proposed work to estimate LST is shown in the Figure 2. In this study, band 10 is used to estimate brightness temperature. Following the instructions of USGS vide January 6, 2014, of not using TIRS band 11 due to its larger calibration unreliability, only band 10 was considered in the technique. The metadata of the satellite images used in the algorithm is presented in Table 2. Chandigarh Administrative shapefile was digitized using Survey of India Topographical maps.

A buffer of 5 km has been marked to the administrative boundary of Chandigarh to add the surrounding areas which includes parts of S.A.S. Nagar, New Chandigarh, Panchkula and Zirakpur. The study area sufficiently includes non-urbanized/sub-urban areas and satellite towns of the city. The study area covers approximately 422 square kms.

Software used - ArcGIS 10.8

Processing of Image/Data

Data Processing was followed in six steps (i) Conversion of Digital Number (DN) to Top of Atmosphere (TOA) Spectral Radiance (ii) Conversion of Top of Atmosphere (TOA) Spectral Radiance to Brightness Temperature (iii) Calculation of Normalized Difference Vegetation Index (iv) Calculation of Proportion of Vegetation (v) Calculation of Land Surface Emissivity (LSE) (vi) Calculation of LST - Land Surface Temperature

Step 1 - Conversion of Digital Number (DN) to Top of Atmosphere (TOA) Spectral Radiance

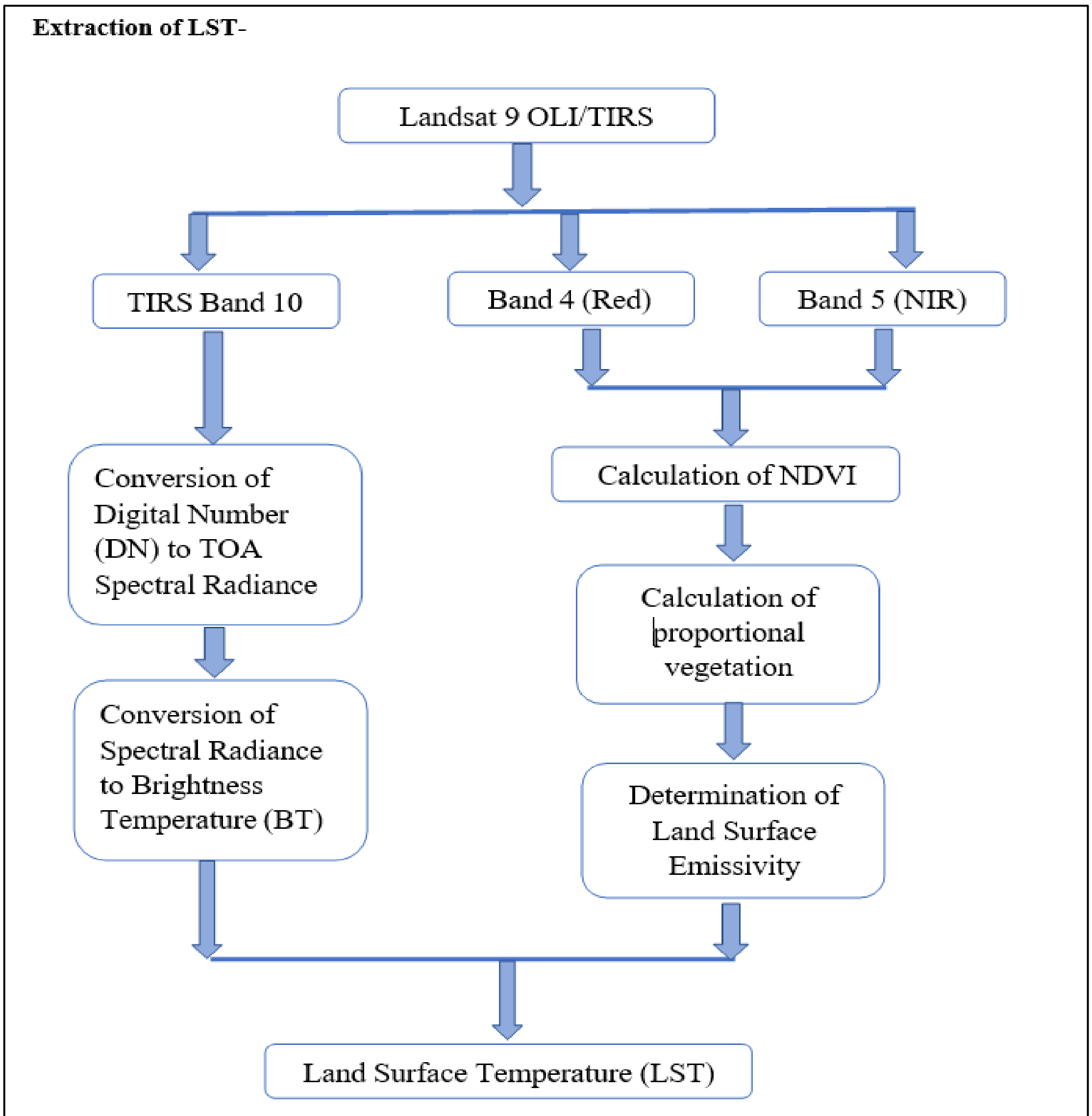
OLI images that have a different sensor have been processed using 32-bit floating point measurements in units of absolute radiance. In the finished level 1 product, these values are then converted to 16-bit integer values. These values were then transformed using the radiance scaling factors given in the metadata file to spectral radiance.

Top of atmospheric (TOA) spectral radiance was calculated by multiplying multiplicative radiometric rescaling factor of TIR bands with its corresponding TIR band and adds in additive rescaling factor.

$L\lambda = (ML * Qcal) + AL – Oi$

Where:

- $L\lambda$ = Top of Atmosphere spectral radiance (Watts/ (m2 * srad * μm))
- ML = Band Specific multiplicative rescaling factor from the metadata. (RADIANCE_MULT_BAND_x, where x in band number).



Methodology flow chart adopted for LST Retrieval

Figure 2

AL = Band Specific additive rescaling factor from the metadata. (RADIANCE_ADD_BAND_x, where x in band number).

- Qcal = Quantized and calibrated standard product pixel values (DN), corresponds to band used
- Oi = It is correction value for band 10 i.e., 0.29

Step 2 - Conversion of Top of Atmosphere (TOA) Spectral Radiance to Brightness Temperature

Thermal band data (Band 10 on OLI) can be transformed to efficient at sensor brightness temperature from at-sensor spectral radiance. The prelaunch calibration constants given by the equation of the plank are used at the sensor temperature.

K1 and K2 values can be identified by the thermal coefficients of TIR band 10 in the metadata file allied with the satellite image. In this process, the temperature results will be estimated in Celsius, it is needed to revise by adding absolute zero which is approximately equal to -273.15. Since the atmosphere in our research area is comparatively dry and therefore, the range of water vapor values is relatively small, the atmospheric effect is not taken into consideration in retrieving the LST. The conversion formula from the spectral radiance of the at-sensor to the temperature of the at-sensor brightness is:

$$BT = \frac{K2}{\ln\left(\frac{K1}{L\lambda}+1\right)} - 273.15$$

Where

- BT = Top of atmosphere brightness temperature (°C)
- Lλ = Top of Atmosphere spectral radiance (Watts/ (m2 * srad * µm))

• K1 Band-specific thermal conversion constant from the metadata (K1_CONSTANT_BAND_x, where x is the band number, 10 or 11)

• K2 Band-specific thermal conversion constant from the metadata (K2_CONSTANT_BAND_x, where x is the band number, 10 or 11)

Step 3 - Calculation of Normalized Difference Vegetation Index

Bands 4 and 5 were used to determine normalize difference vegetation index (NDVI) which is important to pinpoint different land cover types of the study area. NDVI is a dimension less index which estimates the vegetation cover of an area. The high NDVI values indicate healthy vegetation cover while the low NDVI is related to sparse vegetative cover of an area. NDVI is a function that varies in the range [-1, +1], but in practice, negative values correspond to water, i.e., values close to zero. Positive values correspond to soils and, the range from 0.2 to 0.6 indicates the presence of surfaces vegetated.

The calculation of the NDVI is important because, afterward, the proportion of the vegetation (Pv) should be calculated, and they are highly related with the NDVI, and emissivity (ε) should be calculated, which is related to the Pv

NDVI can be computed according to the following Equation

$$NDVI = \frac{NIR\ (Band\ 5) - RED(Band\ 4)}{NIR\ (Band\ 5) + RED(Band\ 4)}$$

Step 4 - Calculation of Proportion of Vegetation

It gives the estimation of area under each land cover type. The vegetation and bare soil proportions are acquired from the NDVI of pure pixels.

$$P_V = \left(\frac{(NDVI - NDVI_{min})}{(NDVI_{max} - NDVI_{min})}\right)^2$$

- NDVI represents DN values from NDVI image
- NDVI min represents minimum DN values from NDVI image
- NDVI max represents maximum DN values from NDVI image.

Step 5 - Calculation of Land Surface Emissivity (LSE)

Calculation of LSE is required to estimate LST since, LSE is a proportionality factor that scales the black body radiance (Plank's law) to measure emitted radiance and it is the ability of transmitting thermal energy across the surface into the atmosphere. At the pixel scale, natural surfaces are heterogeneous in terms of variation in LSE.

In addition, the LSE is largely dependent on the surface roughness, nature of vegetation cover etc. LSE is the average emissivity of an element of the surface of the earth calculated from NDVI values using the equation.

Where

$E = 0.004 * Pv + 0.986$

- NDVI represents DN values from NDVI image
- 0.986 o is the standard emissivity value for vegetation.
- where 0.004 corresponds to the average emissivity value of bare soil,
- Pv is the proportion of vegetation

Step 6 - Calculation of LST - Land Surface Temperature

The LST is the radiative temperature which calculated using Top of atmosphere brightness temperature, wavelength of emitted radiance, LSE using equation

Where,

$$LST = [\frac{BT}{1 + (\lambda + \frac{BT}{C2}) * \ln(E)}]$$

• BT- represents top of atmosphere brightness temperature (°C)

•λ represents wavelength of emitted radiance of the band (10.895µm) [Band 10 = 10.6

- 11.19]

• C2 = 1.4388 × 10−2 m K

C2- represents $h \times c/s$ = 1.4388 × 10−2 mK = 14,388 m K [h represents Planck's constant (6.626 × 10−34 Js)

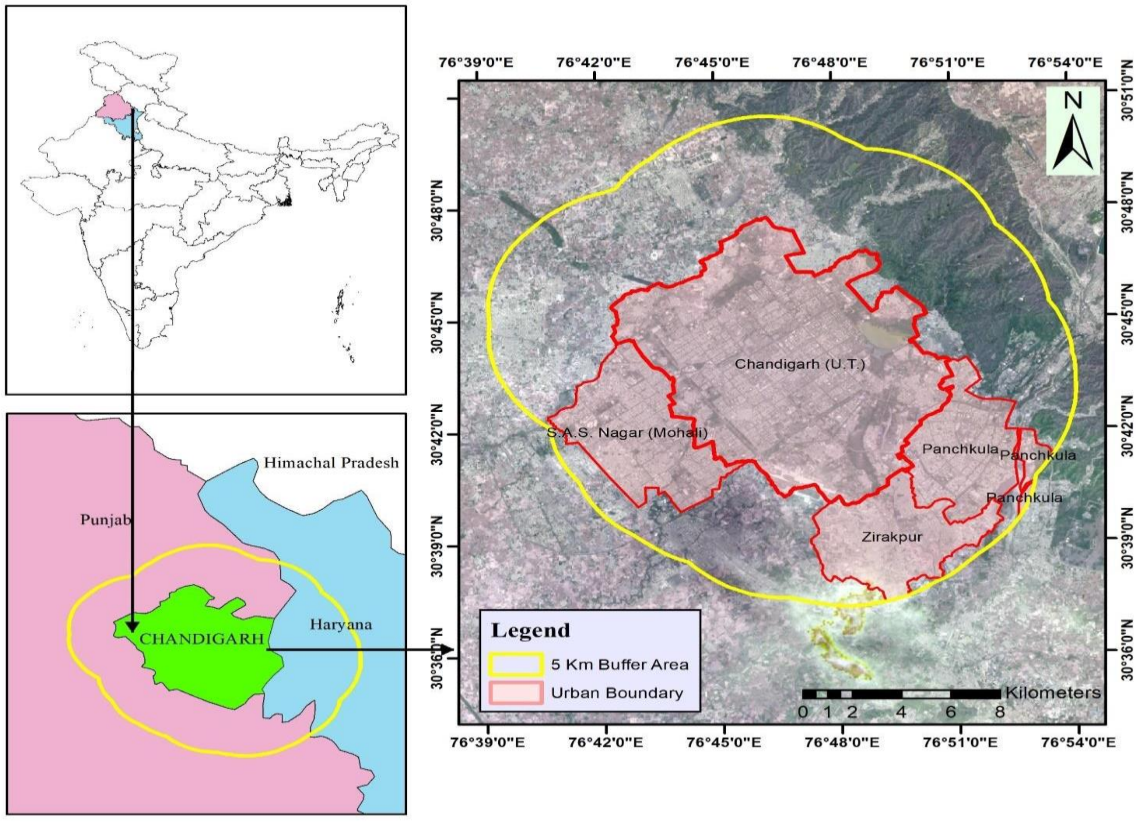
s- represents Boltzmann constant (1.38 ×10−23 J/K); c represents velocity of light (2.998 × 108 108 m/s)].

• E represents land surface emissivity

$$LST = [\frac{BT}{1 + (10.895 + \frac{BT}{14388}) * \ln(E)}]$$

Study Area

Chandigarh (30° 43′ 48″ N, 76° 46′ 48″ E) is located near the foothills of the Shivalik range of the Himalayas in northwest India and covers an area of approximately 114 km². Chandigarh is one of the first planned city of India that serves as the capital of two states of Punjab and Haryana. Population of Chandigarh is 1,055,450 inhabitants with a density of about 9258 persons per square kilometre (Census of India, 2011). Its population growth rate over the decade 2001–2011 has been 17.1 per cent. Chandigarh has a humid subtropical climate characterised by mild winters, very hot summers, unreliable rainfall and great variation in temperature (−1 °C to 45 °C). Temperatures generally remain between 30 °C to 40 °C. Winters (November-end to February-end) are usually mild and these can sometimes get chilly. Average maximum temperature in winter season is generally about 14° C and the absolute minimum temperature is −1° C with an average minimum temperature in a season of about 4° C. The temperature in summer (from Mid-April to June-end) may rise to a maximum of 44° C. The average annual rainfall is 111.4 cm and there is much less rainfall during winter than during summer. According to Köppen and Geiger, this climate is classified as Cwa, temperate or subtropical dry winter and hot-summer climates that is it has cold dry winter, hot summer and sub-tropical monsoon (City



Location map of Chandigarh study area

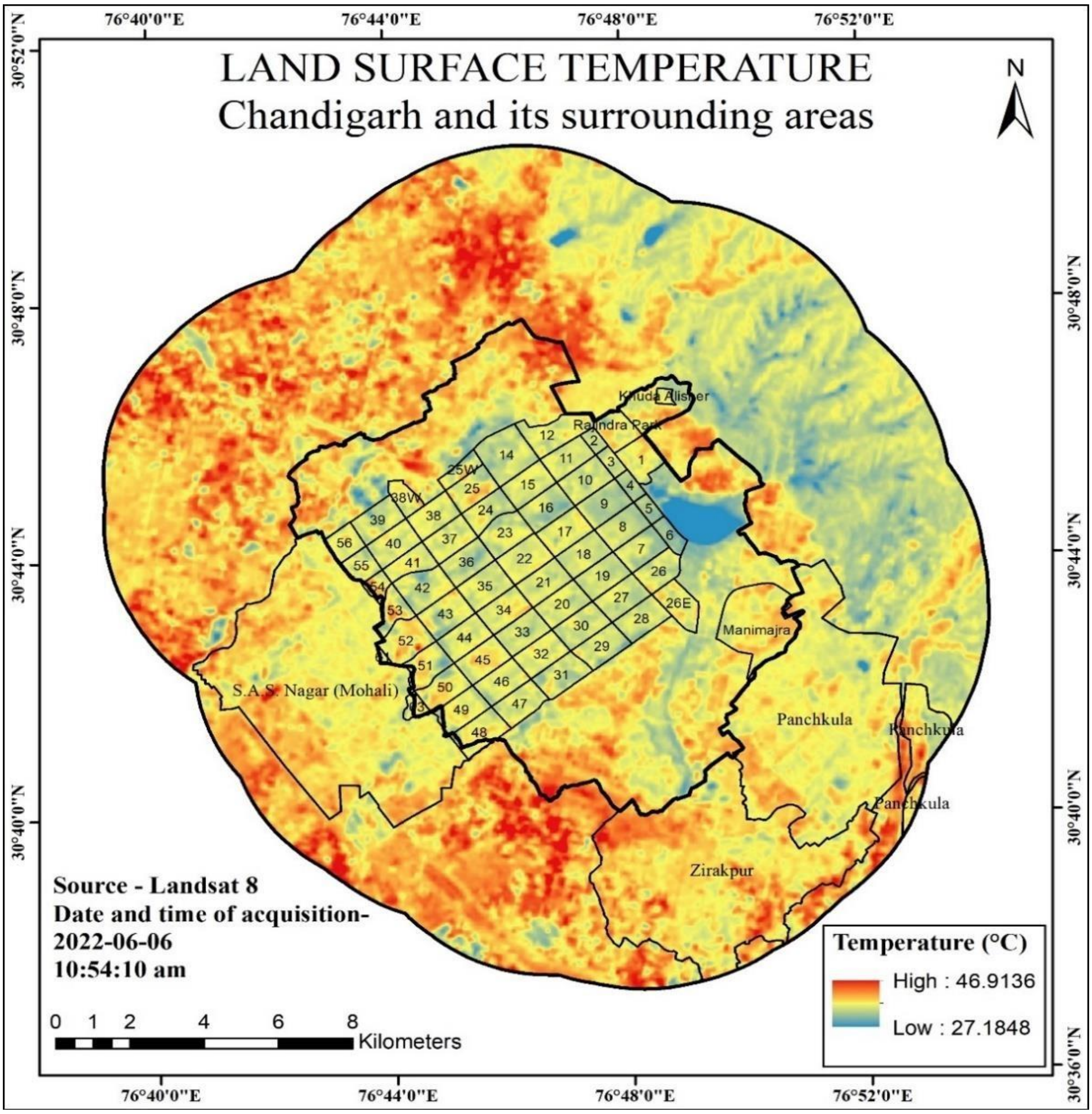
Figure 1

Development Plan Chandigarh). Figure 1 Shows the Study Area.

Chandigarh is surrounded by Panchkula and Zirakpur in south and S.A.S. Nagar (Mohali) in west. On the eastern side we have the foothill zone and in the Northern side a new township by the name of New Chandigarh is coming up. The map of LST during June 2022 show that the highest values of LST are indicated outside the administrative boundaries of the city which have bare soil, roads, high dense built-up areas, airport area and dumping grounds. As Chandigarh is a planned city, it shows true essence of planning. The city having lower temperatures than the surrounding areas due to its well-planned open spaces, parks and vegetation cover.

The overall temperature range is between 27.8 to 46.6 °C. The Sukhna lake, the parks and gardens in each sector, the areas along the Choes patiala ki rao and N Choe, forest area near Dhanas and Botanical Garden in north of sector 14 (Panjab University) all have less Land Surface Temperature.

The overall temperatures in the city according to Figure 3 are quite less as compared with the surrounding areas. Even in surrounding areas it can be seen that planned cities like Panchkula and S.A.S. Nagar are having lesser surface temperatures than the unplanned Zirakpur. The areas North and south-west of Chandigarh are showing higher surface temperatures due to the reason that these are agricultural fields and in the first week of June these are not cultivated. These are bare soils with no vegetation therefore the soil reflectance is maximum and as a result the reflectance values are more and thus higher Land Surface Temperatures.



Figure–3

On the eastern side is the foothill zone which is displaying lesser surface temperatures because of the presence of two man-made water bodies namely Jayanti Devi Dam and Parchh Check Dam. Parchh Check Dam is surrounded by Kansal Ki Khol Reserved Forest and shows lower values of LST while on the east of Jayanti Devi Dam there is forest area which shows Lower values of LST and on the western side of Jayanti Devi Dam there are agricultural fields open land and some villages which shows highest values of LST in the region. The lowest value of LST is 27.18 in Parchh Check Dam.

Figure 4 (i) shows that within the city the LST values are moderate with patches of lower LST along the leisure valley, near Sukhna lake, near Patiala ki Rao. In sectors the lowest LST values are recorded by Sector 2, 3, 4, 5, 6, 9, 14 and 42. The sectors 2, 3, 4, 5, & 6 are low density sectors with plot sizes varying between 2 to 5 *Kanals* and are located near Sukhna Lake and also

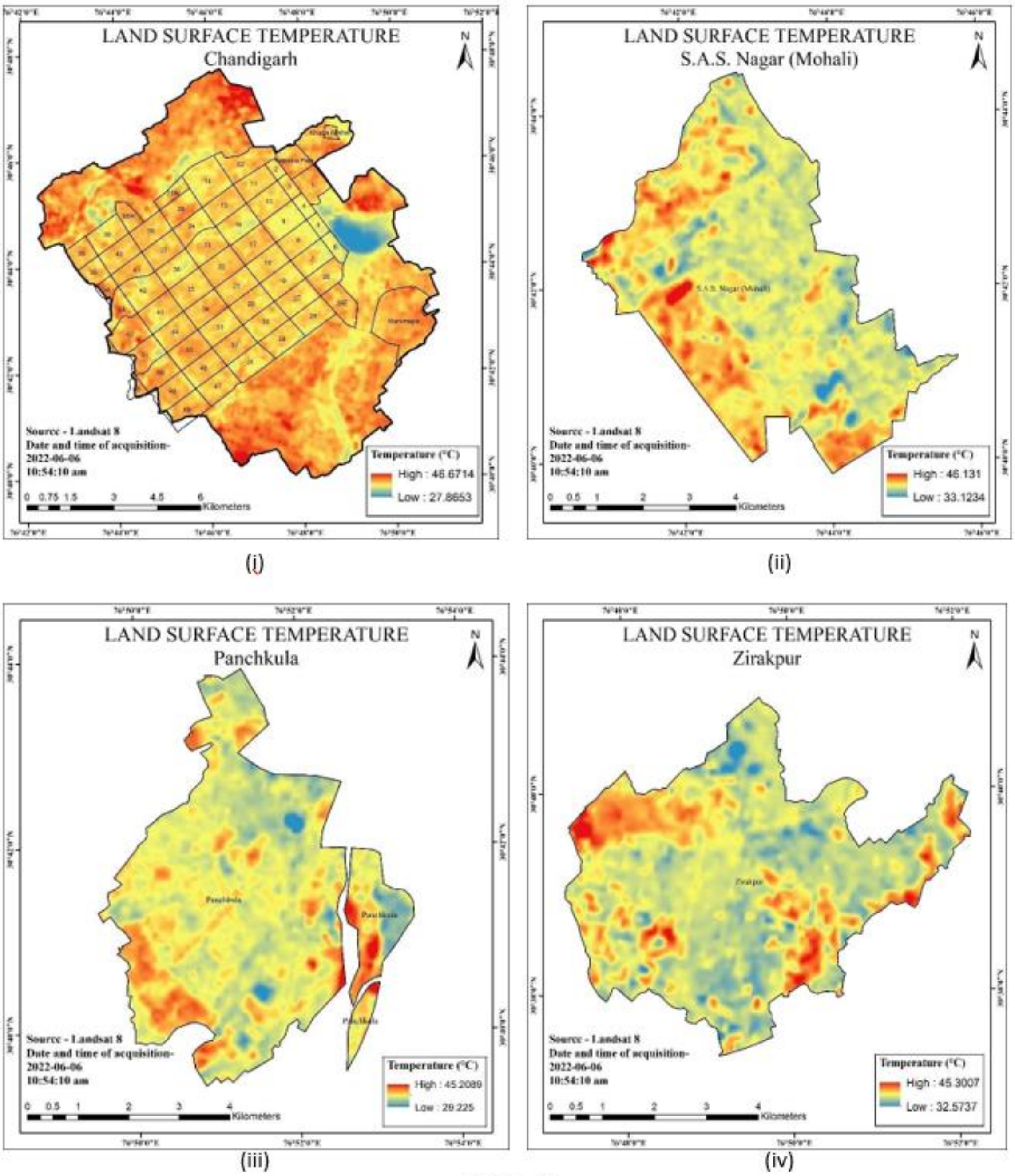


Figure - 4

Figure-4 presents the LST values of all the four administrative units of the study area.

have large number of trees which are instrumental in these sectors recording lower LST. Sector 9 have government offices and also have huge residential houses and more vegetation thus having lower values of LST. Panjab University has less buildings and more open spaces, very high density of vegetation and its nearness to the reserved forest area of Dhanas has led to lower LST values. Otherwise also the temperature in the campus throughout the year is almost 2ºC less than the city. Sector 42 located in southern part of the city is a unique case where LST values are low. It is because sector 42 has large open areas like sports complex, and New Lake with very high density of trees near the hockey stadium, moreover the N choe passes through this sector. Another belt of sectors in the centre of the city starting from sector 17, 22, 35, 34 and 43 are also displaying higher LST values. Sector 17, is the city centre and heart of Chandigarh and Sector 34 is also sub-city centre and commercial sectors, these both sectors have a lot of concrete buildings, markets, pavements and parking. Nearby sectors i.e., Sector 22, Sector 35 also have more built-up. Sector 43 houses ISBT, Judicial Complex, residential and commercial market area. The construction material emits a lot of heat. That's why the Sectors 17, 22, 34, 35 and 43 show high LST values. Another patch in the south of Sector 29 and 31shows high LST values. In this area lies industrial area of Chandigarh. Apart from these major patches there are some patches where high LST values were recorded. Village Burail is enclosed in Sector 45 which is unplanned and congested which shows high values of LST. There is a dumping yard near sector 38 W (Daddu Majra) which records high temperature due to gaseous activities over the area. Sector 25 includes slum area of Chandigarh. It records LST value of 41.1°C. The slum area is congested having dense built-up. Sector 26 E shows maximum temperature of 40.4° C due to presence of grain market and influence of industrial area. Sector 41 shows maximum 40°C land surface temperature, it is because of unplanned Badheri village and congested built-up. Sector 13 - Manimajra due to high concentration of built-up area and presence of motor market shows Land Surface Temperature of 42.8 °C. Sector 52 i.e., Khajeri village is unplanned it shows maximum LST values in the whole region i.e., 45 °C. Sector 53 is concentrated and have less vegetation. It shows Land Surface Temperature of 42.8°C.

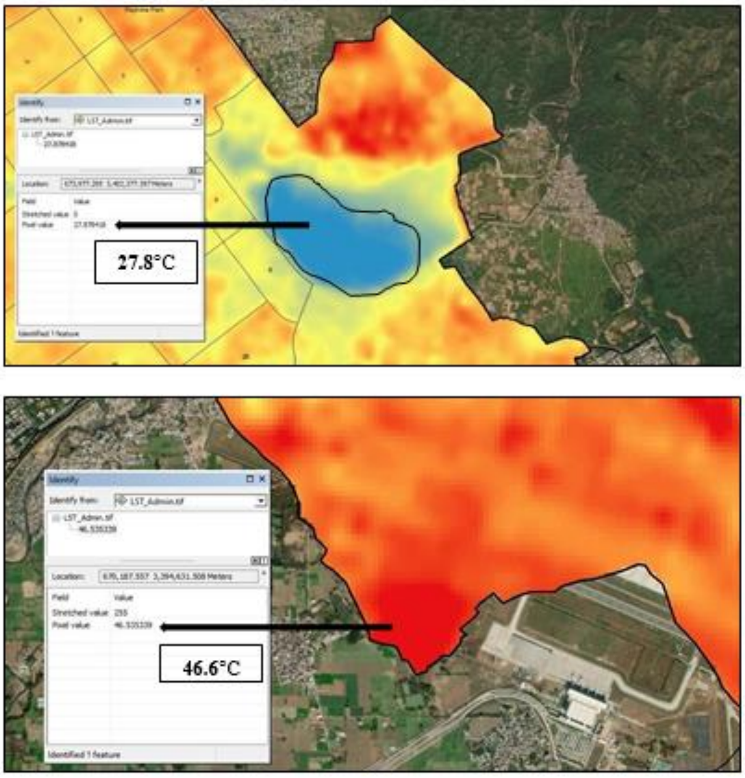
Higher values of LST were recorded in the north east part of the Union Territory. This part of U.T. has village Khudda Lahora which is unplanned and densely populated and also have uncultivated bare agricultural land which is showing high LST values over the area. Just immediately west of it we have patch of area showing less values of LST. Here the Botanical Garden of Sarangpur is located which is showing comparatively less values of LST, because of its green cover. It is spread over 178 acres.

The minimum surface temperature of 27.8°C is recorded at Sukhna Lake and maximum at Chandigarh International Airport which has been recently been named as Shaheed Bhagat Singh International Airport. On north of Sukhna lake there is village Kaimbwala which is also showing high values of LST because of presence of agricultural land which has not been cultivated yet.

Figure 4 (ii) is showing Land Surface Temperature of S.A.S. Nagar (Mohali). It can be observed that the minimum values are higher than Chandigarh U.T. The minimum LST value of 33.1° C was recorded over Godrej and Boyce Mfg. Co. Ltd due to cool roof technology adopted by the industry and maximum LST value of 46.1°C was recorded over Shed of Radha Soami Satsang Beas, Sector 76 (Figure 6).

Figure 4 (iii) shows Land Surface Temperature of Panchkula city with minimum LST value of 29.2 °C and maximum LST value of 45.2 °C. From figure 7 [clip from figure 4 (iii)] we could see the minimum value of LST is of water treatment plant, Sector 1 Panchkula

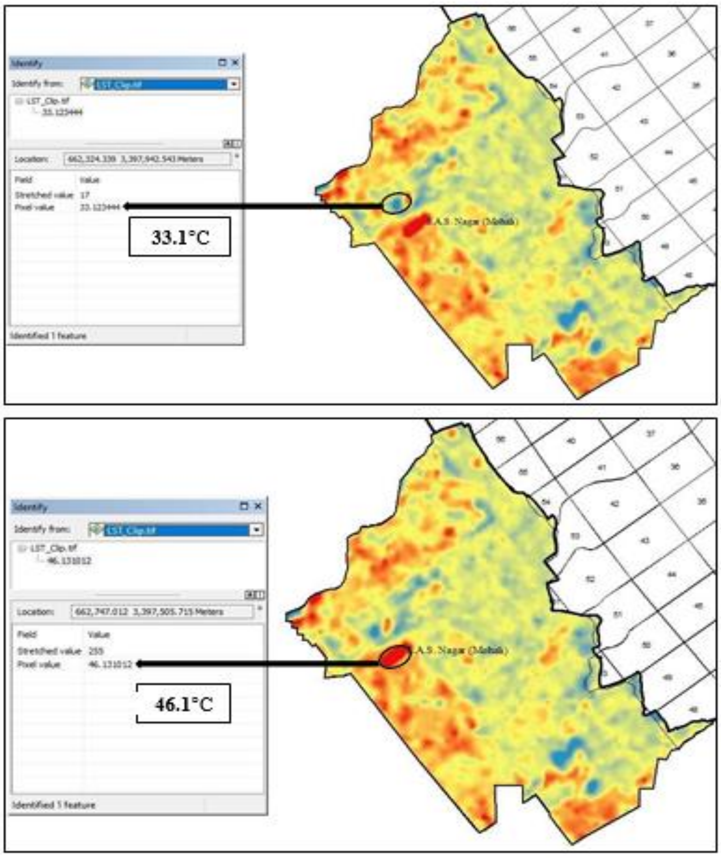
Figure 5



Sukhna Lake

Chandigarh International Airport

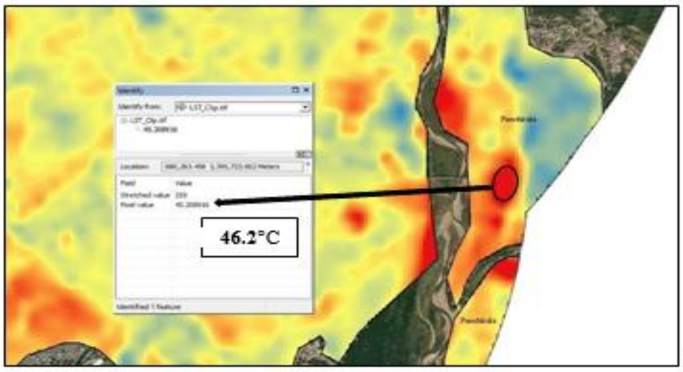
Figure 6



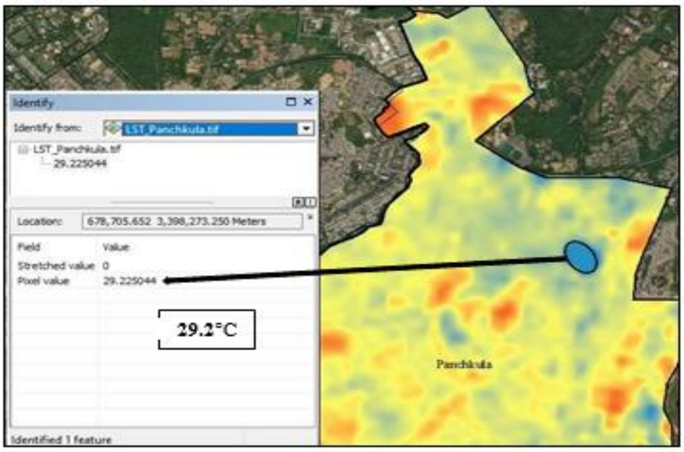
Godrej and Boyce, Phase 8, Sector 75

Radha Soami Satsang Beas, Sector 76

Figure 7

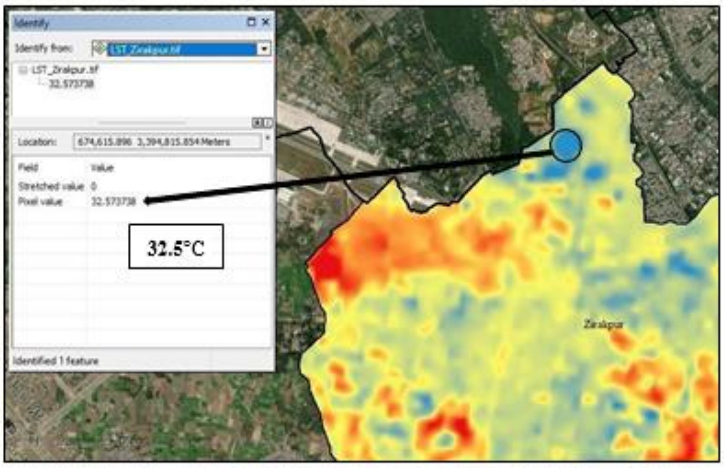


Dumping Area, Sector 23, Panchkula

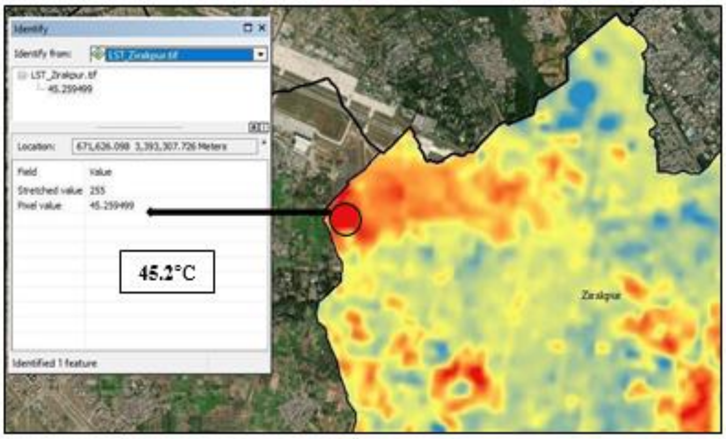


Water treatment plant, Sector 1, Panchkula

Figure 8



Agricultural land near Tribune colony, Zirakpur



Agricultural land, near Chandigarh International Airport and maximum value is of garbage dumping area near NIFT Panchkula, Sector 23. Panchkula is well planned city; it is spacious and have sufficient green spaces.

Figure 4 (iv) shows Land Surface Temperature of Zirakpur town with minimum LST value of 32.5 °C and maximum LST value of 45.3 °C. Zirakpur is haphazardly planned town, it has densely built-up spaces and said to have many illegal group housing societies. Zirakpur is upcoming residential hotspot. Due to more built-up the LST values in Zirakpur are high. The maximum value of LST is on agricultural land near Chandigarh International Airport, and minimum values of LST are on field where Sukhna Choe passes near Tribune colony (Figure 8).

Conclusion

As Chandigarh is nearing almost 70 years of its presence, it is seeing quick urbanization and the issues that accompany it. Factors like traffic congestion, urban heat island, greenhouse gas emissions and climate change are pressing concerns. Mainly concrete has been used as a building material and hardscape material for landscaping. Concrete traps a lot of heat and makes it uncomfortable to walk during daytime in summer. In a green city like Chandigarh, it is disheartening that the city which was designed for both the pedestrian and vehicular traffic is now heavily dominated by vehicles. This trend of rise of motor vehicles in the city compared to the population is one of the reasons for the rise in temperature. If we ignore these facts, city people will really have to face bigger consequences in the coming days.

Analysis of Land Surface Temperature-

There are multiple factors that affect the creation and intensity of the LST and UHI. These include the greenness, distribution of water bodies, impervious concrete, asphalt and metal use, LULC and surface roughness. The spatial patten of Chandigarh shows that North and western parts are relatively cooler areas, the central and southern part exhibit more temperature. The variation in the LST distribution is noted, which exist due to the impact of different properties of LULC. While vegetation areas are directly related to lower surface temperatures, responsible for generating the cooling effect in the urban microclimate, concrete built-up areas add to the existing high temperatures. The Sukhna lake recorded the lowest temperature of 27.8 °C. Sukhna Lake act as heat moderator for nearby sectors. Even though there is a small proportion of area covered with water bodies, the spatial location of these features has a vital role in UHI creation. Apart from enhancing beauty and greenery, the natural vegetation and tree cover have a significant function of maintaining the ecological balance. The process of evapotranspiration enables a cooling effect on the surroundings. The dense tree cover along the linear features, like the roads, Choes, has considerable influence on keeping the temperature at the lower end of the range in the surrounding regions. The LST map exhibit the maximum concentration on outskirts of the city. It is due to presence of bare agricultural fields.

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Literacy and Educational Attainments: A Socio-Spatial Study of Sangrah Block of Sirmaur District (H.P.)

Puran Chand and B.R. Thakur

Abstract

This study addresses the issue of literacy and educational attainments in Sangrah community development block of Himachal Pradesh. The study is based on primary and secondary sources of data. The secondary data have been collected from Census of India for 1991-2011. The study used stratified random sampling to collect the data from 18 sample villages with respect to two communities i.e. SCs (scheduled castes) and General spread across three altitudinal zones. In all 436 households (about 20% of the total) were surveyed. The study brings out that educationally backward areas of 1990s registered an increase of more than 50% in total literacy rate. On an average there has been about 37% points change in literacy rate during the study period. A comparative study of social groups reveals that educational attainments are higher among the SCs community up to elementary stage than general community. At higher educational levels general community's share is three times to that of SCs. The pattern of literacy and educational attainments in the study area are function of various socio-economic factors and geographic correlates.

Keywords: Literacy, Educational Attainments, Community, Spatial, Sangrah

Introduction:

The concept of literacy is not uniform all over the world. Census of India defined a literate as a person aged 7 years and above who can both read and write with understanding in any language. Sjostrom and Sjostrom (1982) argue that neither reading and writing per se, nor a narrow economic functionalism is regarded as sufficient rather literacy is an agent for development both in economic and in humanistic terms, in quantitative as well as qualitative categories. The practice of literacy can be instrumental in people's achievement of a range of capabilities such as maintaining good health and living longer, learning throughout life, controlling reproductive behaviour, raising healthy children and educating them. Improving literacy levels thus have potentially large social benefits, such as increased life expectancy, reduced child mortality and improved children's health (UNESCO, 2006). There is no doubt that literacy is a potential asset for individuals, families, and local, national and global communities. These assets are human, political, socio-cultural and economic. Literacy is seen as a vehicle for empowerment and a means of improving people's quality of life. (Eldred, 2013).

Literacy levels of the population constitute one of the most important determinants of the quality of population and literacy rate is generally accepted as one of the basic indicators of its progress (NSSO, 1991:1). Whatever the causal effects look like, progress in literacy and progress in human development often coincide, just as illiteracy and poverty do. Poverty is not just lack of income, but also deprivation of capabilities. Literacy contributes to strengthening the capabilities of individuals and families to benefit from existing opportunities such as health care access, education, political freedom and income (Lind, 2008). Literacy is always considered an important key for socio-economic growth. Economic prosperity of a country entirely depends on the economic resources it has and human resource is an important part of economic resource. Human resource includes the population, its growth rate, skills, standard of living and the working capacity of the labour force and all the above factors can be enhanced by increasing the literacy rate of a population. Thus, literacy rate plays a key role in economic growth of a country (Desai, 2012). The relationship between education and political participation is well established. Educated people are to some extent more likely to vote and voice more tolerant attitudes and democratic values (Hannum and Buchmann, 2003).

Education is an investment leading to human capital formation that contributes to economic growth (Schultz, 1961). Basic education is catalyst to the social change (Dreze & Sen, 2002). Education indicators and their measurement in the construction of Human Development Index in the UNDP-Human Development Reports are well known (Narayana, 2006). Educational level, thus, is an important demographic indicator as well as essential tool for measuring human progress (Roy, 2008). It is also generally accepted that there are positive and significant returns of education. The differences in education can explain a significant proportion of earnings differences between various socio-economic groups (Bhaumik and Chakrabarty, 2013). Education is a basic need and an important aspiration of people. It has a strong influence on their well-being. Better educated individuals earn higher wages and have a higher probability to have a job and enjoy better quality of life. They live longer lives; report a better health status and a lower occurrence of chronic diseases and disabilities. Better educated individuals also participate more actively in politics and in the community where they live, they commit fewer crimes and rely less on social assistance. At the level of the society as a whole, better education leads to higher GDP growth, higher tax revenues and lower social expenditures (OECD, 2011).

India has made significant achievements in the field of education during the past few years. Despite substantial progress towards the Education for all (EFA) goals since 2000, the education sector in India faces several challenges. The overall education level of India’s population remains lower compared to other emerging market economies. India’s mean years of schooling at 5.12 years in 2010-11 was lower than some of the other emerging market economies such as China (8.17 years) and Brazil (7.54 years) and significantly below the average for all developing countries (7.09 years) (Govt. of India, 2014). Himachal Pradesh typified a remarkable illustration of progress in education. According to Sen (2001) ‘the transition is perhaps most striking in the field of basic education. In 1951, less than 20 per cent of children aged 10-14 in Himachal Pradesh were literate. As per National Family Health Survey 1998-99 the school participation rates among 6-14 years old in Himachal Pradesh were as high as 99 per cent for boys and 97 per cent for girls. In this respect, Himachal Pradesh is at par with Kerala and well ahead of other states.’ It has been observed that less than one-third of

Himachal Pradesh's rural population had no education in 2011, in most other neighbouring states, that number was nearly two-fifths or half of the population. Furthermore, the overall proportion of residents with post-secondary education was the highest in Himachal Pradesh in 2011 across northern states (except urban Haryana)—nearly 15–17 percent of the rural population and 31 percent of the urban population had received post-secondary education (Das et al., 2015).

Sirmaur, including the study area is among four educationally backward districts, which were taken up for the improvement of primary education through DPEP introduced in Himachal Pradesh (DPEP, 1998-99). Sirmaur was selected in The Kasturba Gandhi Balika Vidyalaya (KGBV) scheme. The scheme was applicable since inception in Educationally Backward Blocks (EBBs) where the rural female literacy remains below the national average (46.13%: Census 2001) and gender gap in literacy is more than the national average (21.59%: Census 2001) (NITI Aayog, 2015:1).

Objectives:

- To assess pattern of literacy rates in the study area.
- To examine the level of educational attainments among social groups in the study area.

Geographical Setting of the Study Area:

Sangrah block lies in Sirmaur district of Himachal Pradesh state in India. Sirmaur district is divided into two parts by the Giri River, which runs parallel to the Himalayan mountain range. The northern part is known as the Trans-Giri (beyond Giri) region and the southern as the Cis-Giri (inside Giri). Trans Giri region is inaccessible and mountainous as compared to the southern Cis-Giri part, which is well connected to other parts of the state. Its northern boundary is marked by Churdhar Mountains and southern by Giri River. It is bounded by Tons and Yamuna rivers in the east. Sangrah community development (CD) block is located in the central part of the Trans Giri region. The study area sprawls over 486.4 km^2 area. It had a total population of 70,410 persons in 2011, the whole of which is rural. There were 11,567 households in the block living in 121 inhabited villages as per 2011 Census.

Geographically, the study area is located between 30º22′30″ and 31º01′20″ north latitudes and 77º01′12″to 77º49′40″ east longitudes (Fig. 1.1). The elevation in the block ranges from 630m (Renuka) to 3647m (Churdhar peak). The area supported population density of 193 persons per km^2.The block is characterized by wide differences with respect to income, housing conditions and combination of modern and traditional settlements.

As per 2011 Census in Himachal Pradesh about 89% population lived in rural areas including Sirmaur district with 89.2 % population inhabiting rural areas. The state of quality of life of the people is dismal where more than one-fifth population is still illiterate with about 29% illiterate women. Majority of population (65%) are associated with cultivation and the share of female cultivators is as high as 80% in the district. The Sangrah block being part of Sirmaur district mirrors the almost similar glooming socio- economic picture of the district. In Sangrah block 24% people are illiterate and female illiteracy is as high as 31.39%.

According to Census of India (2011) general community shares about 58% of total population of the study area. It includes the upper castes of the study area. Historically, these are advanced social groups and have greater access to the land property and power structure in the society. The scheduled castes (SCs) are relatively deprived and disadvantaged section of the society. Their level of education, health conditions, income as well as social status remains low as compared to the other social groups.

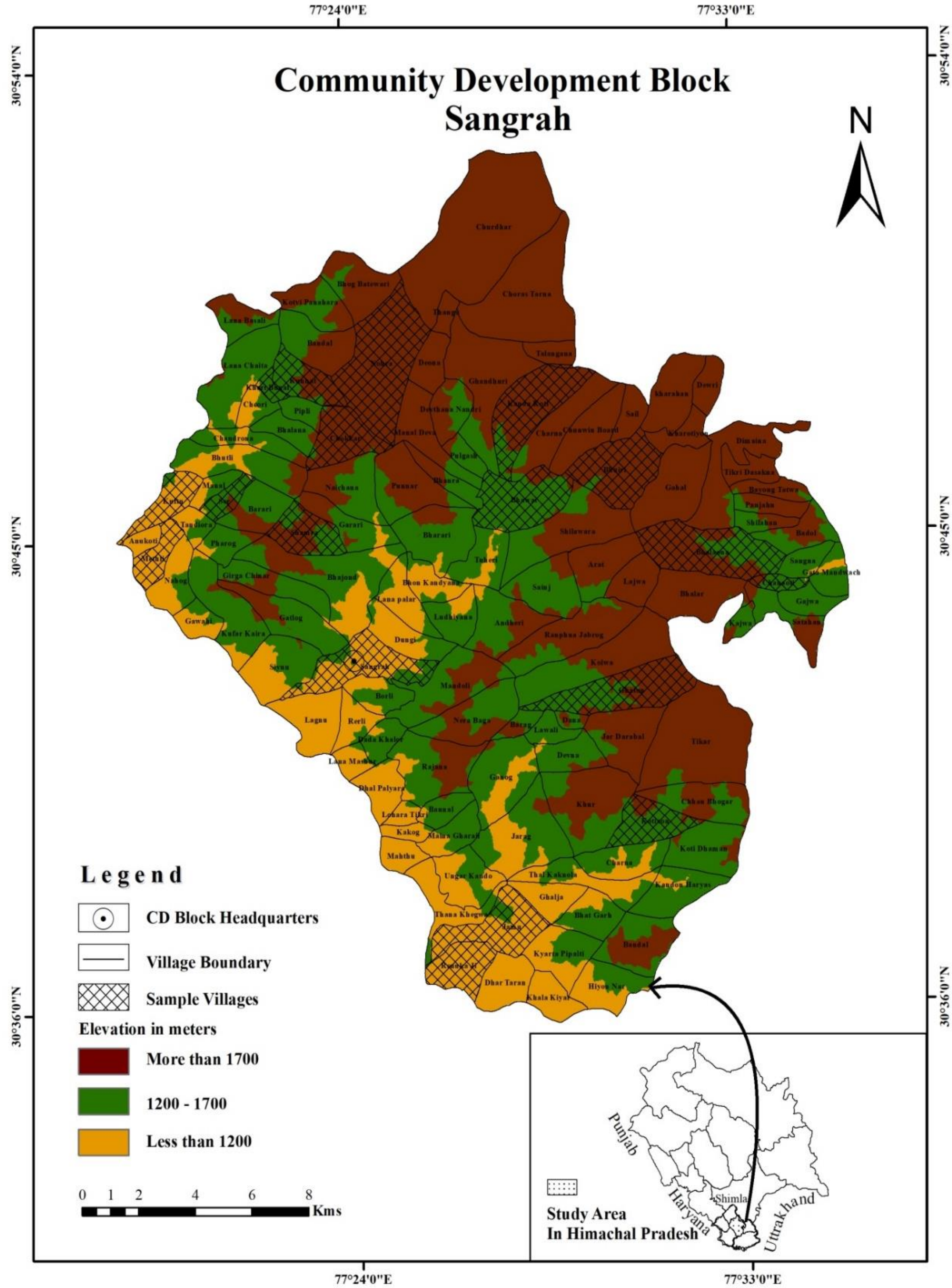


Fig. 1: Study Area

Data Source and Methodology:

The present study is based on primary and secondary sources of data. The study used secondary data for the period of 20 years i.e. 1991 and 2011 for all the 121 inhabited villages of the study area with respect to the quality of life variables. The year 1991 has been taken as base year for present study as community development (CD) block concept came into existence in 1991 in Himachal Pradesh. The subsequent study year is 2011 for which the latest data were available. The collection of secondary data on different aspects of quality of life from village level public offices was a huge challenge. Some of the secondary data have been collected from directorate of Census operations, directorate of economic and statistics, directorate of health and family welfare and department of Panchayati Raj.

The primary data were collected through a set of interview schedules canvassed at the household level. For sampling at the household level, multi-stage sampling for choosing villages was undertaken. The study area was divided into three land altitude zones. Following the Kapos et al., (2000) elevation classes of mountains for global comparison, the study area was classified accordingly however, this criterion did not prove befitting in local context for sampling at the village level. Hence, in order to ensure the regional representation the study area was divided into three elevation zones based on the abstract logic. After superimposing the village boundaries upon relief map, the required villages in each characteristic altitude zone were analyzed for sampling purpose. The low altitude zone having less than 1200 meters height above mean sea level (AMSL) comprised 35 villages. The medium altitude zone covered 53 villages and high altitude zone is inhabited by 34 revenue villages (Fig.1). At second stage, based on the maximum and minimum population size, female literacy and female work participation of each village as per 2011 Census, 6 villages from each altitude zone villages were selected for sampling at the household levels. These 18 villages constituted about 15% sample of total villages of the study area. At subsequent stage, 436 sample households (constituting about 20% of total households) spreading across 18 villages were selected randomly for the primary survey. In each sample village about seventy per cent households were surveyed proportionately from the general community whereas thirty per cent from the scheduled castes community as per the Socio-Economic and Caste Census (SECC) 2011 data provided by Panchayati Raj department of Himachal Pradesh. Finally, households were selected and surveyed randomly from each village using lottery method for each community. In the total share of interviewees, 51.6% (225) were male respondents and 48.4% (211) were females. In the age group between 18-40 years comprised of 40%, 41-59 years about 44% and 60 and above aged accounted for about 16% of total respondents. The face to face interview was conducted and responses were recorded voluntarily. The survey was undertaken from 1st June 2018 to 28 August 2018.

Results and Discussions:

It is evident from the study that about 40% of the people of the study area were illiterate in 1991. Their proportion decreased to about 24% in 2011. The study reveals the remarkable progress in literacy during the study period in the study area. During the study period in 1991 the study area average 39.9% was quite low compared to the national 52.2%, state 61.8% and district average 48.2%. Surprisingly study area bypassed the national average 74.0% in 2011 although it remained below the district and state average in 2011.

Table 1. Villages by Literacy Rate

Census Year	Literates to Total Population (%)					Total Inhabited Villages	Study Area Average	District Average	State Average	National Average
	Less Than 15	15-30	30-45	45-60	More Than 60					
1991	7 (5.8)	28 (23.1)	38 (31.4)	37 (30.6)	11 (9.1)	121 (100.0)	**39.9**	48.2	61.8	52.2
2011	0 (0.0)	0 (0.0)	0 (0.0)	5 (4.1)	116 (95.9)	121 (100.0)	**76.6**	78.7	82.7	74.0

Figures in parentheses show the percent to the total inhabited villages

Source: Computed by scholar based on Census of India, 1991 and 2011

The study reveals that study area seriously lack the educational facilities. Although, the situation has improved over the period (1991-2011) but Census year 1991 reflected glooming picture of the educational institutions in the study area. It is only through some governments' initiative such as Sarva Shiksha Abhiyan, Rashtriya Madhyamik Shiksha Abhiyan and Right to Education etc. that school infrastructure has improved. Special focus has been given to enhance the enrolment at the primary level so that children can avail the benefits of education. It has been observed that all the villages have not been provided with primary school within the habitation and children have to travel or sometimes walk on foot more than 10 kms of distance. This negatively impacts the enrolment ratio at school particularly in case of girls. The distance travelled to access educational institution increases as the level of education increases. It merits serious attention particularly in case of equity provision. The study reveals that high altitude zone enjoys better position in availability of the middle and high schools within the habitation compared to the middle and low altitude zones. The low altitude zone stood at top in terms of availability of primary schools within the habitation. The middle altitude zone was at the top in the availability of the senior secondary schools. At the college level, the high and low altitude zones had better position at college level compared to the middle altitude zone. The lack of basic and higher educational facilities in study area implies that young generation face the challenges of globally competitive skills and consequently job market and better living standards. An area underserved by the educational facilities is likely to encounter and experience the socio-economic inequalities stemming from the benefits of education sector.

Fig 2and Fig 3 shows the distribution of male literacy rates in the study area.It is evident from the study that north and north western part of the study area was at better

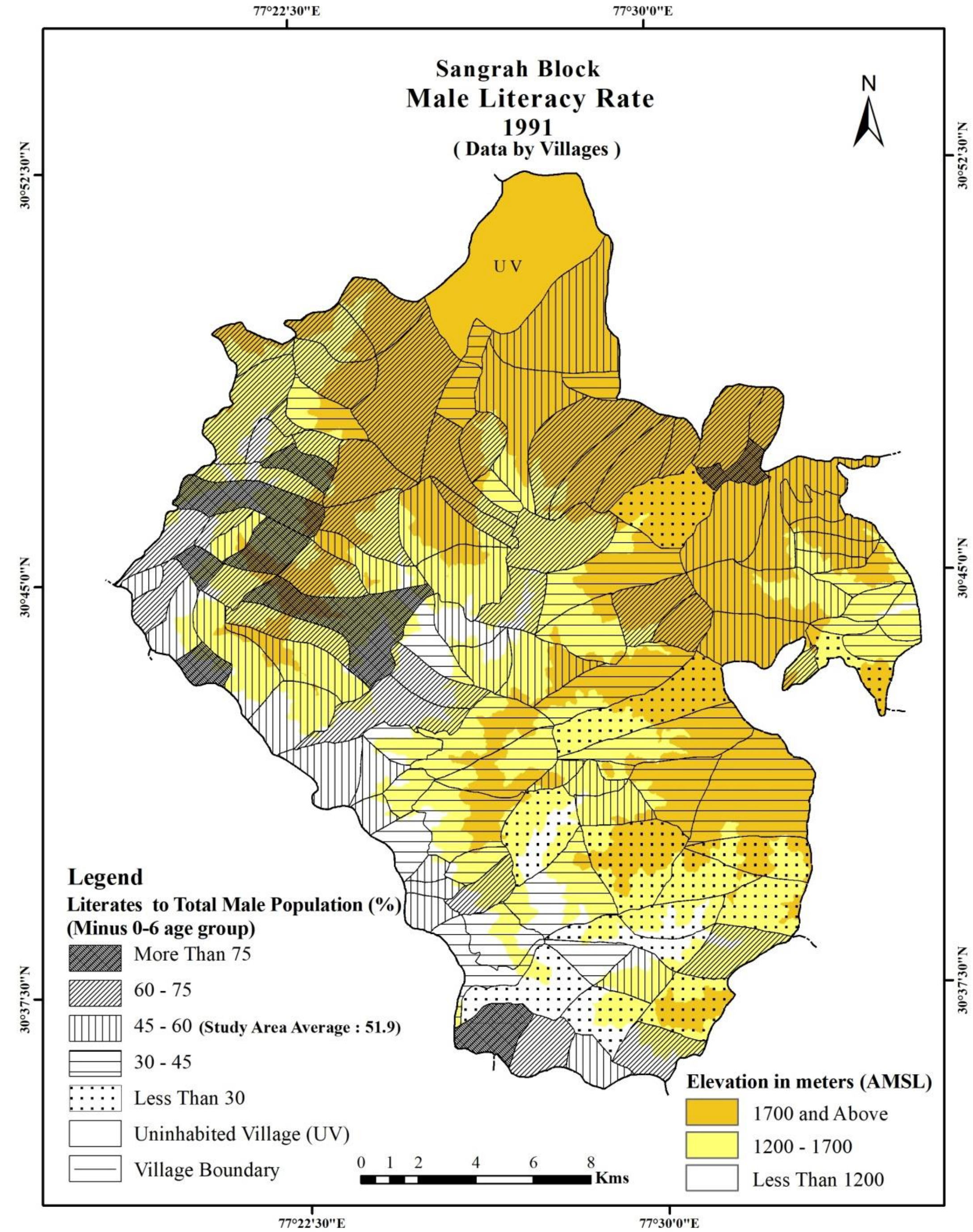
Table 2. Sangrah Block: Villages Served by Educational Institutions

Altitudinal Zone	Period	Primary Schools*				Middle Schools*			High Schools			Senior Secondary Schools			Govt. Colleges Total	Total Villages
		Within Habitations	Distance Travelled (Km)			Within Habitations	Distance Travelled (Km)		Within Habitations	Distance Travelled (Km)		Within Habitations	Distance Travelled (Km)			
			0-5	5-10	>10		0-10	>10		0-10	>10		0-10	>10		
High	1991	35	DNA	DNA	DNA	18	DNA	DNA	4	DNA	DNA	0	DNA	DNA	DNA	33
	2011	55 (93.9)	0 (0.0)	1 (3.0)	1 (3.0)	23 (54.5)	12 (36.4)	3 (9.1)	12 (36.4)	17 (51.5)	4 (12.1)	5 (15.2)	17 (51.5)	11 (33.3)	2 (6.1)	33
Middle	1991	48	DNA	DNA	DNA	10	DNA	DNA	4	DNA	DNA	0	DNA	DNA	DNA	52
	2011	70 (86.5)	5 (9.6)	1 (1.9)	1 (1.9)	23 (38.5)	32 (61.5)	0 (0.0)	11 (21.2)	41 (78.8)	0 (0.0)	10 (19.2)	38 (73.1)	4 (7.7)	0 (0.0)	52
Low	1991	36	DNA	DNA	DNA	7	DNA	DNA	1	DNA	DNA	0	DNA	DNA	DNA	36
	2011	51 (94.4)	2 (5.6)	0 (0.0)	0 (0.0)	20 (47.2)	19 (52.8)	0 (0.0)	7 (19.4)	24 (66.7)	5 (13.9)	3 (8.3)	25 (69.4)	8 (22.2)	2 (5.6)	36
Total	1991	114	DNA	DNA	DNA	35	DNA	DNA	9	DNA	DNA	0	DNA	DNA	DNA	121
	2011	176 (91.7)	7 (5.8)	2 (1.7)	1 (0.8)	66 (31.4)	83 (68.6)	0 (0.0)	30 (24.8)	82 (67.8)	9 (7.4)	18 (14.9)	80 (66.1)	23 (19.0)	4 (3.3)	121

Figures in parentheses show the per cent to the total inhabited villages

Source: Computed by scholar based on Census of India, 1991 and 2011

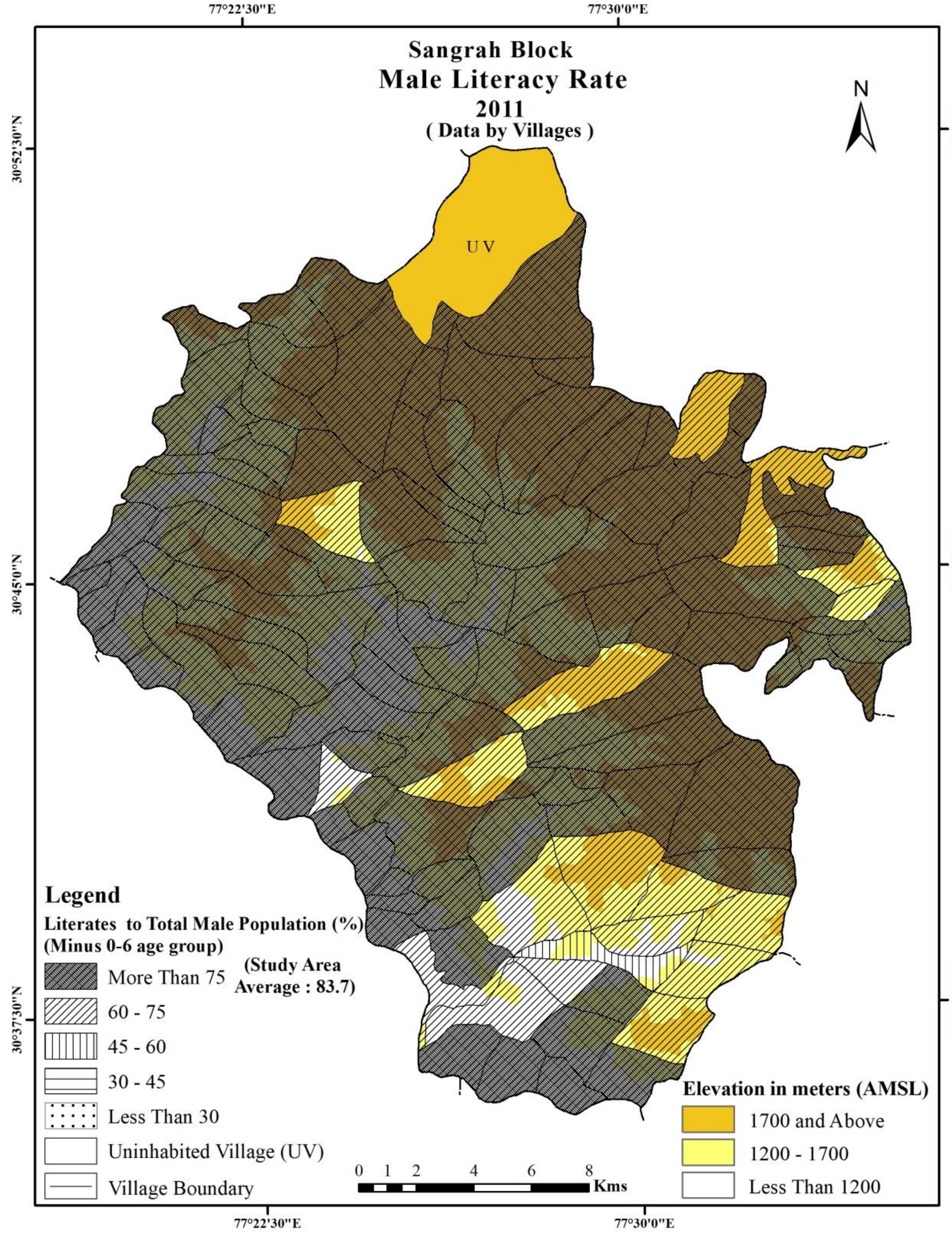
*In case of primary school and middle schools as the numbers of school exceed the total number of villages so the percentage of villages having schools within habitation has been calculated from villages not having schools



Source: Prepared by scholar based on Census of India, 1991

Fig. 2

status of literacy in 1991 and which is also reflected the same in 2011 however the southern and eastern part of the study area observed the villages with low and very low status of male literacy from 1991 to 2011. The similar pattern has been observed for the female literacy rates (Fig 4 and Fig 5) in the study area during study period. It is evident from the study that study area average changed from 26.8% to 69.2% in 2011. The female literacy rate was again observed with low share of literate women is southern parts of the study area. This may be attributed to un-availability of educational institutions, poverty and traditional nature of the

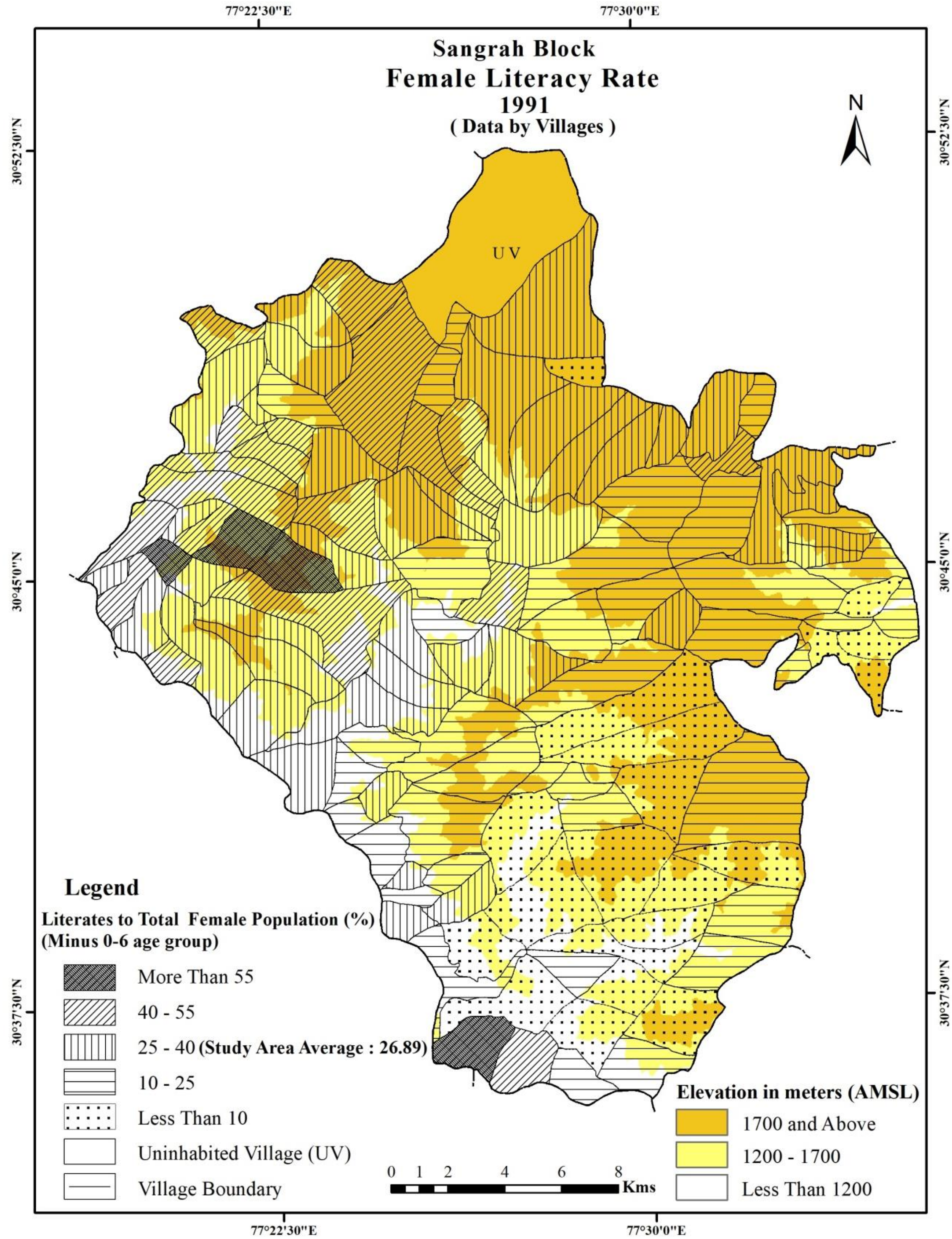


Source: Prepared by scholar based on Census of India, 2011

Fig.3

society here. District primary education programme (1994), Sarv Shiksha Abhiyan (2001) and Kasturba Gandhi Balika Vidhyalaya (2004) are some of the major flagship programmes initiated by the centre and state governments, which led to the improvement in the female literacy in the study area.

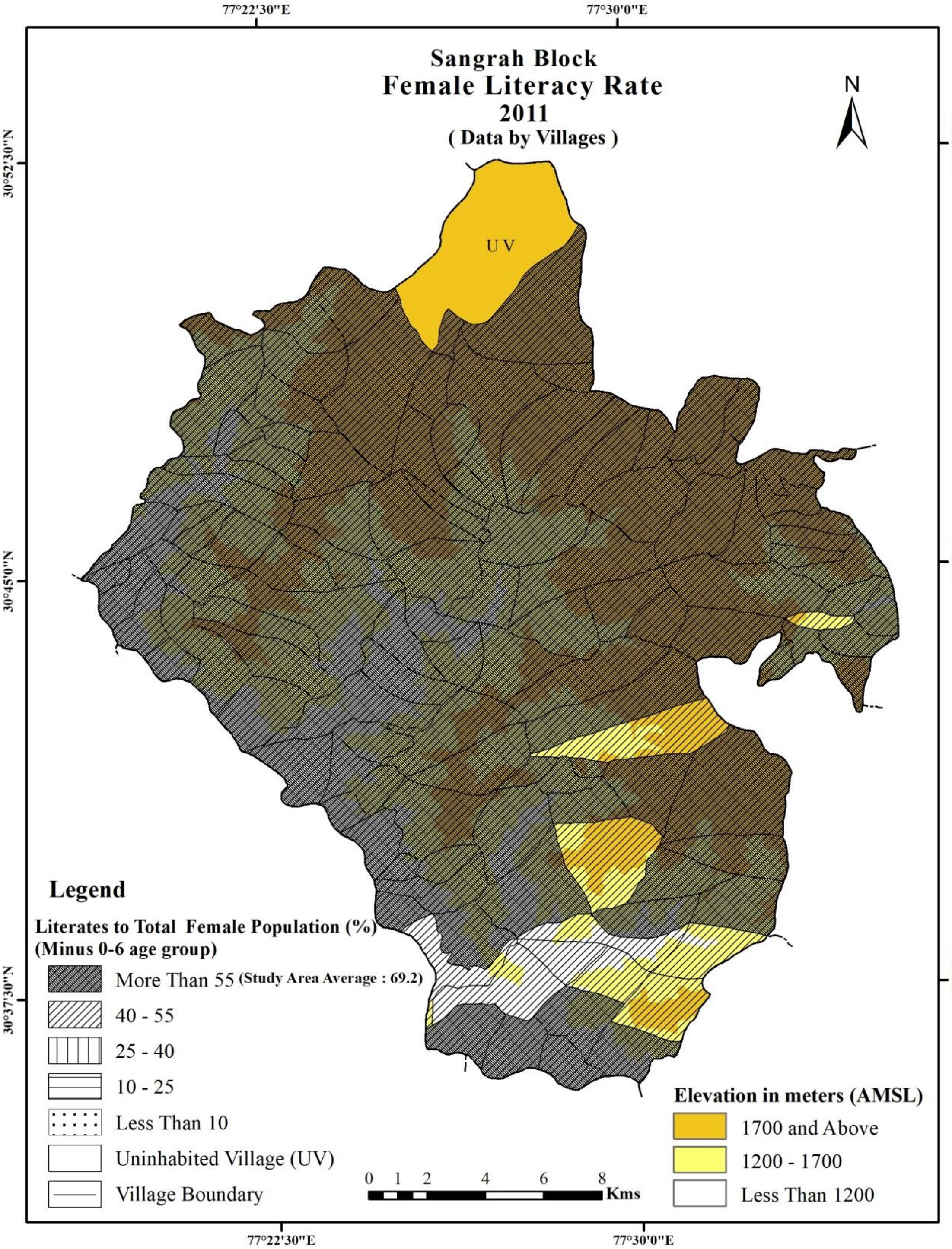
Table 2.12 reveals that study share more than 1/10 of the total literates educated to below primary level whereas primary level



Source: Prepared by scholar based on Census of India, 1991

Fig. 4

educated population share was reported 19.6 % of the total literates in the study area. The middle level educated population shared 15.7% of total literates in the study area. The Matric level educated population shared 20.9 % of the overall literates in the study area. The senior secondary level educated population shared 21.5% of the total literate in the study area.



Source: Prepared by scholar based on Census of India, 2011

Fig.5

The graduate and above level educated population shared 1/10 of the study area literates and gender statistics hovered around the study area averages 10.2% of total in the study area. In general category, the share of graduate and above was reported 11.8%. Among SCs' the share of graduate and above level was reported 4.8%. The others category of educational attainment include technical diplomas/certificate not equal to degree. This category shared 1% of the total literates in this zone. Among males it was recorded 1.3% and females were reported 0.6 % in this category. The study unfolds that in study area level of education is low. The low percentage of people in the education level in the study area may be attributed to unavailability of the educational institution**.** The large number of villages at the middle, high, senior secondary schools and college level are reported with more than 10 km distance to reach educational institute (Table 2).

The study area lies in lesser and mid Himalayan mountain zone. In this zone, the topography is rugged and steep slopes and ridges are common. This makes the school accessibility very difficult for the children. 1/3 of the total villages of the study area are not connected to the bus facility and schools are not connected to the road facility. The parents' education level is second most important factor in the low level of educational attainment in the study area (Table 6). The low level of education in the study area renders individual handicap with respect to various social and economic affairs. The low level of educational attainment among the SCs' compared to the general category may be attributed to the poverty (annual income earned and landholding size). The low level of educational attainment among the females may be attributed to the biased attitude towards female education. Middle altitude zone lies at the bottom in terms of up to middle level educational institution within habitation and percentage share of bus facility. The high and senior secondary schools have higher percentages in high and middle altitude zones. Low altitude zone has highest level share in graduate and above category.

Although the traditional agrarian structure has undergone change and agrarian relations among the communities have also experienced certain changes. But it is fact that economically weaker sections mainly SCs' in the area are still at the receiving end and struggling hard to lead a better quality of life. The zonal pattern of the landholdings Table 4 points out that in high altitude area the highest share was observed in less than 0.5 ha landholding followed by more than 1 ha category. The middle altitude zone shows that 0.5- 1 hectare and more than 1hectare shared the same share. The low altitude zone showed the landholding category of 0.5-1 ha shared more share than more than 1ha landholding category. In brief, traditions affect social hierarchy and feudal ethos can be easily seen on landholding ownership in the study area. It clearly manifests the disadvantageous situation of downtrodden communities in the area where people are less educated with bare means of subsistence. The large share of SCs in the primary activities may be attributed to the low level of income, which restricts them to purchase new land.

It is evident from the study that occupational structure is the key determinant of the average annual income in the study area and educational attainment is major determinant of occupational structure in the study area. Among the SCs, illiteracy, low educational level and less landholding are the key determinants of low average annual income compared to general category.

Table 3. Sangrah Block: Literate Population by Levels of Educational Attainments

Altitudinal Zone	Social Groups	Educational Levels: Below Primary			Primary			Middle			Matric			Senior Secondary			Graduation and Above			Others			Total Literates		
		T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F
High	General	69 (10.1)	36 (9.7)	33 (10.6)	105 (15.3)	60 (16.1)	45 (14.4)	103 (15.0)	51 (13.7)	52 (16.7)	170 (24.8)	100 (26.8)	70 (22.4)	148 (21.6)	74 (19.8)	74 (23.7)	85 (12.4)	47 (12.6)	38 (12.2)	5 (0.7)	5 (1.3)	0 (0.0)	685 (100.0)	373 (100.0)	312 (100.0)
	SCs	33 (12.7)	17 (11.9)	16 (13.7)	57 (21.9)	32 (22.4)	25 (21.4)	51 (19.6)	31 (21.7)	20 (17.1)	49 (18.8)	28 (19.6)	21 (17.9)	58 (22.3)	29 (20.3)	29 (24.8)	11 (4.2)	5 (3.5)	6 (5.1)	1 (0.4)	1 (0.7)	0 (0.0)	260 (100.0)	143 (100.0)	117 (100.0)
	Sub-Total	102 (10.8)	53 (10.3)	49 (11.4)	162 (17.1)	92 (17.8)	70 (16.3)	154 (16.3)	82 (15.9)	72 (16.8)	219 (23.2)	128 (24.8)	91 (21.2)	206 (21.8)	103 (20.0)	103 (24.0)	96 (10.2)	52 (10.1)	44 (10.3)	6 (0.6)	6 (1.2)	0 (0.0)	945 (100.0)	516 (100.0)	429 (100.0)
Middle	General	42 (8.4)	23 (8.4)	19 (8.5)	94 (18.8)	43 (15.6)	51 (22.8)	78 (15.6)	37 (13.5)	41 (18.3)	117 (23.4)	77 (28.0)	40 (17.9)	113 (22.6)	68 (24.7)	45 (20.1)	49 (9.8)	23 (8.4)	26 (11.6)	6 (1.2)	4 (1.5)	2 (0.9)	499 (100.0)	275 (100.0)	224 (100.0)
	SCs	28 (14.7)	15 (14.2)	13 (15.3)	49 (25.7)	28 (26.4)	21 (24.7)	33 (17.3)	18 (17.0)	15 (17.6)	31 (16.2)	15 (14.2)	16 (18.8)	42 (22.0)	24 (22.6)	18 (21.2)	8 (4.2)	6 (5.7)	2 (2.4)	0 (0.0)	0 (0.0)	0 (0.0)	191 (100.0)	106 (100.0)	85 (100.0)
	Sub-Total	70 (10.1)	38 (10.0)	32 (10.4)	143 (20.7)	71 (18.6)	72 (23.3)	111 (16.1)	55 (14.4)	56 (18.1)	148 (21.4)	92 (24.1)	56 (18.1)	155 (22.5)	92 (24.1)	63 (20.4)	57 (8.3)	29 (7.6)	28 (9.1)	6 (0.9)	4 (1.0)	2 (0.6)	690 (100.0)	381 (100.0)	309 (100.0)
Low	General	58 (11.0)	30 (10.2)	28 (11.9)	109 (20.6)	52 (17.7)	57 (24.3)	72 (13.6)	48 (16.3)	24 (10.2)	86 (16.3)	54 (18.4)	32 (13.6)	115 (21.7)	62 (21.1)	53 (22.6)	77 (14.6)	41 (13.9)	36 (15.3)	12 (2.3)	7 (2.4)	5 (2.1)	529 (100.0)	294 (100.0)	235 (100.0)
	SCs	36 (16.2)	17 (14.9)	19 (17.6)	53 (23.9)	23 (20.2)	30 (27.8)	38 (17.1)	20 (17.5)	18 (16.7)	46 (20.7)	25 (21.9)	21 (19.4)	36 (16.2)	21 (18.4)	15 (13.9)	13 (5.9)	8 (7.0)	5 (4.6)	0 (0.0)	0 (0.0)	0 (0.0)	222 (100.0)	114 (100.0)	108 (100.0)
	Sub-Total	94 (12.5)	47 (11.5)	47 (13.7)	162 (21.6)	75 (18.4)	87 (25.4)	110 (14.6)	68 (16.7)	42 (12.2)	132 (17.6)	79 (19.4)	53 (15.5)	151 (20.1)	83 (20.3)	68 (19.8)	90 (12.0)	49 (12.0)	41 (12.0)	12 (1.6)	7 (1.7)	5 (1.5)	751 (100.0)	408 (100.0)	343 (100.0)
Study Area	General	169 (9.9)	89 (9.4)	80 (10.4)	308 (18.0)	155 (16.5)	153 (19.8)	253 (14.8)	136 (14.4)	117 (15.2)	373 (21.8)	231 (24.5)	142 (18.4)	376 (21.9)	204 (21.7)	172 (22.3)	211 (12.3)	111 (11.8)	100 (13.0)	23 (1.3)	16 (1.7)	7 (0.9)	1713 (100.0)	942 (100.0)	771 (100.0)
	SCs	97 (14.4)	49 (13.5)	48 (15.5)	159 (23.6)	83 (22.9)	76 (24.5)	122 (18.1)	69 (19.0)	53 (17.1)	126 (18.7)	68 (18.7)	58 (18.7)	136 (20.2)	74 (20.4)	62 (20.0)	32 (4.8)	19 (5.2)	13 (4.2)	1 (0.1)	1 (0.3)	0 (0.0)	673 (100.0)	363 (100.0)	310 (100.0)
	Total	**266 (11.1)**	**138 (10.6)**	**128 (11.8)**	**467 (19.6)**	**238 (18.2)**	**229 (21.2)**	**375 (15.7)**	**205 (15.7)**	**170 (15.7)**	**499 (20.9)**	**299 (22.9)**	**200 (18.5)**	**512 (21.5)**	**278 (21.3)**	**234 (21.6)**	**243 (10.2)**	**130 (10.0)**	**113 (10.5)**	**24 (1.0)**	**17 (1.3)**	**7 (0.6)**	**2386 (100.0)**	**1305 (100.0)**	**1081 (100.0)**

(T=Total, M= Male, F= Female)

Figures in parentheses show the per cent to the total literate population

Source: Field Survey 2018

Table 4. Sangrah Block: Households by Land Ownership (Ha)

Altitudinal Zone	Social Groups	Landless	Less Than 0.5	0.5 - 1	More Than 1	Total Sample Households
High	General	2 (1.5)	41 (30.6)	35 (26.1)	56 (41.8)	134 (100.0)
	SCs	2 (3.7)	33 (61.1)	11 (20.4)	8 (14.8)	54 (100.0)
	Sub -Total	4 (2.1)	74 (39.4)	46 (24.5)	64 (34.0)	188 (100.0)
Middle	General	1 (1.3)	36 (45.0)	21 (26.3)	22 (27.5)	80 (100.0)
	SCs	0 (0.0)	28 (75.7)	5 (13.5)	4 (10.8)	37 (100.0)
	Sub - Total	1 (0.9)	64 (54.7)	26 (22.2)	26 (22.2)	117 (100.0)
Low	General	1 (1.1)	57 (62.6)	18 (19.8)	15 (16.5)	91 (100.0)
	SCs	1 (2.5)	37 (92.5)	2 (5.0)	0 (0.0)	40 (100.0)
	Sub - Total	2 (1.5)	94 (71.8)	20 (15.3)	15 (11.5)	131 (100.0)
Study Area	General	4 (1.3)	134 (43.9)	74 (24.3)	93 (30.5)	305 (100.0)
	SCs	3 (2.3)	98 (74.8)	18 (13.7)	12 (9.2)	131 (100.0)
	Total	**7 (1.6)**	**232 (53.2)**	**92 (21.1)**	**105 (24.1)**	**436 (100.0)**

Source: Field Survey 2018 *Figures in parentheses show the percent to the total sample households*

Table 5. Sangrah Block: Households by Annual Income (Lakh)

Altitudinal Zone	Social Groups	Less Than 1 Lakh	1-3 Lakh	More Than 3 Lakh	Total Sample Households
High	General	41 (30.6)	64 (47.8)	29 (21.6)	134 (100.0)
	SCs	20 (37.0)	29 (53.7)	5 (9.3)	54 (100.0)
	Sub-Total	61 (32.4)	93 (49.5)	34 (18.1)	188 (100.0)
Middle	General	22 (27.5)	41 (51.3)	17 (21.3)	80 (100.0)
	SCs	15 (40.5)	19 (51.4)	3 (8.1)	37 (100.0)
	Sub-Total	37 (31.6)	60 (51.3)	20 (17.1)	117 (100.0)
Low	General	20 (22.0)	42 (46.2)	29 (31.9)	91 (100.0)
	SCs	19 (47.5)	11 (27.5)	10 (25.0)	40 (100.0)
	Sub-Total	39 (29.8)	53 (40.5)	39 (29.8)	131 (100.0)
Study Area	General	83 (27.2)	147 (48.2)	75 (24.6)	305 (100.0)
	SCs	54 (41.2)	59 (45.0)	18 (13.7)	131 (100.0)
	Total	**137 (31.4)**	**206 (47.2)**	**93 (21.3)**	**436 (100.0)**

Source: Field Survey 2018 *Figures in parentheses show the percent to the total sample households*

Table 6. Sangrah Block: Households by Household Head Education Level

Altitudinal Zone	Social Groups	Illiterate	Below Primary	Primary	8th	10th	12th	Graduate and Above	Others	Total Sample Households
High	**General**	43 (32.1)	16 (11.9)	27 (20.1)	13 (9.7)	23 (17.2)	7 (5.2)	5 (3.7)	0 (0.0)	134 (100.0)
	SCs	27 (50.0)	8 (14.8)	9 (16.7)	5 (9.3)	4 (7.4)	1 (1.9)	0 (0.0)	0 (0.0)	54 (100.0)
	Sub-Total	70 (37.2)	24 (12.8)	36 (19.1)	18 (9.6)	27 (14.4)	8 (4.3)	5 (2.7)	0 (0.0)	188 (100.0)
Middle	**General**	26 (32.5)	10 (12.5)	16 (20.0)	10 (12.5)	13 (16.3)	4 (5.0)	1 (1.3)	0 (0.0)	80 (100.0)
	SCs	15 (40.5)	6 (16.2)	7 (18.9)	5 (13.5)	2 (5.4)	2 (5.4)	0 (0.0)	0 (0.0)	37 (100.0)
	Sub-Total	41 (35.0)	16 (13.7)	23 (19.7)	15 (12.8)	15 (12.8)	6 (5.1)	1 (0.9)	0 (0.0)	117 (100.0)
Low	**General**	23 (25.3)	16 (17.6)	24 (26.4)	12 (13.2)	8 (8.8)	4 (4.4)	4 (4.4)	0 (0.0)	91 (100.0)
	SCs	24 (60.0)	4 (10.0)	4 (10.0)	4 (10.0)	3 (7.5)	1 (2.5)	0 (0.0)	0 (0.0)	40 (100.0)
	Sub-Total	47 (35.9)	20 (15.3)	28 (21.4)	16 (12.2)	11 (8.4)	5 (3.8)	4 (3.1)	0 (0.0)	131 (100.0)
Study Area	**General**	92 (30.2)	42 (13.8)	67 (22.0)	35 (11.5)	44 (14.4)	15 (4.9)	10 (3.3)	0 (0.0)	305 (100.0)
	SCs	66 (50.4)	18 (13.7)	20 (15.3)	14 (10.7)	9 (6.9)	4 (3.1)	0 (0.0)	0 (0.0)	131 (100.0)
	Total	**158 (36.2)**	**60 (13.8)**	**87 (20.0)**	**49 (11.2)**	**53 (12.2)**	**19 (4.4)**	**10 (2.3)**	**0 (0.0)**	**436 (100.0)**

Figures in parentheses show the per cent to the total sample households

Source: Field Survey 2011

In low altitude zone, Table 5, higher share in more than Rs. 3 lakh annual income category compared to high and middle altitudes zones is mainly due to more share of people in tertiary activities supported further by higher share of graduate and both technically and vocationally educated and trained human resources in the zone. From the above discussion, it can be inferred that low income among the SCs' is indicative of low standard of living, low level of consumption and compromise on basic needs of life like health, education and living in cleaner and safer areas. These groups are highly vulnerable to unexpected shocks, which could throw them into extreme poverty and destitution and poorer quality of life.

Conclusions:

The study shows that educationally backward areas of 1990s registered an increase of more than 50% in total literacy rate. The positive change in literacy rate in these villages occurred because of the universalisation of the primary education and growing awareness about literacy. District primary education programme (1994), Sarv Shiksha Abhiyan (2001) and Kasturba Gandhi Balika Vidhyalaya (2004) are some of the major flagship programmes initiated by the centre and state governments, which led to the improvement in the literacy in the study area.

This study concludes that study area lies in lesser and mid Himalayan mountain zone. In this zone, the topography is rugged and steep slopes and ridges are common. This makes the school accessibility very difficult for the children as 1/3 of the total villages of the study area are not connected to the bus facility and schools are not connected to the road facility.

The low percentage of people in the education level in the study area may be attributed to unavailability of the educational institution. The large number of villages at the middle, high, senior secondary schools and college level are reported with more than 10 km distance to reach educational institute. The parents' education level is second most important factor in the low level of educational attainment in the study area. The low level of educational attainment among the SCs' compared to the general category may be attributed to the poverty. The low level of educational attainment among the females may be attributed to the biased attitude towards female education.

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Traditional Cure Methods (Herbal and Magico-Religious) Prevalent in Trans-Giri Region of Himachal Pradesh: A Case Study

SaritaVerma and Anurag Sharma

Abstract:

Himalayan forests are one of the most important sources of medicinal plants, which are used by local people in Trans-Giri Region of Sirmaur District in Himachal Pradesh.Trans-Giri Region is situated in the western Himalayas. The geographical area of the region is 1324 km^2 and forest area is of 273.65 km^2 (26.88% of the total area). Reserved forest and protected forest covers are 244.64 and 28.43 km^2 respectively. The entire tract is mountainous and varies in elevations from 543 m to 3647 m. This is inaccessible remote area with poor road network that is why people follow the traditional cure system as it is the only trustworthy system available to them from ages.This study is focused on the traditional use of herbalplants and magico-religious methods to cure the ailments. Information on medicinal trees of the present study has been gathered through review of relevant literature and by questionnaire survey. Emblicaofficinalis (Amala), Rhododendron arboretum (Burans) and Pinusroxburghii (Chir) etc. are the commonly used medicinal tree species here. Out of total 30 medicinal plants about 33% of trees speciesare used for their bark, about 30 fruit part of trees were used, about 17% for leaves, 13% for roots, 10% for seeds and 3.34% trees for both flowers and whole plant were used by local people.This study document the traditional uses of medicinal tree species of Trans-Giri Region and traditional local method i.e. magico-religious to cure is the ailments which are totally based on the blind trust or faith of the people in their deities. This study can serve as baseline information on traditional treatments methods practised by people of Trans-Giri in Sirmour districtfor agesit could be helpful in conservation of traditionalcure knowledge of this area.

Keywords:

Medicinal plants, Magico-religious, Traditional knowledge, Trans-Giri Region, Curemethods

Introduction:

India is rich in its ethnic diversity of which many aboriginal cultures have retained traditional knowledge concerning the medicinal utility of the flora (Raghupathy, 2008). Over 8000 plant species are used in traditional and modern medicine in India, and 90-95% collection of medicinal plants is from the wild (Adhikari et al., 2010). In ancient literature utilization of plants for medicinal purposes in India has been documented long back (Sanjay et al., 2006). However, organized studies in this direction were initiated in1956 and off late such studies are gaining recognition and popularity due to loss of traditional knowledge and declining plant population (Rao, 1996).However, organized studies in this direction were initiated in 1956 and off late such studies are gaining recognition and popularity due to loss of traditional knowledge and declining plant population (Rao, 1996). A great amount of traditional knowledge about the use of medicinal plant species is still carried and orally transmitted by indigenous peoples. Regions with less accessibility and a comparatively slow rate of development, such as and mountainous areas like the Himalayas are excellent examples.In lower altitudes the knowledge about medicinal tree species is declining comparative to higher altitudes.

Objective:

To explore the local traditional methods of cure (including herbal and magico-religious) in Trans-Giri Region of Himachal Pradesh.

Study Area:

Trans-Giri Region is a less developed region that harbors large number of medicinal plants and is therefore one of the best study sites to document the information on the medicinal trees used by the local people. The Trans-Giri Region lies between latitudes of 30º30’00’’ to 31º0'00" North andlongitudes of 77º10'00" to 77º50'00" East. The geographical area of the region is 1324 sq. kms and forest area is 273.65 km^2 (26.88% of the total area). Reserved forest and protected forest cover 244.64 km^2 and 28.43 km^2, respectively. There are four tehsil and three sub-tehsils under Trans-Giri Region. The entire tract is mountainous and varies in elevation from 543 m to 3647 m. The entire region of Trans-Giri Region falls within the catchments of Giri and Tons rivers.

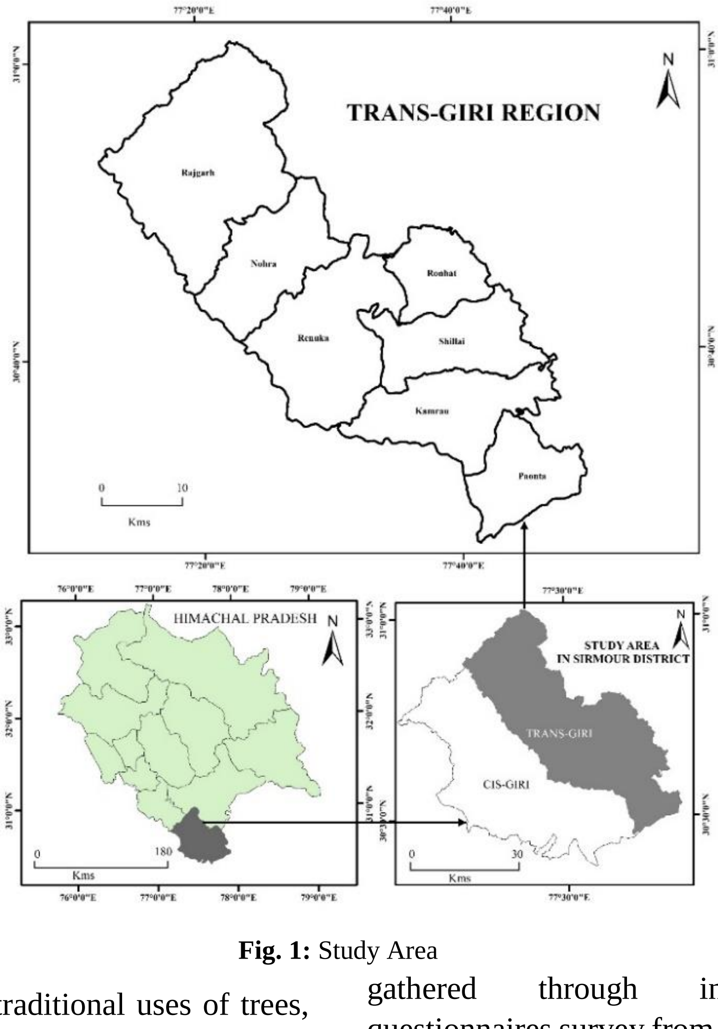


Fig. 1: Study Area

Information on the traditional uses of trees, magico-religious found in Trans-Giri was gathered through interviews and questionnaires survey from local people. The interviews were based on informal discussion with local elders ‘including filling of open ended questionnaires. Traditional knowledge about herbs and magico-religious practices were collected.

For survey work 41 villages were selected.All villages are situated between 543 m to 3647 m altitudes surrounded by sub-tropical, temperate, sub alpine and alpine forests with agricultural fields (DCH, 2011).Dominant plant species of the region are pine, deodar, oak and rhodendron. The inhabitants of the study area have agro lifestyle and fully depend on traditional agricultural practices. People of the area use indigenous knowledge of medicinal plants and they make use of the traditional cure methods knowledge as primary healthcare.

Results and discussion:

The results of this study are based on survey of the 41 villages at various altitudes on the basis of their traditional cure knowledge about medicinal plantspecies and magico-religious practices. The natives of the area use medicinal plants for various therapeutic purposes in their day to day life as primary healthcare. The respondents were both male and female agedbetween30 to 60 years. Out of total respondents 74% were educated and 26% were illiterate. It was found that the young generation had less information about traditional cure methods compared to the old age folks.

It is evident from the study that people in the Trans-Giri region collects a variety of leaves, fruits, seeds, nuts, roots, barks, tubers and rhizomes during summer and winters seasons which have medicinal values. However, the purpose and frequency of collection have reduced significantly with the passage of time.In the other words, the villager’s interaction with their environment has been changed considerable with respect to the search and collection of traditional plants roots, leaves, buds, barks, flowers and associated drying and conservational methods to store the collected medicines.In the old days, these people used medicinal plants for their own need as per the traditional cure practices.

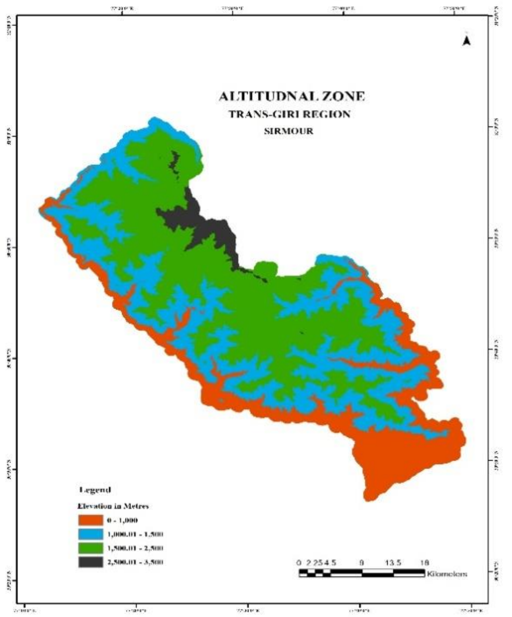
The study reveals that the people of Trans-Giri region lives in close proximity with biodiversity rich landscapes. They have evolved local specific and novel livelihood strategies based on their traditional knowledge system. This knowledge was passed on through generations and it played an important role in the conservation and sustainable use of biodiversity. Thus, there always existed an organic unity between humans and their surrounding environments in the study area.

Medicinal remedies of 30 plants and trees were recorded in the study area. In table 1, plants and trees are arranged with their botanical name, local name, part used and medicinal use. Usually, all parts of the tree including bark, fruits, leaves, root, seeds and flower are utilized by the mountain people. The common use of bark is 33.33% followed by fruits 26.66%, leaves 16.67%, seeds 10%, flowers 30% the whole tree is not commonly used (Fig.2). .More commonly used trees are Rhododendron arboretum (*Burans*), Terminaliabellirica (*Bahera*), Pinusroxburghii (*Chir*) etc. as these trees commonly found in this area. People in the study area use animal parts as medicines for curing various respiratory problems, bacterial and viral infections, gastric disorders, and wound healings (Table 2). Animal substances can help in treatment of various common diseases. A few of them are enlisted above.

Table 1. Information of the Medicinal Herbal Speciesof the Study Area

Sr. No.	Botanical Name	Family Name	Part Used	Local Name	Altitude in Meters	Medicinal Use
1	***Rhododendron arboretum* Smith**	Ericaceae	Flower & bark	Buras	1500 -2600	Digestive respiratory
2	***Ageratum conyzoides* Linn.**	Compositae (Asteraceae)	Leaves stem	Goat weed	2,500	Useful in diarrhea, skin diseases and leprous sores.
3	***Pyruspashia(L)***	Cactaceae.	Fruit & bark	Pear	800-2400	Digestive disorder
4	***Acacia nilotica* Linn**	Mimosaceae	Bark extract	Babul	up to 2000	used to kill worms in cattle
5	***Azadirachtaindica* A. Juss**	Meliaceae	Leaves, Roots and Fruits	Neem	up to 2000	Skin diseases urinary diseases, piles, intestinal worms and leprosy
6	***Cyperusrotundus* Linn**	Cyperaceae	Roots	Motha	up to 2000	Wounds
7	***Caricapapyalinn***	Caricaceae	Fruits juice seeds	Papita	upto –2000	Skin disease
8	**Pinusroxburghil**	Pinaceae	Aerial part	Chir	600 to 1800	Asthma
9	***Linumusitatissimum* Linn.**	Linaceae	Seeds	Alsi	up to 1800	Inflammatory gastro-intestinal disorders
10	***Aloe barbadensis***	Flower and Seed	For skin and jaundice	Alovevera	up to 1800	For skin and jaundice
11	***Punicagranatum* Linn.**	Punicaceae	Flowers and Fruit	Anar, Dadim	1800	Useful in brain affections, coughs and colds,
12	***Nicitianatabacum***	Nightshade	Leaves	Tambacu	Up to 1800	Ringworm,athletes foot, wounds
13	***Emlicaofficinalis* L.**	Euphorbiaceae	Fruits	Amla	up to 1500	Night blindness, dysentery
14	***Zingiberofficinale***	Zingiberaceae	Fresh and Dried Rhizomes	Ginger	up to 1500	For cold &spice
15	***Ficusreligiosa* Linn.**	Moraceae	Fruit, Leaves and Bark	Pipal	up to 1500	Chickenpox, asthma
16	***Acacia catechu* Wild**	Mimosaceae	Bark	Khair	383-1370	Stomach
17	***Lawsoniainermis***	Lythraceae	Bark and Leaves	Mehndi Heena	Up to 1350	Skin disease, hair dye
18	***Cucumissativus* Linn**	Cucurbitaceae	Fruit, seeds, Leaves	Kheera	Up to 1200	Inflammation, throat infection
19	***Aeglemarmeloslinn***	Rutaceae	Fruit	Bel	1200	Correa dysentery & diarrhea
20	***Minosapudica* Linn.**	Mimosaceae	Seeds and Leaves	Lajwanti (Chui-mui)	up to 13oo	Blood purifier.
21	***Pinusroxburghii* Sargent**	Pinaceae	Fruit paste,	Chir (Pine)	up to 1000	Burning sensation of the body, cough and fainting fits and constipation
22	***Ficusracemosa Linn***	Moraceae	Bark, leaves	Gular	up to 1000	Bilious disorder, diabetes
23	***Toona ciliate* (m-roem)**	Meliaceae	Bark	Toon	1000	Menstrual disorder
24	***Morus alba* (L)**	Moraceae	Fruits	Shaitut	up to 1000	Throat disease
25	***Ricinuscommunis*L.**	Euphorbiaceae	Fruit, leaves, root,	Arandi	Up to 1000	Swelling, abdominal diseases, lump
26	***Psidiumguajava* Linn.**	Myrtaceale	Fruit and Leaves	Amrud (Amrood)	365-914	Bark and roots are given in infantile diarrhea and leaves decoction used tocheck cholera.
27	***Eucalyptus tereticornis***	Myrtaceae	Leaves	Safeda	up to 900	Body pain
28	***Dalbergiasissoo*Roxb**	Fabaceae	Leaves	Shisham	Below 900	Gonorrhoea and breast swelling
29	***Zanthoxylumrhetsa***	Rutaceae	Fruit, stem	Timbur	550 to 1740	Toothache,
30	***Cannabiaceae***	Cannabiaceae	Dry leaves	Bhang	up to 500	Piles dysentery & diarrhea

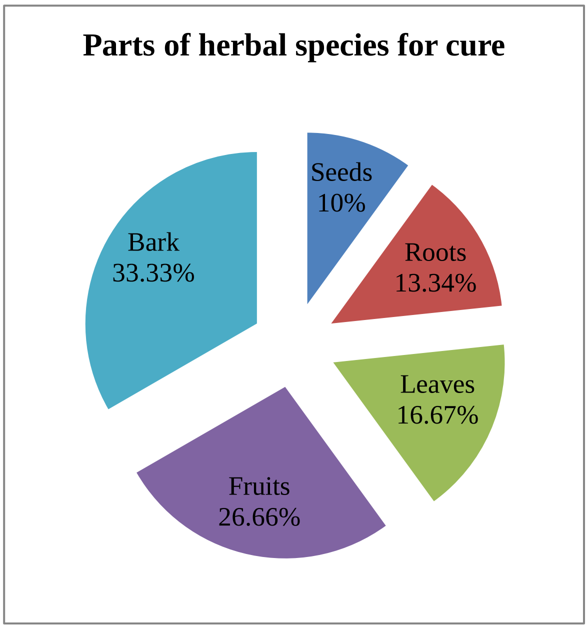
Source: Journal of Medicinal Plant Studies, 2017 *a*



Source:Based on Kapos etal. (2005).

Altitudinal Zones of the Trans-Giri Region

b



Source: Table 2

Percentage of parts used in preparing medicines for various ailments

Fig. 2 (a) shows the relief map of the region association the occurrence of the medicinal plant grown in a particular height.

Table 2. Medicinal Use of Animal Parts in Traditional Therapy of Trans-Giri

Sr. No.	Species	Family	Common Name	Medicinal use along with made of intake
1	*Capra falconeri*	Boviade	Goat	The mutton is believed to stimulate digestion and cure rhinitis. Soups of legs, bones are used to cure weakness.
2	*Columba livia*	Columbidae	Pigeon	Patients suffering from paralysis are often given the meat of a black pigeon.
3	*To putitora*	Cyprinidae	Fish	Blood of fish is used in mouth disease. It is applied on sore wounds in legs too.
4	*Apisindica*	Apidae	Bees	Honey is used as eye drops to cure eye disease.

Source: Field survey & Environmental Impact Assessment Report, 2013

Magico-Religious Method:

Another branch of folk medicine is the magico-religious variety, sometimes called "occult" folk medicine, which is usually based on the use of gestures, holy words and holy actions to cure diseases. It is the local treatment that is perform by the priest, or we can say trust or blind faith of the innocent folk people of the area.

In the study area people have great faith in the *mali/gur*, (local priest) and for them he is a complete doctor. The local people believe that there is no cure for him except the *mali*/*gur*who would be able to remove the evil spirit. In such a case a *Mali* is called upon who attempts to cure the patient using some magical words, charms, amulets and physical manipulation (Plate1). *Najar* (meaning evil look) is also healed by the *Mali/gur*.

According to local belief the *mali*/*gur*can communicate with the particular deity whom they worship.First preference for any treatment in the villages is given to local treatment (*Tantra-Mantra*) followed by herbal then allopathy.They believe that diseases are demonic in nature being ‘sent’ by evil forces into the person or animal, which has to be removed by a ‘counter spell’, which can be provided by some ritual, written charms involving holy words or prepared amulets.

The *Mali* always prefers to treat a patient either on Tuesday or on Friday or on Sunday as these days are being believed to be the days of the evil spirits.

Plate 1: Priest (*mali*) of Deity Shirgul,Churdhar

Table 3. Health Facilities Available in the Trans - Giri Region (1991, 2001 &2011)

Tehsil/ Sub-Tehsil	PHC			CHC			GeneralHospital			M & CW			Sub-Center		
	1991	2001	2011	1991	2001	2011	1991	2001	2011	1991	2001	2011	1991	2001	2011
Paonta *	2	4	6	0	1*	1	1	1	1	0	0	0	8	10	15
Shillai	1	3	3	1	1	1		0	0	0	0	0	18	21	22
Renuka	4	6	9	0	1*	1	1	1	1	1*	1*	1	22	35	32
Rajgarh	2	2	4	0	0		1	1	1	0	1	1	7	9	9
Total	9	15	22	1	3	3	3	3	3	1	2	2	55	75	78

Source: Directorate of Health Department Kusumpti, Shimla; Compiled by the Researcher

**Paonta 30 villages have been taken that fall in Trans-Giri region.*

Above Table 3 shows the available health facilities for the people in the Trans-Giri Region. Above table shows the limited and non-availability of health facilities in the region from 1991, 2001 and 2011. Trans-Giri region is hilly area and a large number of villages are not connected to roads here and it makes the reach to avail the hospital facilities verydifficult. This is why locals use traditional cure knowledge available to them.This is also one of the reasons that people of the region follow their age old methods of treatment.

Conclusions:

The Trans-Giri region has rich heritage of traditional medicinal plants whichhas vital significance in the daily life of people here. This ethno-botanical knowledge are related to many age old cure practices in this area. The study brings out that folk people of the Trans-Giri Region believeand follow their local treatment method for any cure that is why they give first preference to their magico-religious practices followed by herbal treatment and at the end they approach the nearby PHC or CHC for allopathic treatment.

Higher altitude areas about more than 2000 metres near Churdhar Mountains,where slopes are steep and remoteness prevails, traditional cure practices are commoncompared to the low altitude areas of Poanta. The people of the area use these plants as they are locally available and easily found anywhere in the locality which is stored and conserved for the years as modern hospital reach is very difficult for the emergency situations.Moreover, it can be a suggestion for further phytochemical and pharmacological investigations about the medicinal use of the plant, which may be a footstep on the way to the new drug development.

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Identification and Changed Detection of Polyhouses in Haryana using Geospatial Technology

Abhishek Goyat

Abstract

In order to make better use of land resources, polyhouses have emerged as an alternative technique in agricultural field. Polyhouse deals with the modification of the natural environment in order to achieve the better growth of plants. It refers to a framed structure that is covered with transparent plastic film or other UV stabilized polythene of low density in which different types of crops can be grown under the controlled or partially controlled environment throughout the year which is not possible under open field conditions. The use of geospatial techniques can help in mapping of these structures using remotely sensed imagery, global positioning system and geographic information system. The information obtained from these techniques allows the identification of different structures of polyhouses in specific region. Here, we utilized these techniques to identify the polyhouses in Haryana and we also compared this data from the starting phase of these structures in this region. This information can be beneficial for planning of land use along with decision support system or policy makers.

Keywords: Agriculture, geospatial techniques, polyhouses, protected cultivation.

Introduction

Protected cultivation denotes a type of cultivation in which the natural environment is modified to achieve the better growth of plants. Here, the control can be specified over different parameters like water, air, humidity, root temperature, light, plant nutrition and carbon dioxide, along with full protection from the climate.

At first, this method of growing was mostly used in industrialized nations, but as research progressed, it became possible to expand the technique of protected farming to less developed or developing parts of the world. Row coverings, mulching systems, and greenhouses with plastic covers or films were first applied in parts of southern Europe, the United States, and Japan (Espi et al., 2006; Hanan, 2017).

The protected structure, also known as a polyhouse, is a framed building that is coated in transparent plastic film or other low density UV stabilized polythene, allowing various crops to be grown in regulated or semi controlled environments. The structure is typically large enough for one person to operate underneath it while performing the many tasks necessary for the crops to be properly cultivated. A farmer can grow crops under protected conditions that will produce more fruit and vegetables of superior quality on certain days (Gyadi & Phookan, 2019; Bijeta & Pawar, 2019). Additionally, it is possible to grow exotic plants in protected structures that cannot be grown in natural environments (Rajiv et al. 2012).

Protected cultivation is a novel alternative farming method that is catching on in India's rural areas. It also improves the use of water and land resources, reducing reliance on rainfall. In order to cultivate crops in poor climatic conditions, shielded structures are used as microclimate environments. They are especially helpful when crops cannot be cultivated in open fields during specific times of the year or in locations where the climate never guarantees a higher-quality produce (Gusman et al., 2008; Pramanik et al., 2019).

Protected structures are essentially miniature ecosystems created to create conditions favourable to the persistence and development of the crops. The development of protected cultivation has resulted in the creation of favourable microclimates that have increased crop output (Poly house – NIOS, 2019).

Temperature is typically the main environmental factor regulated, and it normally provides warmth to combat very cold situations (Rabbi et al., 2019). High humidity (70-80%) and high temperature (up to 40^{0}C) have a significant impact on the rate of photosynthesis (Djanaguiraman et al., 2018). When light and CO_2 are sufficient and the humidity and temperature are high, photosynthesis typically proceeds more quickly.

The period appropriate for plant growth is efficiently extended by covered structures by heating the air surrounding the crops. Due to the controlled heating environment, native warm season crops can be planted and consequently harvested earlier than open field crops that are susceptible to frost damage.

Protected cultivation is one of the solutions to the majority of agriculture's issues, such as those relating to inconsistent and changing climatic conditions, inefficient use and low output of natural resources, environmental contamination from pesticide use, nutritional safety in climatic, topographically unfavorable areas, etc.

In protected agriculture, hospitable circumstances are typically offered to ensure that plants grow effectively and that production levels be increased through artificial means.

Here, the surroundings of the crops are partially or completely covered to monitor the environmental conditions. This covering, shield the crops from environmental changes in humidity or temperature while allowing them to get enough light for proper photosynthesis, fertilization, and other processes necessary for effective growth and production.

Study Area

The state of Haryana was chosen for the study because, despite the industrial revolution, it is largely an agricultural state, with 70% of its citizens working in agriculture, ranking it as the second-largest producer of food grains in India. Wheat and rice are abundant in the state, thus raising their minimum support prices won't have a significant impact on farmers' earnings. The state offers incentives for the same to encourage farmers to adopt contemporary horticultural methods since it

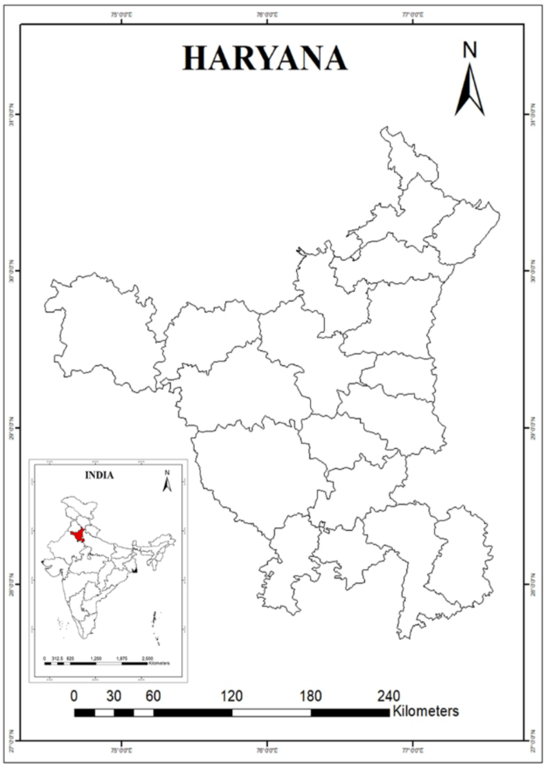

Fig 1: Study area (inset: geographical location of the study area in map of India) [Source: Survey of India; https://indiamaps.gov.in/soiapp/].

administration is attempting to improve agriculture while simultaneously addressing the negative effects of the green revolution and other technology as seen in Punjab. On November 1st, 1966, Punjab and Haryana were split apart to become the state of India. There were 7 districts in 1966, compared to 22 districts today. For governmental purposes, it has been divided into six divisions: Ambala, Karnal, Hissar, Gurugram, Faridabad, and Rohtak. The state is divided into 154 cities and towns, 7,356 villages, 72 sub divisions, 22 districts, 93 tehsils, and 50 sub tehsils.

According to area, Haryana is the twenty-first state in India. It is situated between 27^{o} 39'- 30^{o} 35' N latitude and between 74^{o} 28'- 77^{o} 36' E longitude in the northwest of India (Fig. 1). The state is landlocked and is bordered on three sides by the landlocked national capital Delhi, Himachal Pradesh in the north, Rajasthan in the south, Uttar Pradesh in the east, and Punjab in the west. In 2011, there were 25,353,081 people living in Haryana. The state has an 879-sex ratio and a 76.6% literacy rate. The state's infrastructure is highly developed. All settlements are connected by roadways, and it is the nation's first fully electrified rural state.

The state's total geographic area is 44,212 km^2, or 1.34% of the country's overall geographic area. 3.8 million hectares, or 86% of the state's total geographic area, are arable, of which 3.62 million hectares, or 96.2%, are under cultivation. The state has a cropping intensity of 177%, with a gross cropped area of 6.32 million hectares and a net cropped area of 3.62 million hectares. The state's name, which partly refers to its extremely fertile terrain, also calls it "The Green Land of India." It has high productivity because it extends over the Indo-Gangetic plain, which has good soil.

The state's three main rivers are the Ghaggar, Saraswati, and Yamuna. Yamuna-Ghaggar plain, which stretches from the north-east to the south-west, dominates Haryana. Along with being from north to east to south, the slope is also between 700 and 900 feet above sea level. In the north and east, there is a short band of hills, and in the south and south-west, there is sandy terrain.

Objectives

1. To Know the Distribution of Polyhouses in Haryana.

2. To Find out the Changed Detection of Polyhouses in Haryana.

Method Implemented

The method used in the classification process for preparing choropleth maps in the GIS environment is the Geometrical Interval Classification Method. The specific benefit of the geometrical intervals' classification is that it works reasonably well on data not distributed normally, and there is an irregular spread of polyhouse in the districts. Fourteen districts in 2010-15 and four districts in the 2015-16 year did not have any polyhouse structure. The secondary data is collected from the Directorate of Horticulture, Haryana.

Results and Discussions

The number of structures included in this study are the structures constructed under the National Horticulture Mission (NHM)/MIDH scheme because this is the first scheme of government which initiated the protected cultivation on commercial basis and most of the protected structures are constructed under this scheme. Three districts (Kaithal, Rewari and Faridabad) are excluded from this study because these are not covered under this scheme.

Distribution of Protected Structures in the districts of Haryana from 2005 to 2016 at three quinquennial intervals, i.e., 2005-06, 2010-11 & 2015-16:

2005-2006

In order to fulfil its goal of transforming Haryana into a contemporary horticultural state, the state's administration began implementing the National Horticulture Mission programme in 2005-06. (Centrally sponsored scheme having special provisions for protected cultivation). Therefore, the

Table. 1

Sr. No.	**District**	**2010-2011**
1	Ambala	1
2	Bhiwani	1
3	Kurukshetra	3
4	Mewat	2
5	Panchkula	11
6	Panipat	1
7	Yamuna Nagar	3
Total		**22**

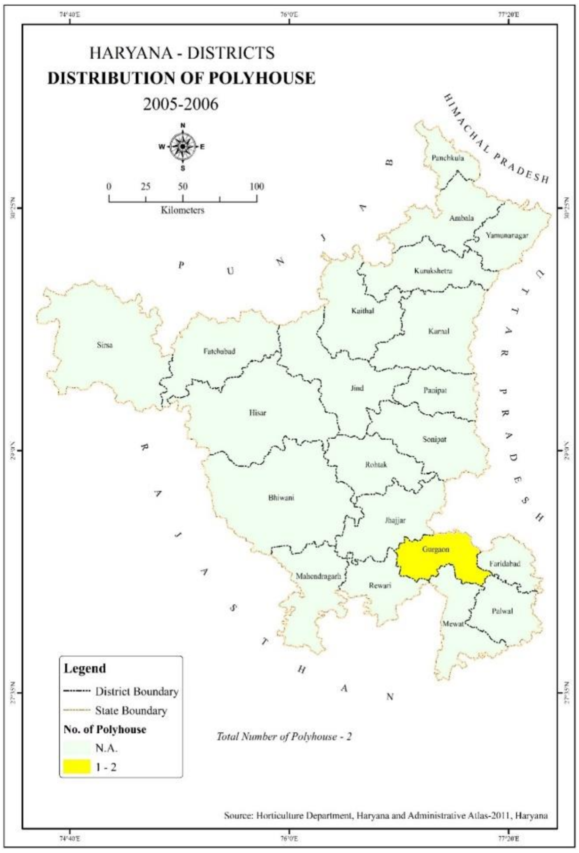

Fig. 2

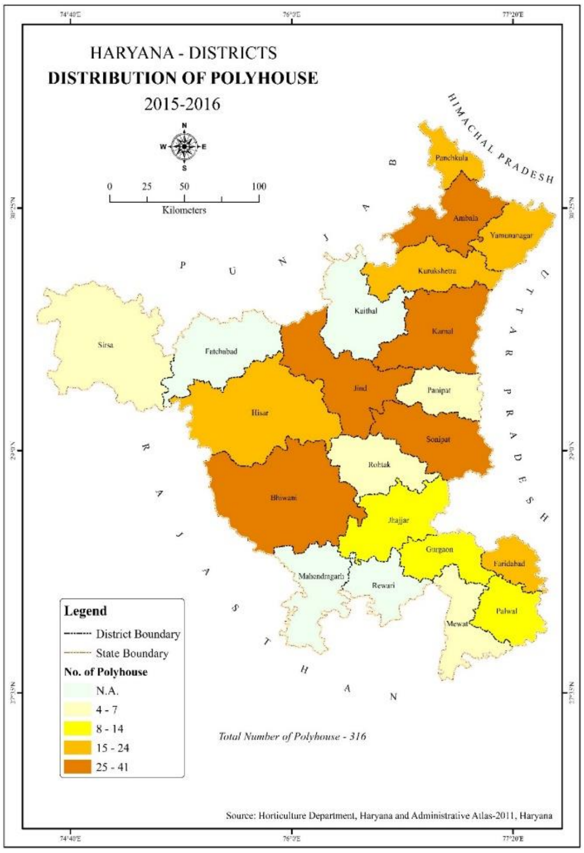

Fig. 4

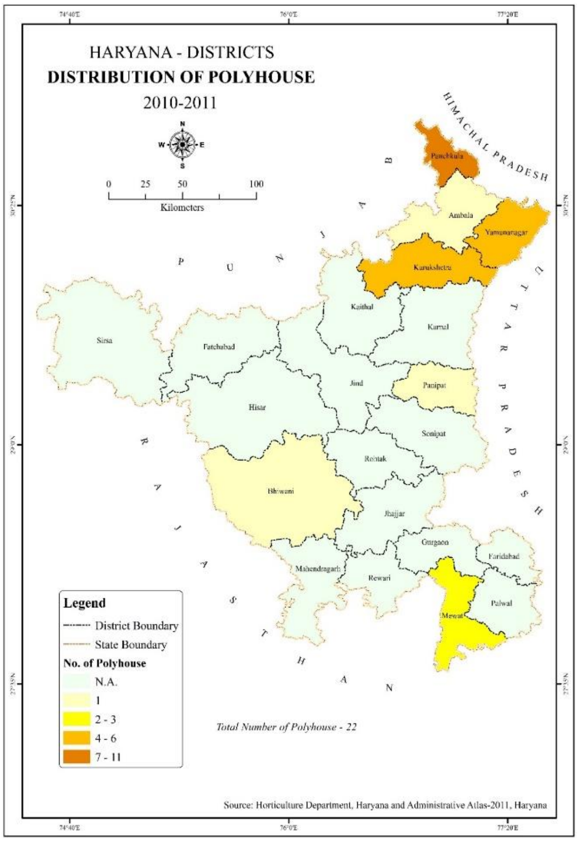

Fig. 3

NHM scheme's first two subsidized protected structures were built in Gurugram district in 2005–2006, which was a poor start and also meant that it was only available to one district in the state.

2010-11

In 2010-11 there were 22 protected structures constructed in Haryana with highest number of structures in Panchkula (11) and lowest (1) in Ambala, Bhiwani and Panipat (Table. 1).

2015-16

In 2015-16 there were 316 protected structures constructed in Haryana with highest number of structures in Bhiwani (41) and lowest (4) in Mewat district. This was tremendous growth in the protected structures in Haryana (Table. 2)

Table 2: Number of Protected Structures Constructed in Haryana

Sr.No.	**District**	**2015-2016**
1	Ambala	26
2	Bhiwani	41
3	Faridabad	23
4	Gurgaon	11
5	Hisar	16
6	Jhajjar	12
7	Jind	37
8	Karnal	30
9	Kurukshetra	20
10	Mewat	4
11	Palwal	10
12	Panchkula	21
13	Panipat	6
14	Rohtak	6
15	Sirsa	6
16	Sonipat	25
17	Yamunanagar	22
Total		**316**

Source: Compiled from the data given by Directorate of Horticulture Panchkula.

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Backward Linkages of Chandigarh Migrants: A Geographical Analysis

Ajit Kumar Yadav and Abhishek Malik

Abstract

Backward links between migrant workers and their home town/village or region include integration inside the Chandigarh city. These ties include remittances, which are crucial. The research investigates the relationship that currently exists and the function that migrants' remittances play inside Chandigarh. It also investigates how relocation affects the social, cultural, and economic links of migratory workers

Keywords: Migration; Chandigarh; Urban Planning; City Migrants; Migratory Workers

Introduction

Backward networks are significant because they aid in the migration process. Between the migrant's place of origin and their destination, there is a robust social and economic network. The social and economic environment has a significant impact on movements. Backward connections are significant because they aid in the migration process. Between the migrant's place of origin and their destination, there is a robust social and economic network. The social and economic environment has a significant impact on movements. There are clearly multiple rationales for the use of migrant labour in destination areas. While shortages of local labour provides one important rationale (Singh and Iyer, 1985; Oberai and Singh, 1983).

Analysis of the recent trends of labour mobility, on the basis of NSS estimates from the 49th (1992–93) and 55th rounds (1999–00) have been carried out by Srivastava and Bhattacharya (2002) and a few central conclusions from that analysis are discussed below. This period shows a sharp increase in urban male mobility, with a significantly larger percentage of male migrants reporting economic and employment linked reasons for mobility. For other streams, there has been a decline in the percentage of migrants giving economic reasons for mobility.

Most migration literature makes a distinction between ‘pull’ and ‘push’ factors, which, however, do not operate in isolation of one another. Mobility occurs when workers in source areas lack suitable options for employment/livelihood, and there is some expectation of improvement in circumstances through migration. The improvement sought may be better employment or higher wages/incomes, but also maximisation of family employment or smoothing of employment/ income/ consumption over the year. At one end of the migration spectrum, workers could be locked into a debt-migration cycle, where earnings from migration are used to repay debts incurred at home or in the destination areas, thereby cementing the migration cycle. At the other end, migration is largely voluntary, although shaped by their limited choices. The NCRL has recognised the existence of this continuum for poor migrants by distinguishing between rural labour migration for survival and for subsistence. The landless poor, who mostly belong to lower caste, indigenous communities, from economically backward regions, migrate for survival and constitute a significant proportion of seasonal labour flow (Study Group on Migrant Labour, 1990).

Movement of individuals from one location to another that is permanent or semi-permanent is known as migration. Rarely has migration of people taken place in a one-way; instead, it is frequently followed by some of the migrants going back. Every stream of migration likewise generates a return stream of migration, which may or may not be equal, according to Ravenstein (1885). India is the primary country of origin for international migrants and accounts for the majority of domestic migration (De, 2019; UNDESA, 2020). According to figures from census of India 2011, there were 450 million total internal migrants, accounting for both inter- and intra-state mobility, a 45 per cent increase from the Census of 2001. (De, 2019). According to the Economic Survey of India 2017, there are 60 million interstate migrants in India, and the average annual movement of migrants across states between 2011 and 2016 was estimated to be 9 million (Sharma, 2017).

Thus, migration provides migrant workers and their families with a positive means of subsistence, supports the economic development of the destination state or country, and helps the sending state or country through remittances and the transfer of skills. Kerala migrants are high-skilled employees in the Gulf who make high earnings, enabling them to send back more money (Rajan & Zachariah, 2020). It sees migration as a decision made by a household to reduce risks by diversifying the family's sources of income or to get around financial restrictions on family production activities (Stark, Taylor, & Yitzhaki, 1986).

Only 10.2% of Indians in the decade from 2001 to 2011 were labour migrants, according to Census 2011. From the prior census (2001), when it was 14.4%, this demonstrates a falling trend in labour mobility (Census of India, 2001; Census of India, 2011).

Study Area

Chandigarh was the first planned city built after independence from British rule in 1947. It is the capital city of the states of Punjab and Haryana and the Union Territory of Chandigarh. It houses a population of 1,054,600 inhabitants (2011) and is one of the richest state/union territory of the nation. The City of Chandigarh was declared a Union Territory in the year 1966 with joint capital of both the states of Punjab and Haryana. It is situated at the foot of Shivalik hills. The area of Union Territory of Chandigarh is 114 sq. km. only with 6 villages falling in the jurisdiction of Union Territory.

The region has been witnessing a high population growth since the inception of Chandigarh. On one hand, a sharp decline in mortality and morbidity and on the other, in-migration, have been responsible for the phenomenal growth in population. In-migration in particular has played animportant role for strengthening Chandigarh’s linkages with the surrounding areas (Kaur 2009)

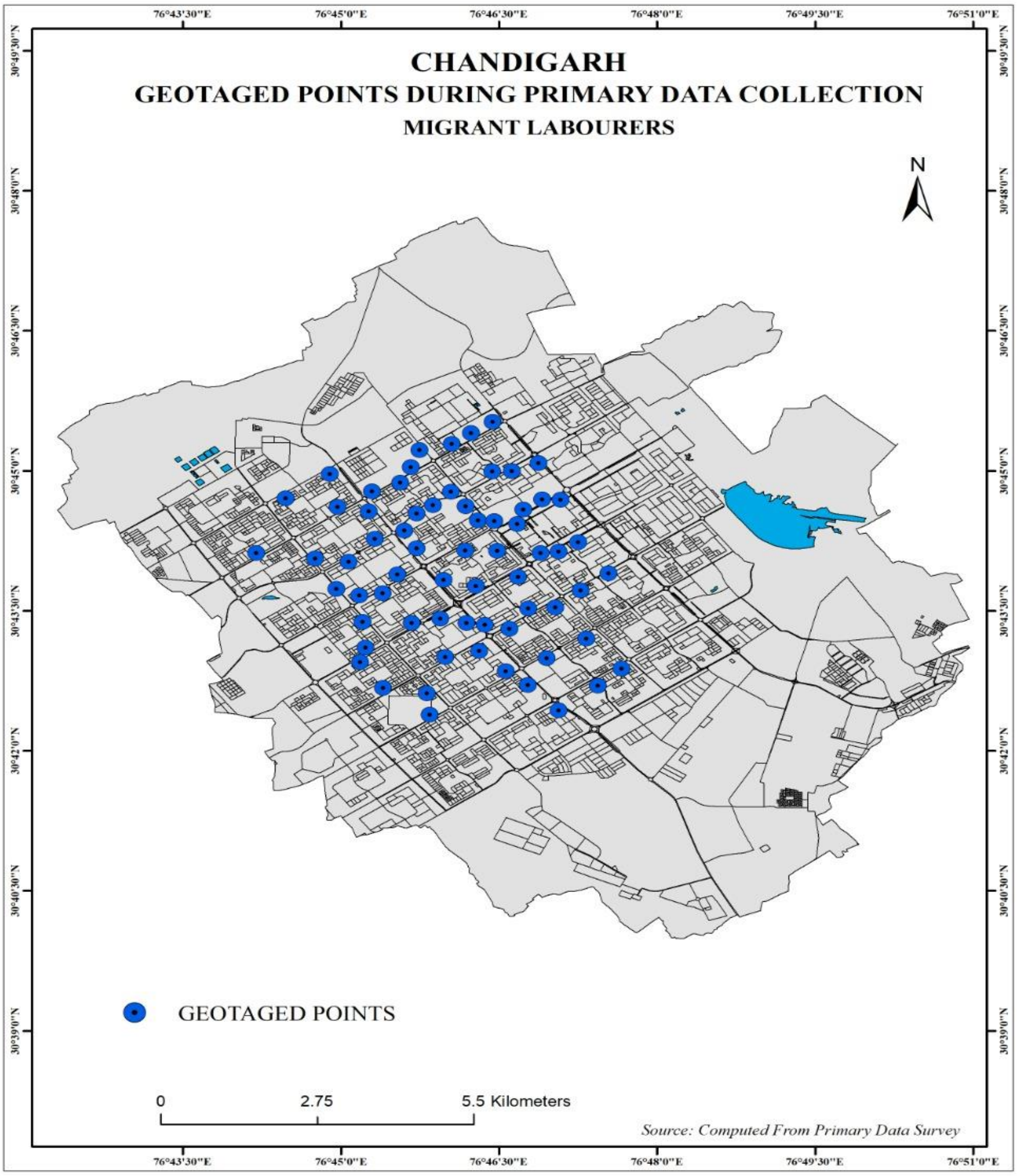

Fig. 1

After analysing the data on Percentage share of reason of migration from Uttar Pradesh and Bihar to Chandigarh, it was seen that the major reason behind the migration from Bihar in the year 1991 was dominated by Work/Employment with 52.68 per cent migrants followed by the reason of Moved with household with 23.03 percent. Similarly for the year 2001 Work/Employment reason again dominated with 57.63 per cent, again followed by the same reason that is Moved with household with 21.04 per cent. Again, in the year 2011 it was seen that the prime reason for the Migration was Work/Employment (47.65 per cent) followed by Moved with household (26.07 per cent). Similarly, after analysing the reason of migration from the state of Uttar Pradesh, it was seen that Work/Employment reason dominates the category with 36.56 per cent of migrants moving due to work and employment purpose, followed by the reason of Moved with household with 31.98 per cent in the year 1991. For the year 2001, undistinguished type of pattern was observed in relation with the reason of migration from Uttar Pradesh to Chandigarh with 42.88 per cent of migrants citing Work/Employment as the major reason for migration, followed by Moved with household with 27.65 per cent.

Similarly for the year 2011 again, the reason of Work/Employment dominated the category with 37.72 per cent of migrants in the category followed by the same reason of Moved with household with 30.33 per cent.

Table:1.1

Chandigarh city: Percentage share of reason of migration from Uttar Pradesh and Bihar

	Bihar			Uttar Pradesh		
Reason	1991	2001	2011	1991	2001	2011
Work/employment	52.68	57.63	47.65	36.56	42.88	37.72
Business	6.03	0.84	0.48	6.71	1.21	0.68
Education	1.88	0.81	1.09	1.59	0.82	1.04
Marriage	5.70	7.14	9.09	11.44	12.79	13.59
Moved after birth	-	2.82	4.83	-	4.09	4.94
Moved with household	23.02	21.04	26.07	31.98	27.65	30.33
Natural Calamity	0.10	-	-	0.06	-	-
Others	10.60	9.72	10.79	11.67	10.56	11.70
Total	100.00	100.00	100.00	100.00	100.00	100.00

Source: Computed from census of India, D3, Chandigarh, 1991, 2001 and 2011

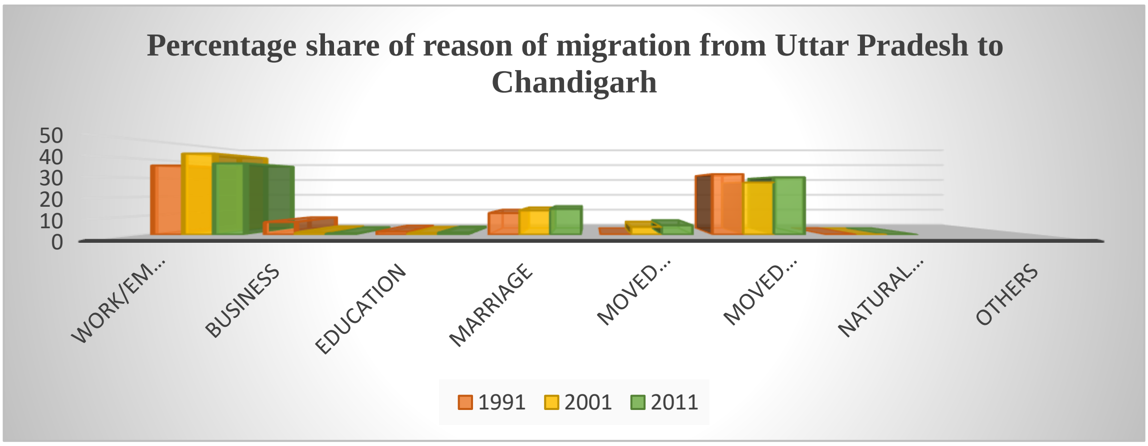

Fig. 2

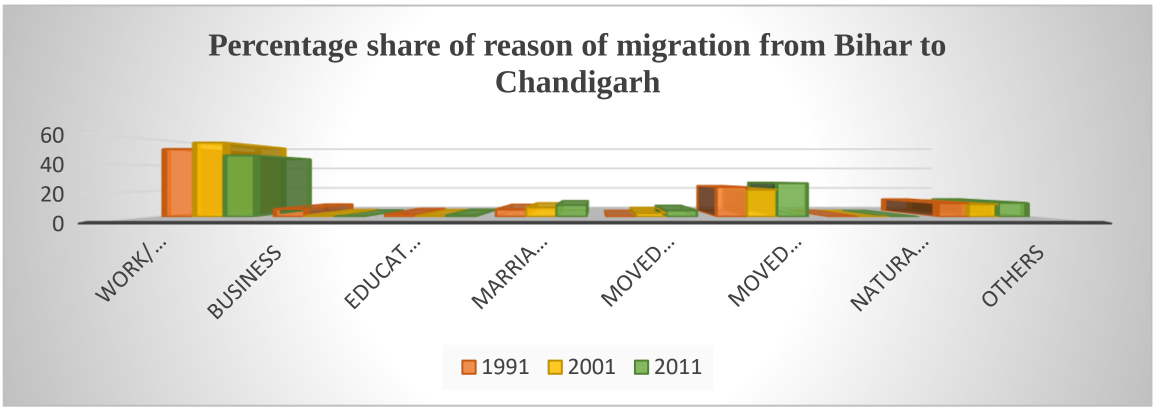

Fig. 3

Socio-Economic Linkages

A person's ability to travel from one location to another is influenced by their socioeconomic level. Migration from rural areas to urban areas is more likely to involve moves between districts and states than vice versa. Bihar and Uttar Pradesh provide 31% and 25%, respectively, of the migrants to Chandigarh. Due to employment prospects in the construction and manufacturing sectors, in-migration peaked before 2000. People moved during this time primarily for employment reasons followed by home moves and marriage. Less respondents 1 People from Uttar Pradesh moved during this time in search of employment. Due to government initiatives in rural areas, such as job creation programmes, the supply of cheap housing, and infrastructure improvements, in-migration to Chandigarh has significantly decreased over the years. Factors such as age, education level, wealth, land owned, productivity and job opportunities influence the participation of individuals and households in migration, but so do social attitudes and supporting social networks (Haberfeld et al, 1999; Rogaly et al, 2001; Mosse et al, 2002).

Initiation of Migratory Move

Migrant labourers are exposed to large uncertainties in the potential job market. To begin with, they have little knowledge of the market and risk high job search costs. The perceived risks and costs tend to be higher the further they are from home. There are several ways in which migrants minimise risks and costs. For a number of industries, recruitment is often done through middlemen. In many cases, these middlemen are known to the job seekers and may belong to the source area. In other cases, migrants move to the destination areas on their own. This is generally the case where ‘bridgeheads’ have been established, lowering potential risks and costs. The movement of migrants in groups, often sharing kinship ties, also provides some protection in the context of the harsh environment in which migrants travel, seek jobs and work. Mosse et al (2002), based on a study of villages in the Western India Rain-fed Farming Project (WIRFFP), have shown that the incorporation of workers in the labour market in different ways may depend upon their initial status, with somewhat better-off migrants having superior social net-works and being better able to exploit bridgeheads in urban locations. As with other types of interlocked relationships, the poorer migrants trade their freedom of making individual contracts with employers to the possibility of securing advances and employment from contractors. In the agricultural sector, labourers are sometimes directly recruited by the employer. In Punjab, labourers are often recruited by employers at the railway stations (Sidhu and Grewal, 1980).

Since most people migrate due to familial networks, social networks are crucial to the migration process. A relatively small percentage of people move alone, and the presence of family or friends at the destination is the primary determinant in migration to cities. The majority of respondents 54 per cent and friends 24 percent, who travelled with them to the destination, received assistance with housing and jobs. Additionally, about 22 per cent of persons moved with contractors who gave them job opportunities.

Factors Leading to Migration

Employment-related factors are the primary driver of migration to cities from Bihar and Uttar Pradesh, followed by other factors. In the former category, male migrants predominated, whereas female migrants made up the minority. The main reason individuals move is usually for work 85 per cent. The other driving forces behind migration in Chandigarh include people relocating with their families 15 per cent.

Social Stratification

In Chandigarh, people from various social backgrounds coexist side by side while yet feeling a sense of camaraderie. People who live in the same neighbourhood often get along well. The diversity of the community affects the customs and way of life of the residents. When they begin residing in the same neighbourhood, they have a sense of belonging, which somewhat lessens their psychological unease. Social stratification based on community is evident in case studies. People from Uttar Pradesh and Bihar are concentrated in Chandigarh's corner. Due to the significant degree of similarities between the traditions and lifestyles of people from the same state, i.e., Uttar Pradesh and Bihar, they are positioned close to one another.

Subsequently analysis the present table the 91.5 per cent Hindu and 8.5 per cent Muslim migrant came to Chandigarh (table 1.2)

Table:1.2: Religion of the migrants worker

Religion	Migrants Worker	Percentage
Hindu	183	91.5
Muslim	17	8.5
Total	200	100

Source: Primary survey, Chandigarh City February 2020

Table:1.3: Caste of the Migrants worker

Caste	Migrants worker	Percentage
Upper caste	23	11.5
Middle caste	70	35
Lower caste	107	53.5
Total	200	100

Source: Primary survey, Chandigarh City February 2020

Table:1.4: Education of the Migrants worker

Education	Migrants Worker	Percentage
No Education	15	7.5
Primary	175	87.5
Secondary	8	4
Graduation and above	2	1

Source: Primary survey, Chandigarh City February 2020

Table:1.5: Age of the Migrants worker

Age-Group (in year)	Migrant Worker	Percent age
< 15	5	2.5
15 to 19	35	17.5
20 to 24	65	32.5
25 to 29	45	22.5
30 to 34	35	17.5
>35	15	7.5
Total	200	100

Source: Primary survey, Chandigarh City February 2020

Caste is an important determinant of occupation, education, and social status in the community and therefore, it may be one of the factors of prime importance responsible for migration. Keeping in view the total number of households, these castes were grouped into three categories on the basis of the homogeneity in the pattern of living and relative importance of the caste in the area.

Upper Castes:*Thakur, Bhumihar, Brahmin, Srivastava.*

Middle Castes: *Koiri, Kurmi, Ahir, Gareria, Teli, Baniya, Sonar, Halwai, Prajapati, Kahar, Lohar, Nai, Mali, Bind, Chauhan, Rajbhar,*

Scheduled Castes:*Chamar, Dharkar, Dhobi, Gaud, Pasi, Musahar.*

After analysis 11.50 per cent upper caste, 35 per cent middle caste and 53.50 per cent lower cate migrants came to the Chandigarh (table1.3).

Education is expected to influence the knowledge and attitudes towards migration process. Education acts as a very strong channel in the process of human movement, particularly in rural to urban migration. Education was categorized into four parts namely no education, primary, secondary and graduate & above.

After analysis the 7.50 percent no educated, 87.50 per cent primary educated, 4 per cent secondary educated and only 1 percent graduation and above educated migrant came to Chandigarh (table 1.4)Age of individuals is an important demographic variable that influence pattern of migration. Several attempts have been made to study the migration differentials by age. In the present study, age will be recorded as a continuous variable. It was classified into less than 15 years, 15 -19 years, 20-24 years, 25-29 years, 30-34 years and more than or equal to 35 years.

Data on individual migrants gleaned from micro surveys shows a significant clustering of migrants in the 16–40year age group (Conell et al, 1976). This is even more the case with poorer semi-permanent or temporary labour migrants (Srivastava 1999, and forthcoming). With respect to education, migration rates are high both among the highly educated and the least educated, and among seasonal migrants there is a high preponderance of illiterate people (Connell et al, 1976; Rogaly et al, 2001; Haberfeld et al, 1999).Factors such as age, education level, wealth, land owned, productivity and job opportunities influence the participation of individuals and households in migration, but so do social attitudes and supporting social networks (Haberfeld et al, 1999; Rogaly et al, 2001; Mosse et al, 2002).

Housing Typology

Migrant labourers, whether agricultural or non-agricultural, live in deplorable conditions. There is no provision of safe drinking water or hygienic sanitation. Most live in open spaces or makeshift shelters in spite of the Contract Labour Act which stipulates that the contractor or employer should provide suitable accommodation (NCRL, 1991; GVT, 2002; Rani and Shylendra, 2001). Apart from seasonal workers, workers who migrate to the cities for job live in parks and pavements. Slum dwellers, who are mostly migrants, stay in deplorable conditions, with inadequate water and bad drainage. Food costs more for migrant workers who are not able to obtain temporary ration cards. Housing should be seen as a fundamental human right and can provide opportunities for repurposing unused apartments, abandoned spaces, and underused buildings.

To address the affordability of migrant housing in cities, creative construction techniques and new building materials are highly beneficial. DISHA, a voluntary organisation in Ahmedabad, is addressing the living and working conditions of construction workers, migrating mainly from the Panchmahals area of Gujarat. The NGO has formed a labour union and has been able to provide shelters for the workers, with government support (www.disha.india.org). Majority of migrant have not a permanent house they are occupiedthe out-side shop space during day time they

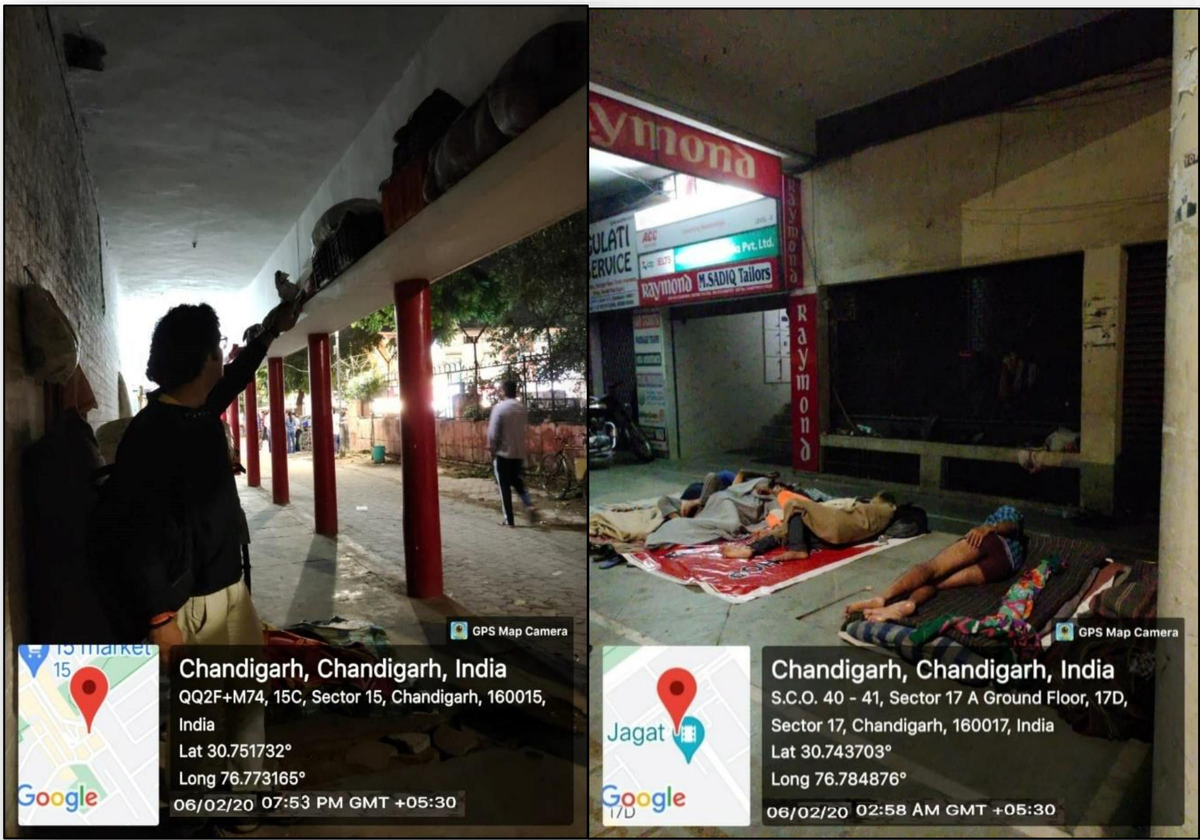

Fig. 4

put their luggage on upper part of the shape of wall and during night time they used. There is much interesting observation pertaining to the non-permanent space convert to the permanent space by the migrants from Uttar Pradesh and Bihar in Chandigarh. Those who occupied the space Infront the any shop during night time other migrant cannot use their space for the purpose of the cooking and sleeping.

Relationships between the place of origin and the destination are more durable and solid.

The major impacts of migration on source areas occur through changes in the labour market, income and assets, changes in the pattern of expenditure and investment. Although seasonal outmigration potentially has the effect of smoothing out employment over the annual cycle, rural outmigration could cause a tightening of the labour market in some circumstances. However, empirical evidence from out-migrant areas does not often attest to this (Connell et al, 1976; Srivastava, 1999). This may be because outmigration often takes place in labour surplus situations. There is also evidence of the replacement of outmigrant male labour by female and even child labour (Srivastava, forthcoming). Srivastava's (1999) study of seven villages in Uttar Pradesh showed some variation over regions. While the situation in the study villages in Eastern and central Uttar Pradesh conformed to a situation of labour surplus, this was not the case in Western Uttar Pradesh where seasonal migration coincided with the agricultural peak season (Rabi) and employers complained of labour shortages. Significantly in all the regions studied, labourers on their part gave uncertainty of employment along with employment conditions and poor relations with their agricultural employers as the major reasons for outmigration. Even if labour tightening is not an outcome, outmigration may still speed up qualitative changes in existing labour relationships in rural areas, and thereby affect the pace of change. This may occur in several ways. First, there is the well-documented impact of migration on attitudes and awareness as migrant labourers and return migrants are more reluctant to accept adverse employment conditions and low wages. Secondly, outmigration leads to a more diversified livelihood strategy. Combined with some increase in the income and employment portfolio of poor households, this may tend to push up acceptable level of wages (reservation wages) in rural areas and may make certain forms of labour relationships (as for example, those involving personalised dependency) less acceptable (Srivastava, ibid; cf. also Rogaly et al, 2001). A greater relationship with the place of origin is maintained by longer stays in the city. Of the entire sample, 38 per cent of respondents who migrated between 6 and 10 years ago have a close connection to Chandigarh and their place of origin. They have become accustomed to their line of work, and their incomes have increased with time. They have assets in both Chandigarh and their native place as a result of their improved economic situation, which enhances their ties. Due to their permanent residence in Chandigarh and ownership of actual land in their home countries, this is the case. One of the primary reasons they maintain ties to their home countries is that they receive a portion of their income from these assets. Seven per cent who moved five years ago are less connected to their home countries. They are dependent on the remittances sent from their home because, in the beginning, they struggle to make ends meet, have erratic income, and perform temporary labour.

Purpose of Visit to Native Place

Many factors lead migratory slum dwellers to travel back to their home countries. A sizable portion of respondents 55 per cent travel back to their ancestral homes for religious ceremonies. followed by 45 per cent personal factors. Only a small number of people send a portion of their remittances back but receive no income. In other words, there exist sufficient cultural ties for a migrant to visit his home country.

Interactions between the Native and the Destination Place

Links between a migrant's place of origin and their final destination are formed through trade in products and services. In example studies, the exchange of home goods at 86% seems to be important. When someone travels back to their hometown, they bring household goods like wheat, rice, ghee, sugar, pickles, etc. Migrants have trouble collecting rations from the Public Distribution System because they lack documentation for their addresses, their income, and the ration card application process. When visiting their hometown, visitors also bring clothing. There is some amount of confidence between the buyer and seller, and the clothes are inexpensive. Electronics and agricultural equipment trades make up a very small part of all transactions. When people travel back to their place of origin, they bring with them farm equipment and electronic products like radios, mobile phones, toys, etc.

Migrants' Perceived Change in Their Lives

A person's social, cultural, and economic circumstances change as they are impacted by city culture. All other changes are subordinated to economic change. Sixty-six percent of respondents in the entire sample indicated economic changes, including increases in income and savings. About 20 per cent of respondent's report experiencing social changes after moving to Chandigarh, including altered sleep patterns, everyday job schedules, and psychological uneasiness. 14% of respondents cited cultural change in the form of altered eating patterns, tobacco addiction, drinking, and smoking.

Occupational Structure

Most migrants work in the unskilled labour sector. Significant 86 per cent of respondents in the 21–40 age range work mostly in unskilled occupations, such as domestic help, street sellers, and construction labourers. They work multiple jobs at the same time. People in this age range are more adaptable, able to work hard, and eager to switch places to live. The remaining percentage of people work as skilled employees, such as drivers 16 per cent, helpers 13 per cent, and peons 3 per cent. Because most of them attempt to maintain a balance between schooling and employment, the workers in the age group of 15 to 20 years tend to be 72 per cent workers.

Money earned and saved

The wages and savings of migrants have seen a striking transformation since moving to Chandigarh. Before moving, 62 per cent of migrants made two to three thousand rupees a month, followed by 26 per cent who earn between three and five thousand and 8 per cent who made between five and six thousand and 4 per cent earn more than seven thousand. Before migration 68.5 per cent migrants saved one to two thousand rupees while 28.5 per cent migrants saved two to three thousand rupees whereas 3 per cent saved three to five thousand rupees. After migration 2 per cent migrants earn three to five thousand rupees while 14 per cent earn five thousand rupees and 84 per cent earn more than seven thousand rupees. After migration 43.5 per cent migrants saved one to two thousand rupees while 35 per cent migrants saved two to three thousand however 18 per cent migrants saved three to five thousand and only 3.5 per cent saved five to seven thousand (Table 1.6).

Table 1.6: Change in Income and saving of respondent after Migration

Income Level (Rs. Per month)	Income Before Migration	Saving Before Migration	Income After Migration	Saving After Migration
Rs > 1000 to 1999	-	137	-	87
Rs. 2000 to 3,000	124	57	-	70
Rs. 3,001 to 5,000	52	6	4	36
Rs. 5,001 to 7,000	16	-	28	7
>Rs. 7,001	8	-	168	-
Total	200	200	200	200

Source: Primary survey, February 2020_- showed the Nil value

Remittances

A certain proportion of remittances is channelled through informal means and thereby is undocumented in the official data. Here again, lack of reliable estimates makes meaningful inferences difficult. However, based on the findings of certain micro level studies, it could be ascertained that such undocumented remittances were fairly prominent in the late 1970s and 1980s. A survey of return migrants from the Middle East during the mid-1980s showed that respondents channelled around 25 to 30% of the total remittances through undocumented means (Nair,1986). However such undocumented flows almost dried up during the 1990s due to the liberalisation of foreign exchange. Apart from these policy measures, the arrival of e-banking, which provide instantaneous transfer also encourages migrants to use formal means for remittances. (Zachariah et al, 2002b).

The migrant's place of origin and destination are connected by a remittance flow. 56% of migrant workers, according to primary data, send money back to their home town/ village. Since their children are educated, the majority of respondents in Chandigarh use bank accounts to make remittances. They are aware that financial facilities are available. The Punjab National Bank and cooperative banks are where nearly 10% of respondents have bank accounts.

Conclusion

The connections that migrants had in the past are very strong. The move has limited the sociocultural and economic ties of the migrants. The Chandigarh government's decision to transfer residents distant from their workplaces and social networks without providing enough connectivity is the primary cause of the weak linkages. To ensure that the eviction process does not affect the migrants' source of income, the relocation site should be chosen close to their place of employment. The move should also provide jobs for those who are really impoverished. When migrant reach their destination place, they typically settle in urban areas. However, there are little statistics on the number of migrants in cities, particularly in developing economies where these figures could improve urban planning and help cities better manage migration. Cities respond to some of the integration issues as well as the urgent requirements of migrants. Cities will continue to be crucial to human mobility over the next few decades given the anticipated rises in urbanisation and migration.

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A Geographical Study of Land Use Land Cover, Agriculture, and Water Sources in the Balh Watershed of Himachal Pradesh

Ajay Kumar, Navneet Kaur and Shilpa Devi

Abstract

A land area that drains water into a specific waterbody is termed as watershed. Every watershed is distinct in terms of physiographic and other characteristics, therefore natural resource conservation and management can be carried out accordingly. Balh watershed is a sub watershed of Suketi river basin located in district Mandi of Himachal Pradesh. It is unique in terms of available fresh water sources, forests and agriculture activities. Presence of these characteristics makes it easy to implement conservation and management activities in any watershed. Therefore, various characteristics of land use land cover, water sources and agriculture etc. have been analysed in the present study.

Keywords: Land use land cover, Water resources, Agriculture, Balh watershed

Introduction

Environmental deterioration leads to soil degradation, which leads to decreased output and, as a result, increased poverty. Ecological sustainability, on the other hand, contributes to an increase in productivity and leads to a secure livelihood. India's population has surpassed 100 million people, and food demand is expected to exceed 252 million tonnes by 2025. As a result, the country's reliance on agriculture will continue to grow, posing a threat to the country's limited land and water resources, hence in order to meet the rising food demand, an adequate watershed development strategy is much needed.

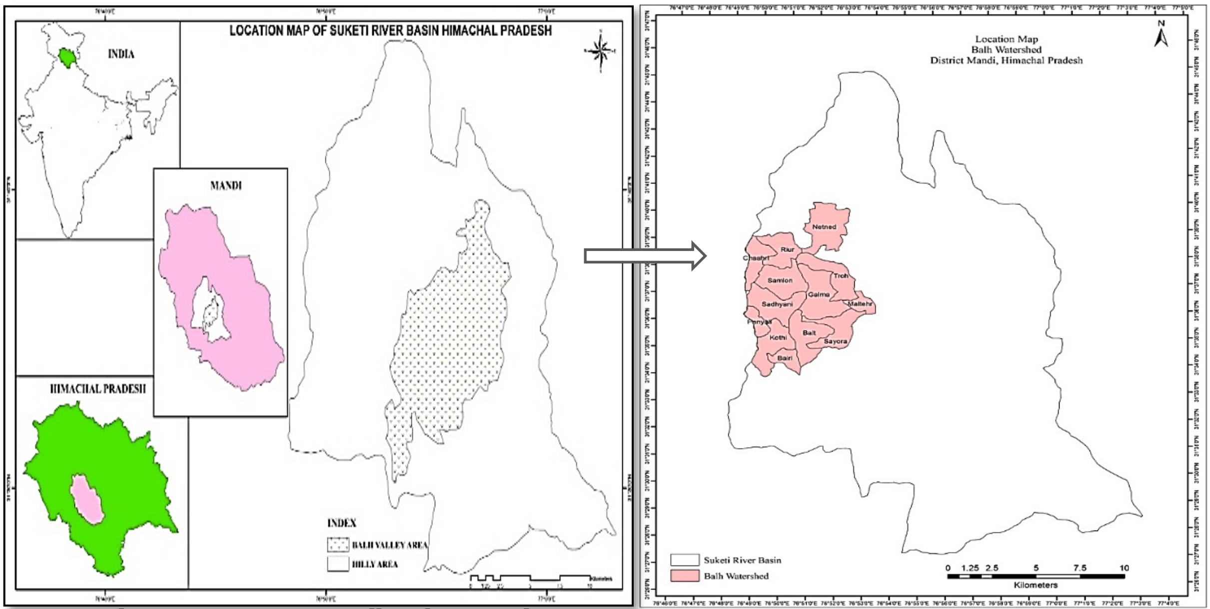
In Himachal Pradesh majority of people draw their sustenance from natural resources i.e. 80 percent of the household consumption is based on biomass which include food, fodder, fuel, fibre etc. Food grain crop productivity has grown, but pulse crop area and production have declined dramatically. It has been observed that farmers in several sections of the state have leaning toward crop diversification. Farmers in the Mandi district are growing more than two crops per year, as well as high-value vegetable crops. The rate of vegetative cover reduction is particularly significant as a result of increased anthropogenic interference, resulting in massive run-off and soil erosion.

Due to excessive exploitation and less recharge groundwater table has considerably degraded in many valley patches of the state. Due to heavy rainfall the seasonal nallas are becoming wider and deeper, causing damage to agricultural land, forests, and grasslands. To feed the world's ever-growing population, watershed conservation and management practices of accessible natural resources are needed. The present study tries to incorporate land use land cover analysis, agricultural characteristics, and the availability of water resources in the Balh watershed of Mandi district. Proper conservation and management practises have also been suggested to be implement in this area for its sustainable development.

Study area

Present study has been carried out in Balh watershed of Himachal Pradesh and it is a part of Suketi river basin. This watershed is located in Balh block of Mandi district which includes 13 panchayats i.e. Bairi, Balt Chahri, Galma, Kothi, Malthehr, Netned, Panyali, Riur, Sidhyani, Samlon, Sayora, and Troh. It has a total area of roughly 54.59 square kilometres and located between76°48'40" east to 76°54'20" east longitude and 31°33'40" north to 31°40'20" north latitude. Total population of this watershed is 32,886 which is residing in 9150 households with the average household size of 3.5 persons. Agriculture and animal husbandry is the main occupation of people here but there is lack of irrigation facilities.

Map 01. Location of Balh Watershed



Source: district Census Handbook, Mandi, 2011.

Objective of the Study

To study the characteristics of land use land cover, agriculture and water sources in Balh watershed is the main objective of the present study.

Data Sources and Research Methodology

The current research inculcates both primary and secondary data. Land use land cover analysis has been carried out by using satellite imageries from the United States Geological Survey's (USGS) earth explorer for the year 2018. Data on agriculture and irrigation has been collected from respected panchayat secretaries, and field work conducted to analyse the various water sources in the watershed. Maps have been created with Arc GIS software, while charts and graphs were prepared by using MS Excel.

Results and Discussion

The following section of this study explore various land use land cover, agricultural, and water resource related characteristics:

Land use land cover characteristics of Balh watershed

Land use and land cover studies are essential to determine how land in a given area is used for various purposes. Land use and land cover analysis provides a detailed picture of waterbodies, forests, agricultural land, settlement pattern, and other features in any area. It becomes easy to take appropriate steps for the area's sustainable development based on land use and land cover studies.

Table 01. Land Use Land Cover Classification of Balh Watershed

Sr. No.	Classification of Land Use	Area (In Hectares)	Area (In Percentage)
1.	Forest Land	2909.25	**53.23**
2.	Agricultural Land	1737.18	**31.90**
3.	Built Up Area	88.2	**01.61**
4.	Other Area	723.96	**13.26**
5.	**Total Area**	**5458.59**	**100**

Source: United States Geological Survey (USGS) Earth Explorer, 2018.

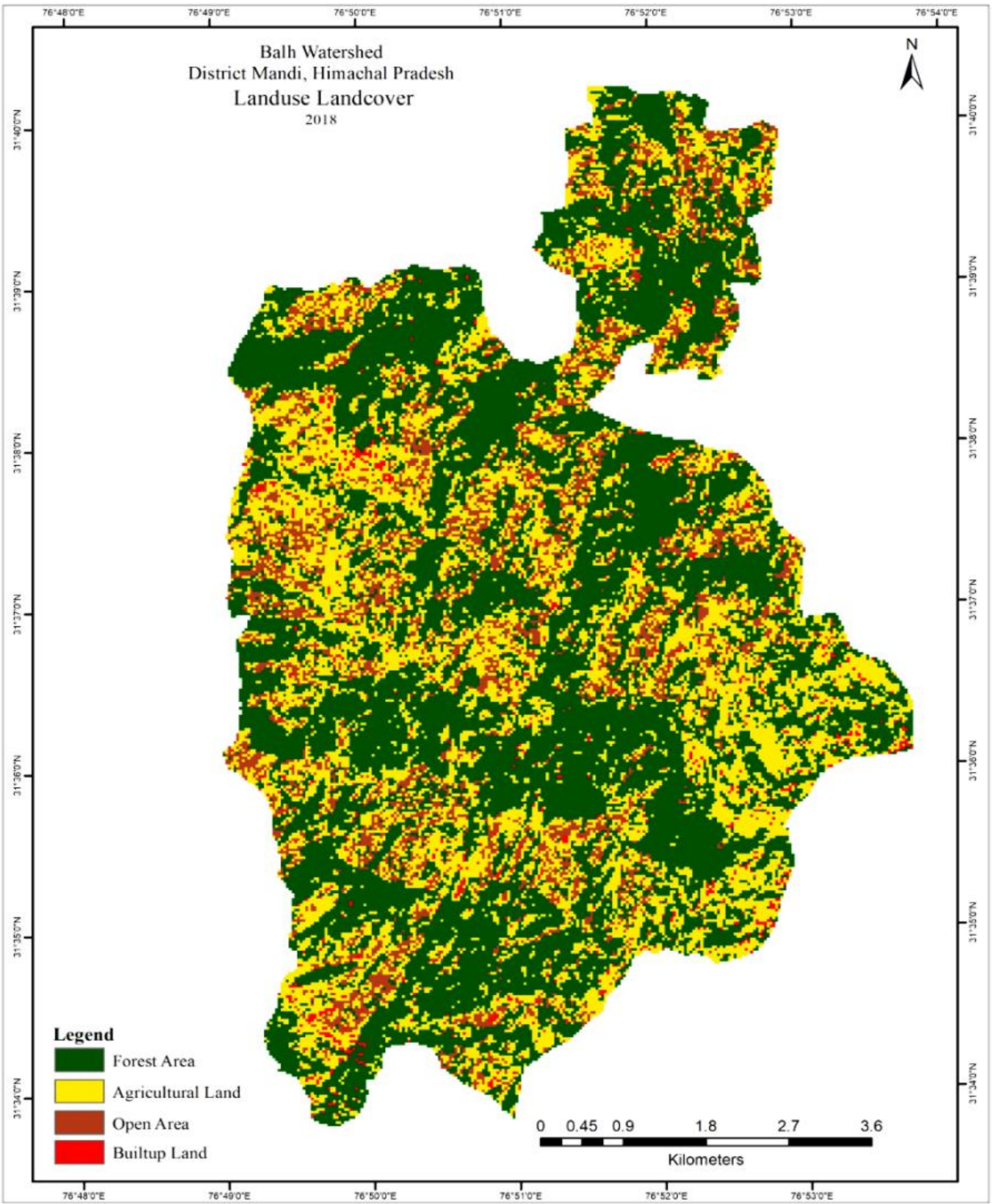
The current study analysed the land use and land cover of the Balh watershed using satellite imagery from 2018. According to the analysis, forest land covers more than 50% of the watershed area, agricultural land covers more than 30%, open area is around 13%, and built-up area coverage is less than 2%. (Table 01). Panchayat level analysis of forest cover shows that 2 panchayats have forests on less than 50 percent land, 7 panchayats have forests on 50 to 55 percent land area and 4 panchayats have forests on more than 55 percent land area owned by them.

Forests are also heavily spread in the high and mid hills, whilst grasses fill the lower hill and valley regions. The vegetation types in the high, middle, and lower hills vary greatly, in which high hills are dominated by Pinus, Quercus, wild apricot, and shrubs; mid hills are dominated by Celtris australis, Prunus cerasoides, Sapindus mukorossi, and Ficus; and lower hills are dominated by Ficus, Celtis australis, Grewia optiva, Bauhinia variegate, Toona ciliate, Bombax ceiba etc. Other grasses present in the Balh watershed include Dactylis, Glomerate, Sarloo, Bainju, Imperata cylinderica, Kumroo, Hetropogon contortus, and many others.

The analysis of land use land cover also shows that agricultural land covers maximum area of the watershed after forest cover. Approximately 32 percent (1737.18 hectares) of land comes under agriculture in the watershed. Other than agricultural land and forest cover, huge open spaces are also found in the watershed which account for approximately 13 percent area of the watershed. Open spaces include barren land, wasteland and other open land which currently not in use. These areas can be used for plantation of horticulture, fodder and trees of medicinal importance.

Panchayat wise analysis show that two panchayats have less than 10 percent area under open spaces, seven panchayats have 10 to 15 percent and five panchayats have more than 15 percent area under open spaces. Except this, very small area of watershed comes under built up area which include road, settlements and other buildings like hospitals, schools, panchayat offices, market places etc.

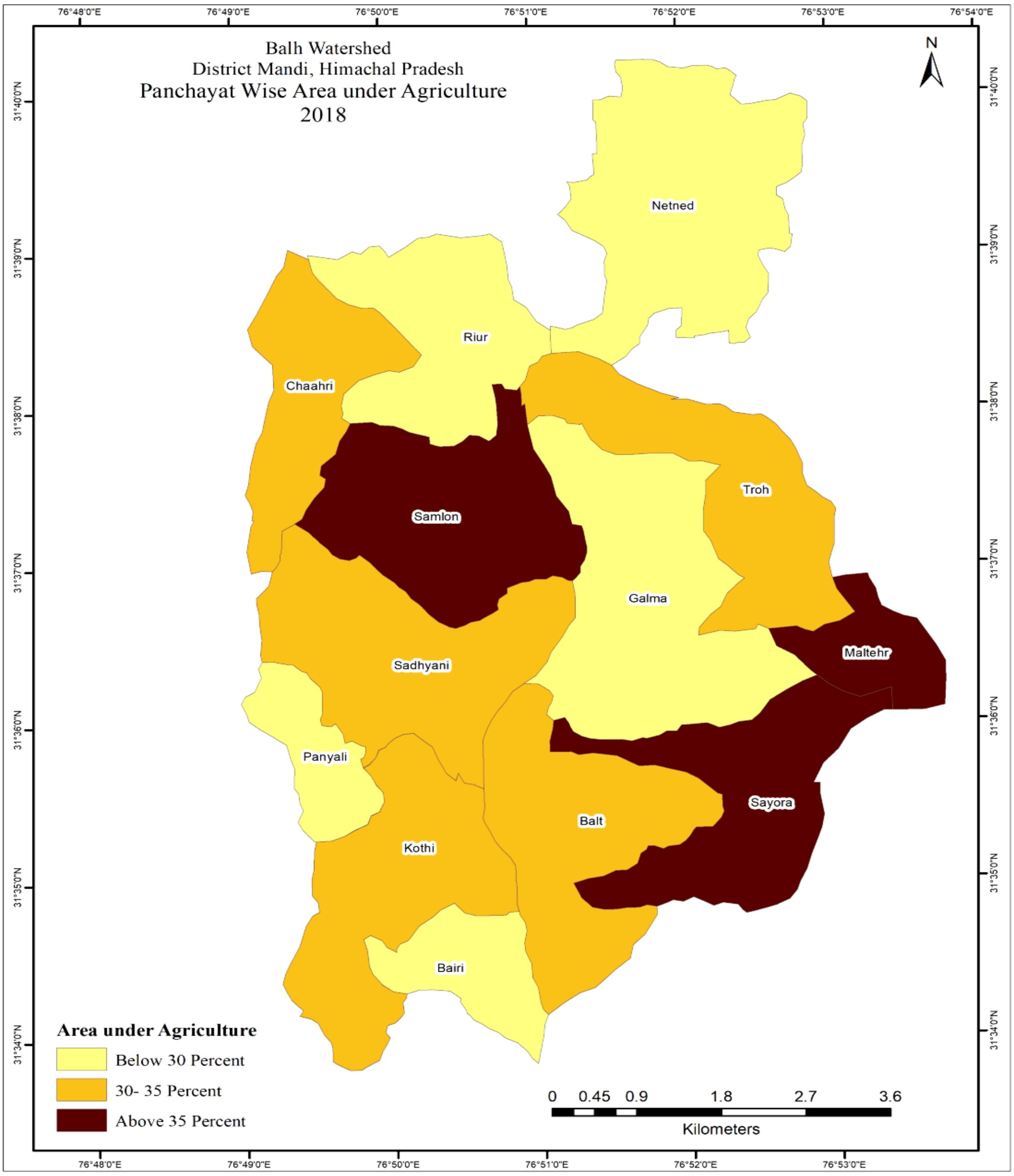
Approximately 88.2 hectares area (1.61 percent) comes under built up in Balh watershed. As population is continuously increasing in this watershed, built up area will increase accordingly and there will be adverse impact on agricultural and forest area of the watershed. Thus effective implementation of watershed development programmes is required in the watershed.



Source: USGS Earth Explorer and District Census Handbook, 2011.

Agricultural Characteristics of Balh Watershed

Maximum agricultural land is found in low hills and plain patches of the watershed. Wheat Maize and Paddy are the predominant food grain crops and along with these some pulses are also grown in the region. Vegetables like peas, tomato and cucurbitaceous are also grown in the watershed. Other than cereals, pulses and vegetables, fruits like mango, emblica, citrus, pomegranate, plum and papaya also grown in the area. Maize, paddy, chari and cucurbits are sown in May, June and July months and harvested in September and October months. Wheat, barley, mustard, chickpea, berseem, peas etc. are sown in October, November and December months and harvested in April and May months. Agriculture pastoral farming system is usually practiced in the watershed



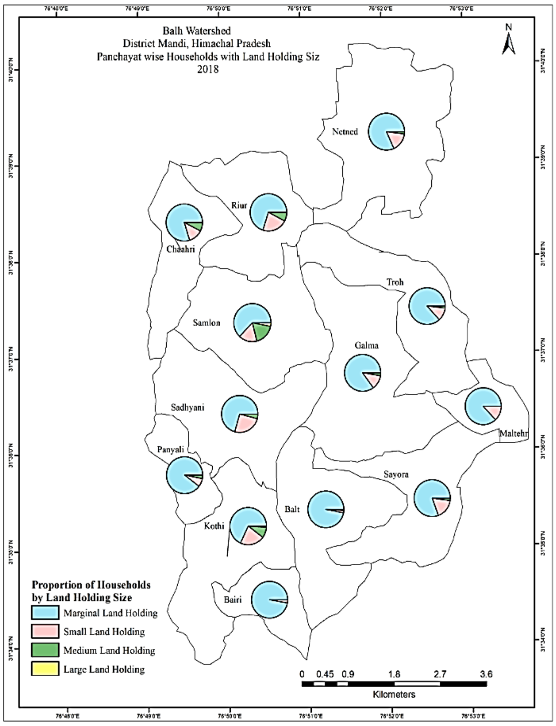
.Map 03. Area Under Agriculture in Balh Watershed

Source: District Census Handbook, 2011.

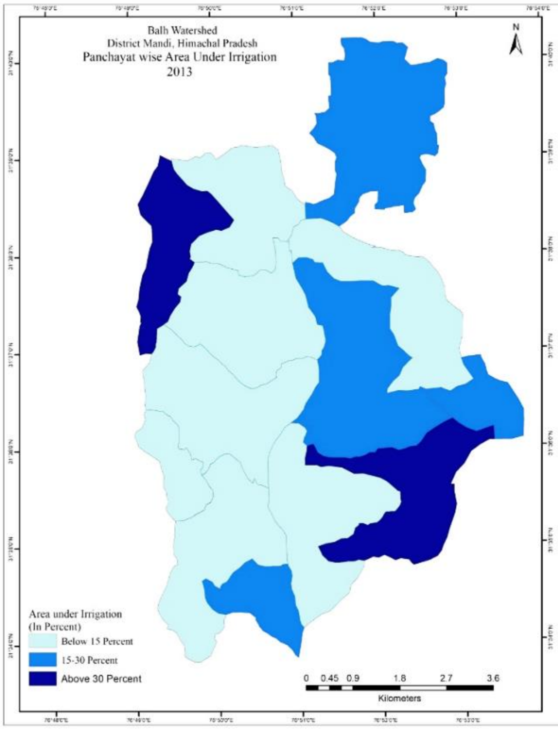
It is clearly visible from the map 03 that three panchayats have agricultural area of more than 35 percent out of their total area, five panchayats have 30 to 35 percent and remaining five panchayats have less than 30 percent agricultural land. Due to hilly mountainous and rugged topography, agricultural land is unevenly distributed in small patchy landholdings. Data collected from different panchayat secretaries in the watershed reveals that more than 80 percent households have marginal landholdings (below 1 hectare), 14 percent households have small landholdings (1-2 hectares), 4 percent households have medium landholdings (2-4 hectares) and very few households have large landholdings (Map 04).

Irrigation facilities are not adequately available in the watershed as it is clear from the study that approximately 17 percent agricultural area comes under irrigation and approximately 83 percent agricultural land is rainfed. Out of total panchayats, more than 30 percent of the agricultural land is benefitted with irrigation facility in only two panchayats, four panchayats have 15 to 30 percent agricultural area under irrigation and remaining seven panchayats have irrigation facility on less than 15 percent agricultural land (Map 05).

Map: 04



Map: 05

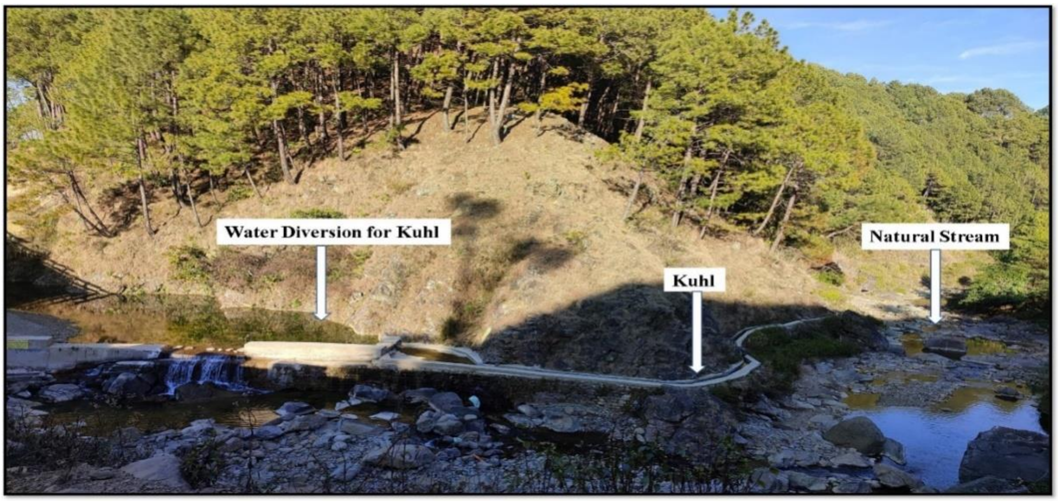


Source: District Census Handbook, 2011.

Major sources of irrigation in the watershed are kuhl and tanks. Kuhls are small channels which are constructed on a main rivulet or stream and it divert a small proportion of stream water and flows through this channel and irrigate the fields (Plate 01). In other areas where kuhls are difficult to construct, irrigation is being done through tanks. Water from rainfall or tap is being stored in these tanks for irrigation purposes. These irrigation facilities are unable to fulfil all the requirement therefore area specific irrigation schemes are needed to be initiated in the watershed.

Plate: 01

View of a kuhl in Balh Watershed



Source: Field Work, 2019.

Characteristics of Water Resources in Balh watershed

There is abundant availability of water sources in the basin which includes streams, khads, baories, ponds and tanks (Plate 02-05). Numerous drinking water supply schemes are also functioning in this area. It is clear from the field work that total 288 sources are found in watershed out of which 29 are small streams, 10 khads, 96 baories and 153 tanks and ponds. These sources are unevenly distributed in all panchayats. Out of total 288 sources, 49 are found in Riur panchayat, 41 in Kothi, 29 in Bairi, 26 in Sayora, 24 in Chahri, 22 in Sidhyani and remaining 97 in other seven panchayats (Table 02). Although these sources are fulfilling all water requirements in the watershed, however discharge of water sources got reduced during summers due to which water scarcity occurs every year.

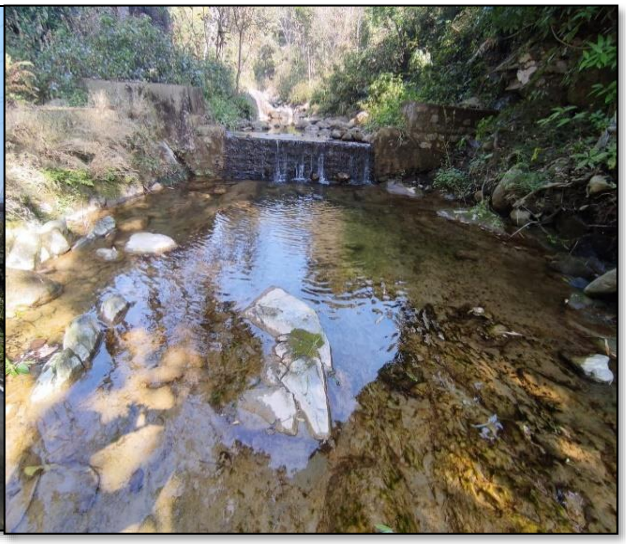
Table 02. Distribution of Water Sources in Balh Watershed

Sr. No.	Panchayats	Streams	Khad	Baories	Pond/Tank	Total
1	Bairi	3	1	9	16	**29**
2	Balt	3	1	5	6	**15**
3	Chahri	2	0	8	14	**24**
4	Galma	4	1	10	5	**20**
5	Kothi	2	1	4	34	**41**
6	Malthehar	3	1	4	0	**08**
7	Netned	1	1	7	2	**11**
8	Panyali	2	0	3	3	**08**
9	Riur	2	0	10	37	**49**
10	Sadhyani	1	1	8	12	**22**
11	Samlon	2	1	7	10	**20**
12	Sayora	2	1	12	11	**26**
13	Troh	2	1	9	3	**15**
	Total	**29**	**10**	**96**	**153**	**288**

Source: Field Work, 2019.

Plate: 02
View of a Khad

Plate: 03
View of a Stream



Source: Field Work, 2019.

Plate: 04
View of a Baori

Plate: 05
View of a Tank

Source: Field Work, 2019.

Besides these sources numerous government water supply schemes are also functioning in the watershed. These supply schemes get affected in summers due to reduced amount of water in source, thus people rely on traditional sources such as baories and ditches, hence these traditional sources play a vital role in fulfilling water requirements in the watershed during summers. Unfortunately, these traditional water sources are demolishing due to natural causes and human ignorance. There is a need to protect these sources from demolition and thus is only possible with effective implementation of water conservation activities. Local communities, panchayats and other government authorities should take joint responsibility in this regard and then duly the sustainability of water resources can be established.

Conclusion and Suggestions

It is clear from the above discussion that more than 85 percent of the watershed area is covered with forests and agricultural land, however it will decrease with increasing population and built-up activities. Significant proportion of the watershed is not used for agriculture, settlements or other uses, therefore trees with fodder and horticultural value should be planted in these areas.

It is also visible from the study that agricultural land is not equally distributed in all panchayats of the watershed and productivity of food grain crops is very less as compare to national average. The landholding size is extremely small and can be used for seasonal and off-season vegetable farming for commercial purposes as market places in adjacent cities such as Mandi and Nerchowk are available. There is also potential for greenhouse and organic farming in the basin, which might help farmers to increase their income. Due to the mountainous and uneven terrain, irrigation facilities are not widely spread in the area; however small-scale irrigation schemes can be constructed using accessible water sources. Traditional water sources should be renovated, and watershed initiatives such as drought proofing, flood control and protection, water conservation techniques etc. should be undertaken in the watershed in order to attain sustainability.

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Cartographical analysis of spatio-temporal variations in the ground water due to tubewell irrigation in Haryana state, India

Anil

Abstract

The aim of this study is finds out the impacts of tubewell irrigation on ground water in Haryana. It has been observed that continuous tubewell irrigation is the main cause of groundwater depletion after the Green Revolution. There has been tremendous development of surface irrigation resources since its promotion in the state. In the Haryana state in a year 2005, the net area sown was 3567 (000 ha) of which 2936 (000 ha) was under irrigation (82.3%). In the state available water potential has depleted due to over exploration a large number of shallow and deep tubewells. This has led to a decline in the water table. During the period 2005 to 2013, district Kaithal recorded maximum decline in the water table (8.90 mt) followed by Fatehabad (8.84 mt), Palwal (8.59 mt), Kurukshetra (6.88 mt), Gurgaon (6.03 mt), Ambala (5.98 mt), Mahendargarh (5.89 mt), Faridabad (5.12 mt), Sirsa (5.03 mt) and Panipat (4.98 mt). The rate of decline in ground water has been estimated to be about 46 cm per annum. The management strategies viz., water conservation practices, artificial recharge, crop diversification, reclamation and recycling of waste water and efficient irrigation system such as sprinkler and drip irrigation should be adopted to minimize the pressure on ground water in the area.

Keywords: Ground water level, Tubewell irrigation, Depletion, Water table

Introduction:

Ground water played a major role in the success of the Green Revolution, especially in Haryana, Punjab and western Uttar Pradesh (Aggarwal & Kaushal, 2009). Haryana, located in the northwestern part of the country has seen a significant growth in the utilisation of groundwater for agriculture in recent decades (Singh & Kasana, 2017). Haryana accounts for 6.9% of India's food output despite covering only 1.4 percent of the country's geographical territory and 2.5 percent of its agricultural area (Anonymous, 2012). Haryana is considered as agriculturally developed state; about 80% of the geographical area is under cultivation and around 83% of it is irrigated. Therefore, the demand of water for agriculture is high and increasing in the state of Haryana (Anonymous, 2012).

A substantial rise in the area under wheat and rice took place after the green revolution. Moreover, there is an increase in commercial crops in areas that were growing rain-fed crops earlier (Chaudhary & Aneja, 1991; Hira, 2009). Consequently, farmers started to grow crops that were water intensive and required protective irrigation thus leading to the pumping of ground water (Singh & Amrita, 2015). Around 88 percent of the collected groundwater is used for irrigation while 9 percent and 3 percent are used for domestic and industrial purposes, respectively (Jain, Agarwal, & Singh, 2007). Protective irrigation requirement over the years has increased and so is the dependency on groundwater irrigation (Singh, 2000). As groundwater extraction increased through the pump set and tubewell, the level of groundwater depth also increased (Bhalla, 2007). The state has a total number of tubewells around 7 lac 72 thousand that extracts ground water (Anonymous, 2012). The decline in ground water had been estimated around 46 cm per annum in Haryana state which is a threat to aquifers and sustainable development (Alley, 2002; Akther, 2009; Konikow & Kendy, 2005). Hence, there is a need to examine groundwater level fluctuations in order to manage the groundwater (Hogue, 2007; Sreekanth, 2009; Singh, 2010).

Objective:

The objectives of this paper are to ascertain the following:

- To analysis the spatio-temporal variations in the groundwater in Haryana state.
- To examine the cause of groundwater level depletion.
- To suggests suitable measures to prevent further decline in the groundwater and curative measures for its sustainable uses.

Study area:

Haryana is situated in the northwestern part of India between the latitudes of 27° 30' to 30° 35' N and longitudes of 74° 28' to 77° 36' E. It is a part of arid and semiarid northwestern plains with an annual rainfall of 545 mm. The Aravalli mountains lies in the southwest, the Shivalik hills in the north and the Yamuna river in the eastern part of the state. There are four distinct regions of the state that are northern, southern, western and eastern areas. All four are distinct territories; the northern part is hilly, and the eastern part receive higher rainfall and has fertile soils. The direction of slope is from north to south slope with elevation ranging between 700-900 feet (Anonymous, 2012). The southwestern part is sandy and rocky. Haryana has highly developed agriculture sector that depend largely on irrigation. There is no perennial river in the area and irrigation is done through the Bhakhra and Yamuna canal system. After the green revolution tubewells became the main source of irrigation and as a result the groundwater stand over-exploited due to high demand of water for rice and wheat cultivation. Hence, there is an urgent need to consider the issue of ground water use and its consequences.

Data Sources and Methodology:

This study is based on secondary data sources. These sources include the Statistical abstract of Haryana state (2005-06 to 2013-14), CGWB, ground water reports, working papers, journal articles, etc. To analyze the datasets, simple statistical tools and cartographic techniques have been used such as graphical and tabular representation. To show the relation between ground water depth and number of tubewells, simple correlation technique was used. The choropleth maps and line graph have been used for the graphical representation of data.

Analysis and Discussion

Ground water resources in Haryana:

Haryana has 0.7248 m ha-m (million hectares metre) available ground water of which 0.65236 m ha-m is utilizable for irrigation in net return. Net draft of groundwater is 0.60798 m ha-m leaving balance of 0.11686 m ha-m for future use (Anonymous, 2000). However the draft of ground water is not uniform. In western part (Hisar, Bhiwani, Rohtak, Sirsa) of the state large portion of underground water is brackish and hence is not being pumped much whereas in north-eastern part of the state (Ambala, Karnal, Kurushetra, Yamunanager, Panipat, Kaithal), the underground water is fresh and is being over exploited.

Irrigation system in Haryana:

There is no perennial river in the area and is is being irrigated by bhakhra and Yamuna canal system. Haryana has very well developed surface irrigation system as shown in table-1. After the inception of Haryana State in 1966, a ground water policy was formulated to develop the available ground water. In the year 2005, net area sown was 3567 (000, ha) and net area under irrigation was about 2936 (000 ha). The area under irrigation is equally covered by both canal and tube well irrigation system. In the state available ground water potential has been over exploited by a large number of shallow and deep tubewells in private and public sector (table-2).

Table 1. Ground water development in Haryana

	2005-06	2012-13
No. of tube wells and Pumping sets	635520	772310
Tube wells (000, ha)	1514	1757
Net area sown	3567	3513

Source: Statistical abstract of Haryana state

In the year 2012-13, the number of tubewell in Haryana was about 7.7 lakhs compared to 6.3 lakhs in 2005-06. The present average ground water development in the state is 74 % and the average number of tubewell is 17/km^2. In northeastern and southern part of Haryana the districts of Kurukshetra, Panipat, Ambala, Yamuna Nagar, Karnal, Faridabad, Gurgaon, Rewari and Mahendergarh has very high ground water development as shown in table-2. Six districts viz. Ambala (86% development), Kurukshetra (130%), Karnal (121%), Panipat (106%), Rewari (105%) and Mahendergarh (145%) falls in dark zone where there is more than 85% of utilisation whereas districts of Yamuna Nagar (80%), Kaithal (83%), Gurgaon (79%) falls in the grey zone where is there 65 to 85% of development.

This indiscriminate exploitation of ground water resources has led to a continuous decline in the ground water table. In 2013, the total number of tubewells was highest in district Kurukshetra followed by Kaithal, Sirsa, Bhiwani, Jind, Sonipat, Karnal, etc. and lowest in Panchkula, Faridabad, Mewat, Rohtak due to industrial district and poor quality of ground water.

During the study period from 2005 to 2013, district Kaithal has maximum decline in the water table (8.90 mt) followed by Fatehabad

Table 2. District wise total number of pump set and tubewells in Haryana state for the study period 2005-13

Sr. No	District	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
1	Ambala	23322	23843	23710	23710	26316	27042	27792	28127
2	Panchkula	4996	5034	4095	4407	4652	4755	4864	5091
3	Y. Nagar	29260	31526	31163	32147	30865	31710	32584	33254
4	Kuruksh.	37002	39945	37554	38311	71910	74204	76542	74944
5	Kaithal	56565	57120	57186	59072	60772	61907	63138	64244
6	Karnal	63746	65628	67434	59874	40347	41973	43600	44204
7	Panipat	29665	30318	30560	30527	31929	33023	34131	34313
8	Sonipat	39610	41045	42570	43600	44265	44598	45035	46041
9	Rohtak	18226	18735	20045	20175	19989	19690	19470	18785
10	Jhajjar	35914	36312	40510	29423	29312	29008	28811	29394
11	Faridabad	30126	31258	9811	9727	10061	10307	10564	10678
12	Gurugaon	23023	23348	22946	23373	24576	25533	26494	26319
13	Mewat	13700	14135	13284	12192	15657	15755	15891	16334
14	Rewari	28685	29725	28825	29582	33531	34525	35544	35884
15	Mahend.	24207	25093	25613	26026	27408	28512	29618	30442
16	Bhiwani	32790	34043	36359	36601	51174	51674	52286	57891
17	Jind	41002	43732	45748	49085	50201	50916	51723	53485
18	Hisar	25218	26540	29184	31009	31101	30987	30972	32713
19	Fatehabad	32327	34823	34495	36844	38012	38941	39913	40736
20	Sirsa	46136	50223	52745	56651	56229	57171	58209	62902
21	Palwal	-	-	24423	25003	25150	25126	25176	25529
	Total	635520	662426	678260	677352	723457	737357	752357	772310

Source: Statistical abstract of Haryana state

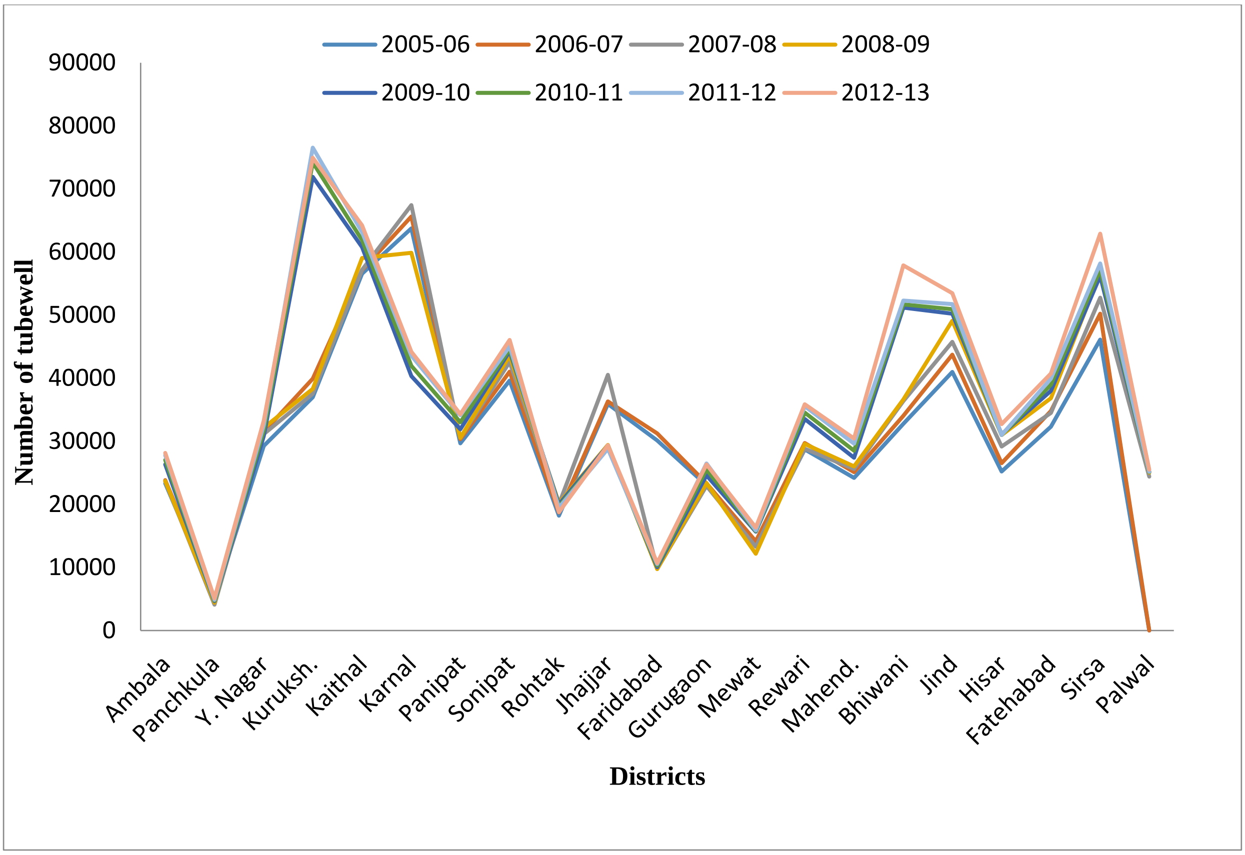

Fig. 1-District wise number of pump set and tubewells in Haryana during 2005-13

(8.84 mt), Palwal (8.59 mt), Kurukshetra (6.88 mt), Gurgaon (6.03 mt), Ambala (5.98 mt), Mahendargarh (5.89 mt), Faridabad (5.12 mt), Sirsa (5.03 mt) and Panipat (4.98 mt) as shown in table 3. During this period overall 4.16 metre fall in the ground water table has been recorded. About 5-9 mt fall in the ground water table has been recorded in 37% of total state area. Similarly 0-5 mt fall in the water table has been recorded in 58% of total state area as shown. Only Rohtak and Jhajjar districts shows increase in the ground water level because the number of tubewells and pumping sets decreased due to poor quality of ground water. A continued pattern of rice and wheat crops and sugarcane farming is responsible for the over drafting of groundwater. The inadequate groundwater recharge due to erratic rainfall and farming practices such as continuous puddling in rice crop and soil compaction due to heavy machinery and lack of canal system has disturbed the subsurface hydrological regime and therefore are contributing in the degradation of groundwater resources.

During the study period 2005-13, the average depth of groundwater in the state was 12.79 mt. Mahendargarh district has the highest depth of groundwater table (33.01 mt) followed by the district Kurukhetra (22.73 mt), Gurugaon (20.87 mt), Rewari (17.46 mt), Panchkula (14.09), Sirsa (13.52), etc.. The lowest depth of ground water table was in Rohtak (2.86 mt) and Jhajjar (4.88 mt) districts because lesser number of tubewells and pumping sets due to the deterioration of groundwater quality.

Table 3. District wise Depth of Groundwater Table (m) in Haryana during 2005-13

	District	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	Average	Change (2005-13)
1	Abmala	13.36	16.07	17.26	17.06	17.42	16.72	17.73	19.34	16.87	5.98
2	Bhiwani	7.17	7.37	7.71	8.32	9.01	8.03	8.92	9.10	8.20	1.93
3	Faridabad	10.46	10.81	11.22	11.80	12.26	12.96	13.97	15.58	12.38	5.12
4	Fatehabad	9.61	6.73	11.34	12.89	15.99	16.33	17.61	18.45	13.61	8.84
5	Gurgaon	17.51	19.17	20.13	21.19	22.48	22.05	20.96	23.54	20.87	6.03
6	Hisar	5.64	5.52	6.33	6.11	6.97	6.45	6.56	6.10	6.21	0.46
7	Jind	5.98	6.17	6.67	6.81	8.91	7.29	8.38	9.16	7.42	3.18
8	Jhajjar	5.37	5.09	5.12	5.05	5.34	4.13	4.52	4.42	4.88	-0.95
9	Kaithal	9.08	11.95	13.25	14.07	15.15	15.59	16.79	17.98	14.23	8.90
10	Karnal	9.27	10.26	11.23	12.29	13.02	12.21	13.23	13.63	11.89	4.36
11	Kuruksh.	19.55	20.97	21.98	22.85	23.02	22.37	24.69	26.43	22.73	6.88
12	Mahen.	27.63	39.2	29.69	32.63	35.31	32.29	33.07	34.29	33.01	6.66
13	Mewat	7.61	8.47	8.49	8.82	9.17	9.18	8.70	8.80	8.65	1.19
14	Palwal	8.63	9.53	9.64	9.61	9.77	15.76	17.82	17.22	12.24	8.59
15	Panipat	9.30	9.91	10.12	10.84	11.69	12.60	14.07	14.28	11.60	4.98
16	Panchkula	13.07	13.12	11.42	13.32	15.15	14.52	15.99	16.20	14.09	3.13
17	Rohtak	3.16	3.20	2.95	2.94	3.10	2.38	2.76	2.46	2.86	-0.70
18	Rewari	16.67	17.17	17.68	17.38	18.55	16.50	17.36	18.43	17.46	1.76
19	Sonipat	6.07	6.32	6.18	6.30	6.96	6.47	6.49	7.14	6.49	1.07
20	Sirsa	10.27	10.20	12.22	13.6	15.36	15.42	15.80	15.30	13.52	5.03
21	Y. Nagar	7.70	8.10	7.27	9.66	10.85	8.91	10.26	10.20	9.11	2.50
	Stat.Avg.	10.62	11.68	11.80	12.54	13.59	13.24	14.08	14.78	12.79	4.16

Source: Haryana Ground water year books

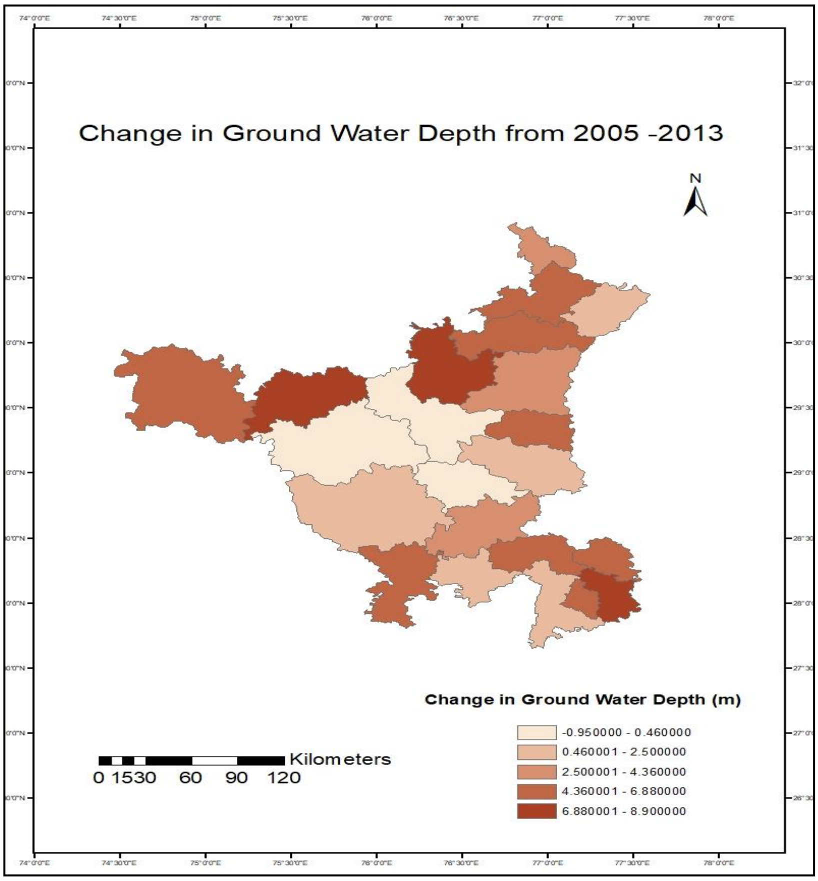

Fig. 2- Change in the Depth of Groundwater Table (m) in Haryana during 2005-13

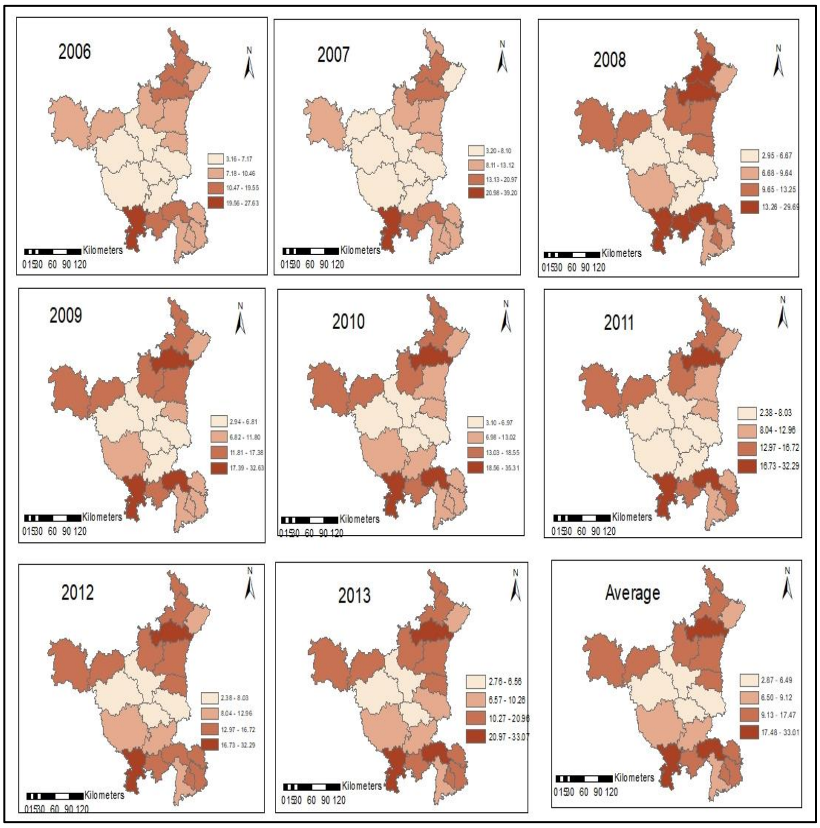

Fig. 3- District wise pattern of Groundwater Depth (m) in Haryana during 2005-13

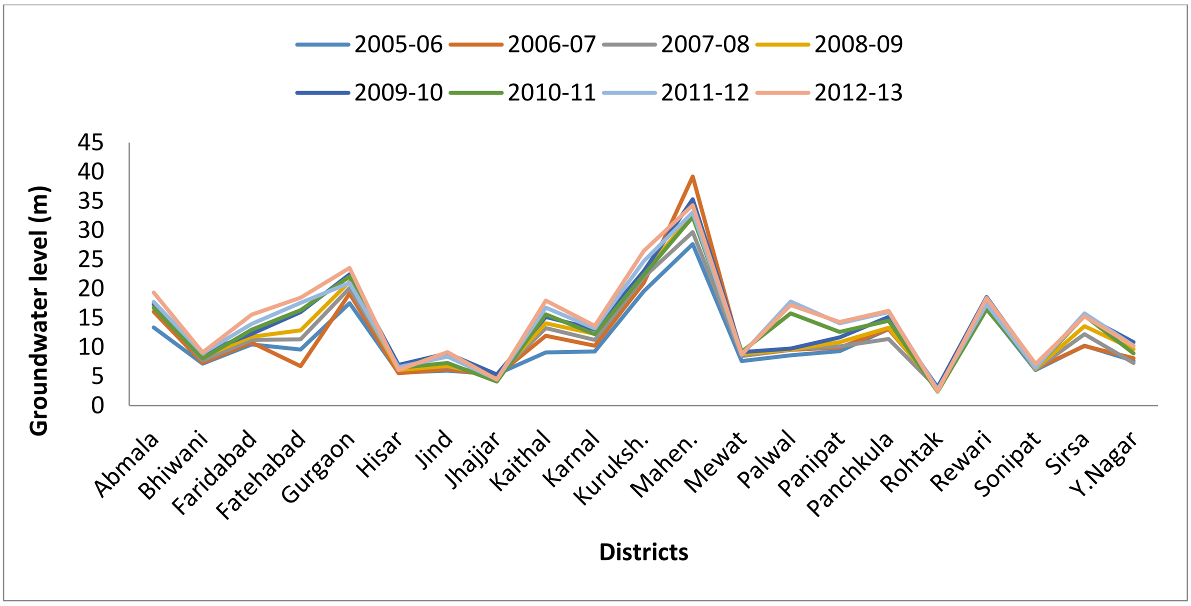

Fig. 4- District wise Groundwater Depthe (m) in Haryana for the study period 2005-13

Correlation between depth of the ground water and number of the tubewells

As shown in below table 4, depth of the groundwater table is increasing as the number of tubewells and pump sets increase. So the number of tubewells and the depth of the groundwater table are highly positive correlated. The value of correlation for Haryana state is 0.973 which is highly positively correlated and scatter diagram between depth of groundwater and the number of tubules is given below. This the major cause of groundwater depletion is tubewells irrigation.

Table 4. Number of Tube-Wells & Pump Sets and Depth of Groundwater (2005-13)

Sr. No.	Years	Total numbers of pump sets and tube wells	Depth of Groundwater Table (m)
1.	2006	635520	10.62
2.	2007	662426	11.68
3.	2008	678260	11.80
4.	2009	677352	12.54
5.	2010	724345	13.59
6.	2011	737357	13.24
7.	2012	752357	14.08
8.	2013	772310	14.78

Source: Statistical abstract of Haryana state

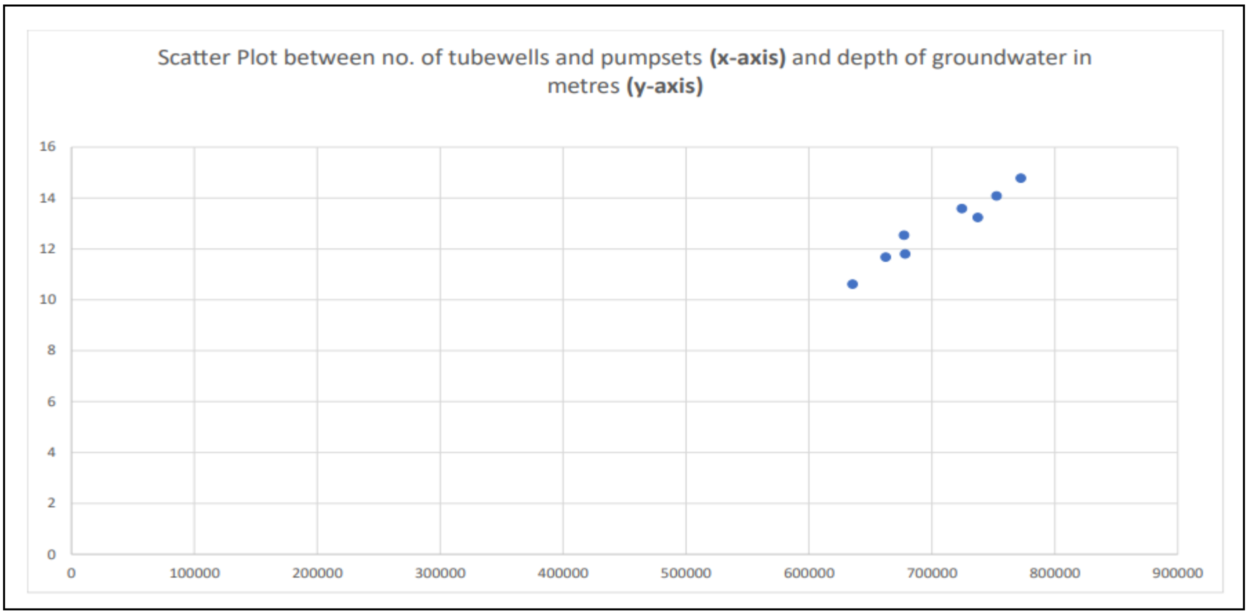

Fig. 5- Linear relationship between depth of groundwater and the number of tubules and pump sets in Haryana state for the study period 2005-2013

Table 4: Correlation between Tubewells and Groundwater Depth

Sr. No	Range	Nature of Correlation	District
1	0.585-0.999	Highly Positive	Panipat, kaithal, Fatehabad, Jind, Sirsa, Hisar, Bhiwani, Sonipat, Kurukshetra, Gurgaon, Ambala, Palwal
2	-0.137-0.585	Moderate	Panchukla, Y. Nagar, Jhajjar, Mewat, Rewari, Mahendergarh
3	-0.801- -0.137	Low	Rohtak, Faridabad, Karnal

From the above table, it is clear that the districts of Panipat, Kaithal, Fatehabad, Sirsa, Bhiwani, etc. are highly positive correlated as the depth of the ground water table is increasing as the number of tubewells are increasing. The constant rice, wheat cropping system and heavy duty crop like sugarcane is mainly responsible for over drafting of ground water. As these crops have very high water requirement. So the amount of tubewells increase as well as depth of groundwater table is increasing. So these districts are highly correlated. District Panchukla, Y. Nagar, Jhajjar, Mewat, Rewari, Mahendargarh is moderately correlated. While districts Rohtak, Faridabad, Karnal is negative correlated because deterioration of the ground water quality.

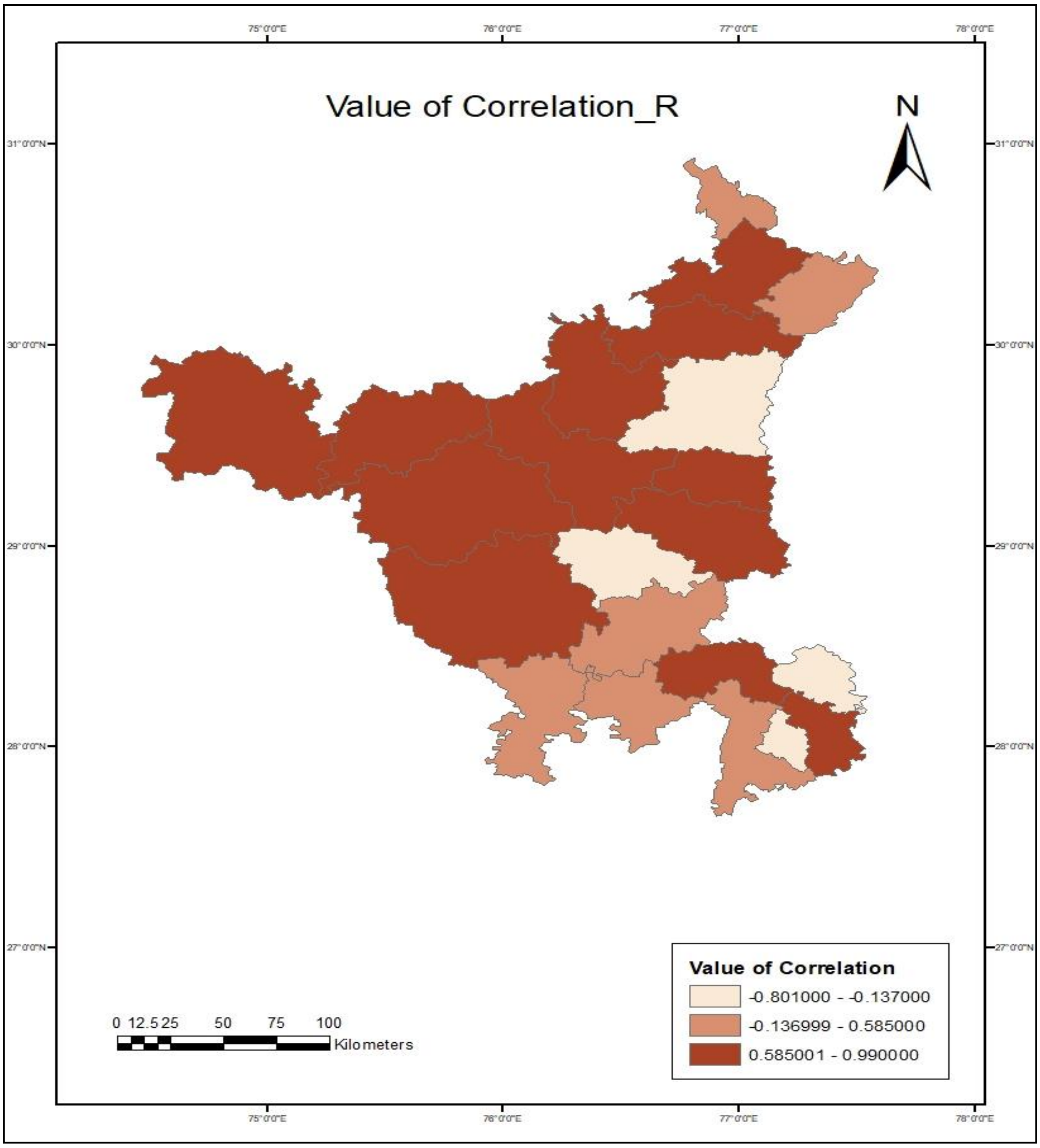

Fig. 6- District wise relationship between groundwater depth and number of tubewells in Haryana (2005-13)

Management strategies:

Keeping in view the degradation of ground water resources, it is essential to optimize the utilization of ground water resource in the state. The following management strategies should be considered to tackle the problem.

1. **Water conservation practices:** The efficiency of ground water utilisation is very important. It is essential to improve the water use efficiency by strengthening of bunds, cleaning of field channels, adopting proper architect of irrigation plots which is depending on slope, soil physical conditions and drainage. The depth and time of irrigation of different crop should be optimized.
2. **Artificial recharge:** Artificial recharge by water spreading water injection in the wells, accumulation of water in stream, drains and pits

should be adopted to replenish the receding ground water resources.

3. **Crop diversification:** The continuous adoption of rice-wheat cropping sequence for more than three decades in the state has contributed to a tremendous decline in the watertable. Thus, there is dire need of having crop diversification to replace the rice - wheat system. During Rabi the wheat can be replaced by oil seed, winter maize and in Kharif season the rice can be replaced by pulses. In Punjab, the government has launched a scheme for crop diversification through contractual farming and strategy is being planned in Haryana also.
4. **Reclamation and recycling of waste water:** The large amount of industrial effluent, sewage water produced and their disposal is a great problem. However, these can be used for irrigation after suitable treatment. This treatment considerable decreased the toxicity hazards thus make it suitable for irrigation. This waters can also be used efficiently for forest plantation.
5. **Efficient irrigation system:** A more efficient irrigation system like drip and sprinkler irrigation methods can be adopted for saving the water and also to utilize the saline/sodic water for cultivation of crops without affecting the yields drastically.

Conclusion

In summing up, it is quite clear that there is a very high decline in the groundwater in the Haryana state. The major cause of ground water depletion is tubewell irrigation. This is very alarming situation and there is dire need to check the further decline in watertable and to minimize the pressure on ground water via management strategies, i.e. Water conservation practices, artificial recharge, crop diversification, reclamation and recycling of waste water and efficient irrigation system such as sprinkler and drip irrigation.

Acknowledgement

I would like to express my gratitude from the bottom of my heart to my supervisor **Prof. Krishna Mohan**, who has guided and motivated me for this work. It is not possible for me without his valuable suggestions and feedback.

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Landuse Change in Peri Urban Area: Study of Urban Expansion of Bengaluru

Brahmjot Kaur

Abstract

Population growth has always been a constant and so has the problems arising because of this population growth. There has been a constant mismanagement of such population growth in major cities and urban areas across the world with no focus on sustainability and planning. According to the United Nations, 2010, it is estimated that more than 50% of the world's population lives in urban areas, and the projected proportion of urban population will reach 69.6% by 2050. Urban population across India has been growing consistently from 27.81% in 2001 to 31.16% in 2011. Among its 30 districts in Karnataka, Bengaluru district attracts large population of 9.6 m for urban Bengaluru alone (Census, 2011). It is continued to be one of the fastest growing cities in India and Asia. The population of Bengaluru grew by 35.09 % in 2001 to 47.18 % in 2011 (Census, 2011). This unplanned urbanization led to a threat to different ecosystems thriving in the area until few decades ago. The problem aggravated with scientist suggesting Bengaluru will be depleted of ground water by the year 2030 (Composite Water Resources Management: Performance of States-NITI Aayog, 2018).

Keywords: GIS, NDVI, Urban growth, Eutrophication, Water Extent

Introduction

Population growth has always been a constant and so have the problems arising because of this population growth. There has been a constant mismanagement of such population growthin major cities and urban areas across the world with no focus on sustainability and planning. According to the United Nations, 2010, it is estimated that more than 50% of the world's population lives in urban areas, and the projected proportion of urban population will reach 69.6% by 2050. Urban population across India has been growing consistently from 27.81% in2001 to 31.16% in 2011. Among its 30 districts in Karnataka, Bengaluru district attracts largepopulation of 9.6 m for urban Bengaluru alone (Census, 2011). It is continued to be one ofthe fastest growing cities in India and Asia. The population of Bengaluru grew by 35.09 % in 2001 to 47.18 % in 2011 (Census, 2011). This unplanned urbanization led to a threat to different ecosystems thriving in the area until few decades ago. The problem aggravated with scientist suggesting Bengaluru will be depleted of ground water by the year 2030 (Composite Water Resources Management: Performance of States-NITI Aayog, 2018).

Objectives

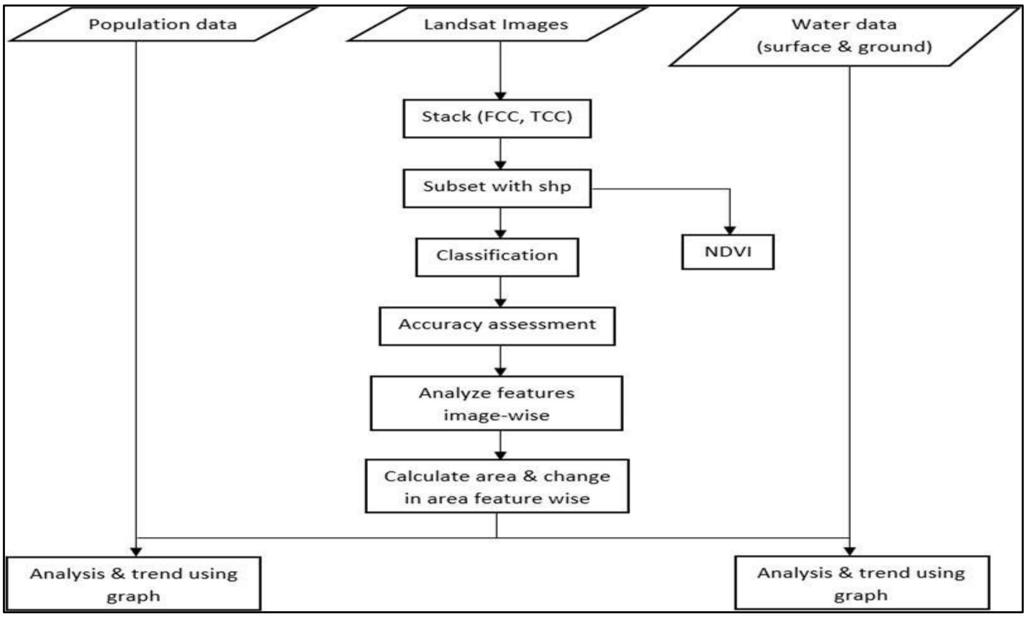
This paper depicts the methodology and quantification of growth of urban population and land use change to urban areas. It also portrays the change in the agricultural area and reduction in yield because of land degradation over decades. This paper also depicts changein the water resources, drying of lakes in the area, degradation of water and ground water depletion. All this is done and depicted using GIS techniques and digital cartography. This paper also presents some solutions to the underlying issues and also few policy recommendations.

Study Area

The district Bengaluru urban is located in the southeastern part of Karnataka. It is having an area 2190 sq. km and is located between North latitude: 12˚39' 32'' - 13˚14' 13'' and East longitude: 77˚19'44'' - 77˚50'13''.The district is divided into four taluks: Anekal, Bengaluru North, Bengaluru South, and Bengaluru East. Bengaluru is the *sixth-largest* city in India and one of the fastest-growing cities in Asia. It has acquired the name of 'Silicon City", due to its progressive trend in Information technology. After the IT boom, Bengaluru city has suddenly overgrown its size and the district administration is facing a challenging task for providing necessary infrastructures to the related economic activities, trade, commerce and housing facilities. For the Census of India 2011, the definition of urban area is a place having a minimum population of 5,000 of density400 persons per square kilometer (1,000/sq mi) or higher, and 75% plus of the male working population employed in non-agricultural activities.

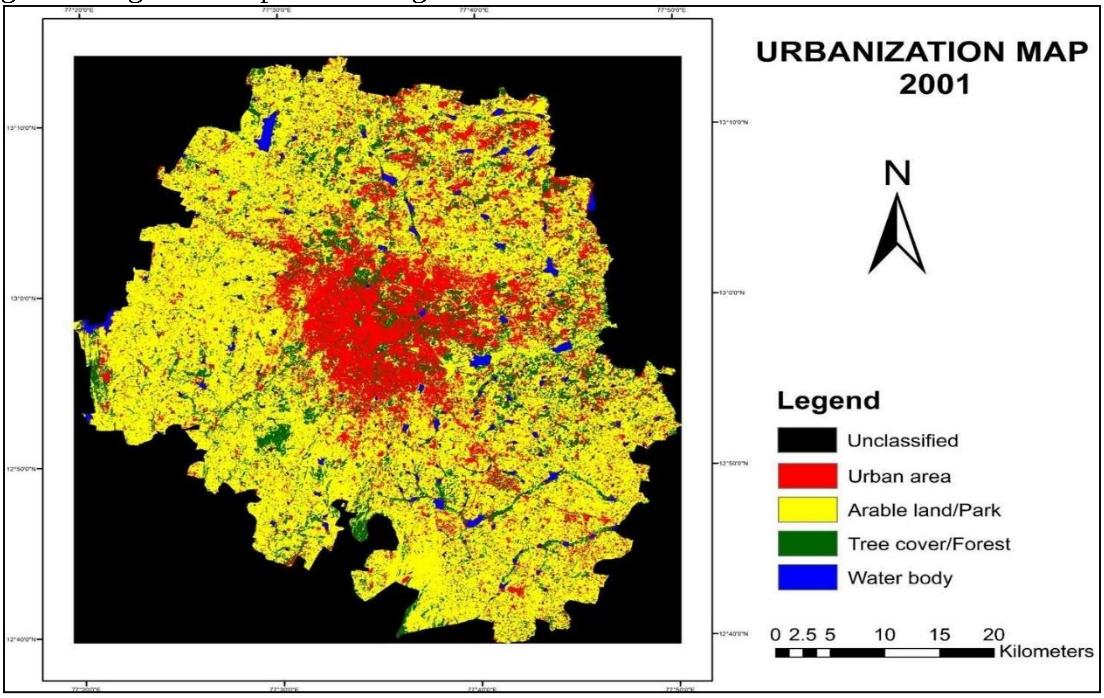
Data Sources

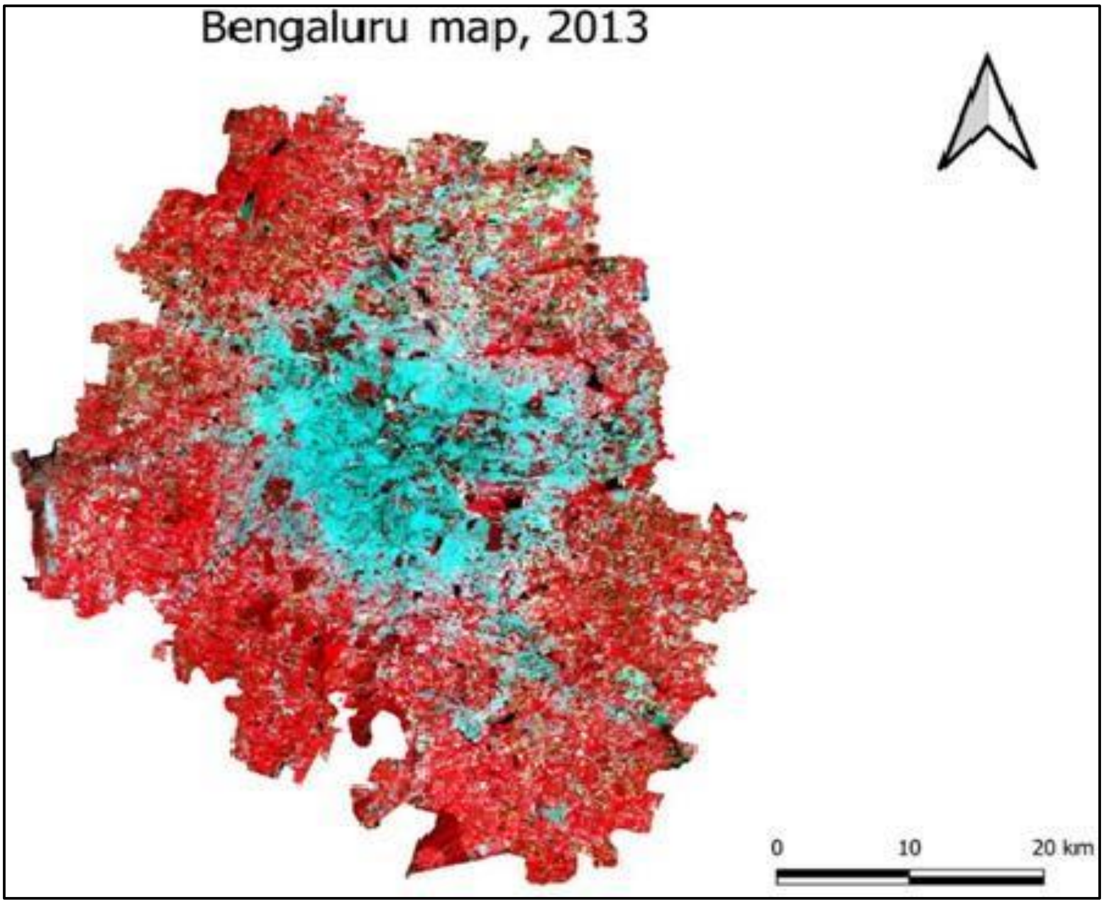
Data	Type	Source
Bengaluru District shapefile	Vector	Karnataka State Remote Sensing Application Centre - https://kgis.ksrsac.in/kgis/downloads.aspx
Landsat Satellite Images - 2001, 2013, 2021	Raster	USGS Earth Explorer - https://earthexplorer.usgs.gov/
Bengaluru Census Data - 2001, 2011	Excel File	Directorate of Census Operations, Karnataka - https://www.censusindia.gov.in/2011census/dchb/2918_PART_A_DCHB_Bengaluru.pdf
Ground Water level data	pdf file	Ministry of Water Resources - http://cgwb.gov.in/District_Profile/karnataka/2012/Bengaluru_URBAN-2012.pdf
Agricultural land data	pdf file	Agricultural development and rural transformation center- http://www.isec.ac.in/Agri%20Profile-Karnataka.pdf

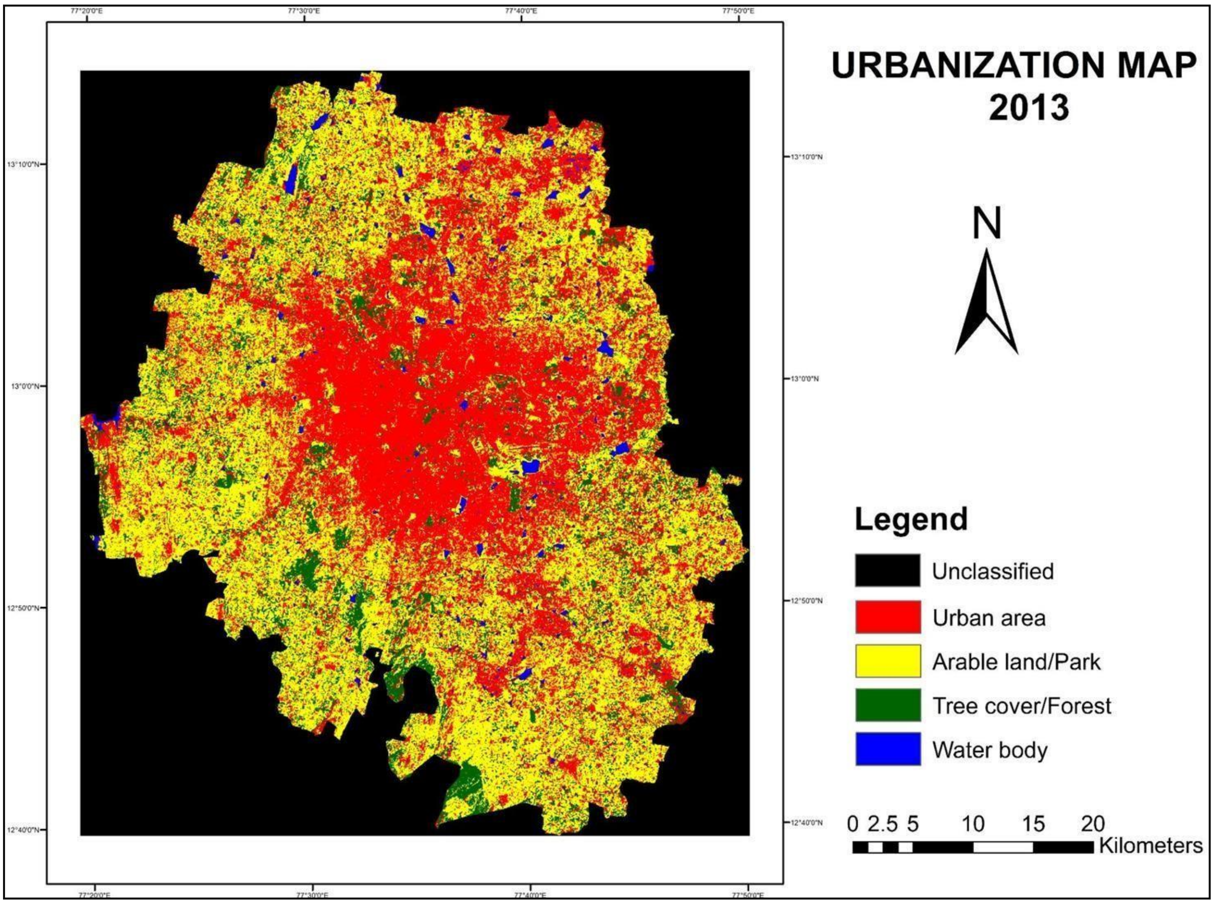


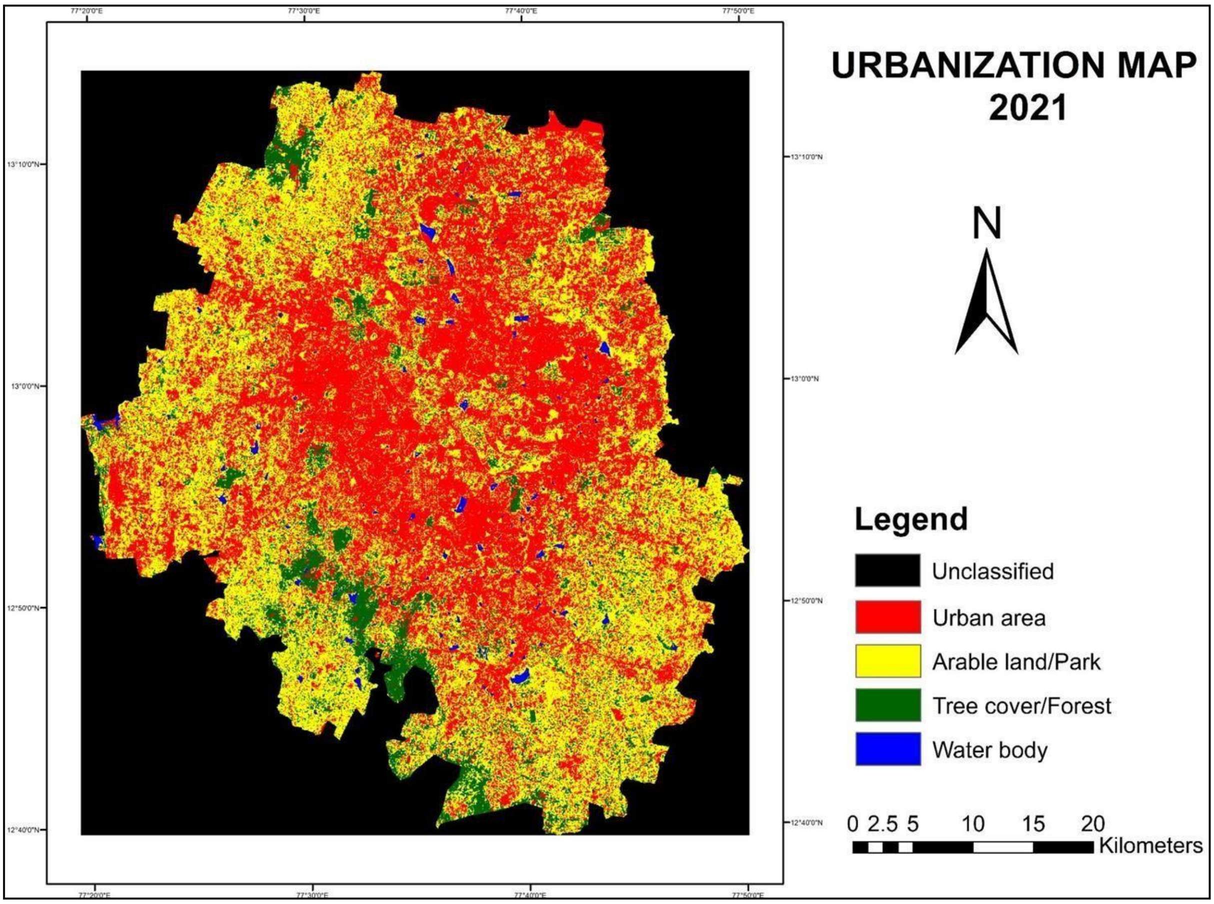
Methodology

Using the above methodology, classification is done on the Bangalore image, clipped using the Bangalore shape file. Images used are from years 2001, 2013 and 2021. Images are taken from USGS Earth Explorer. It is very evident from the maps prepared below that urban area has increased through all these years.






URBANIZATION MAP
2013
N
Legend
Unclassified
Urban area
Arable land/Park
Tree cover/Forest
Water body
0 2.5 5 10 15 20
Kilometers

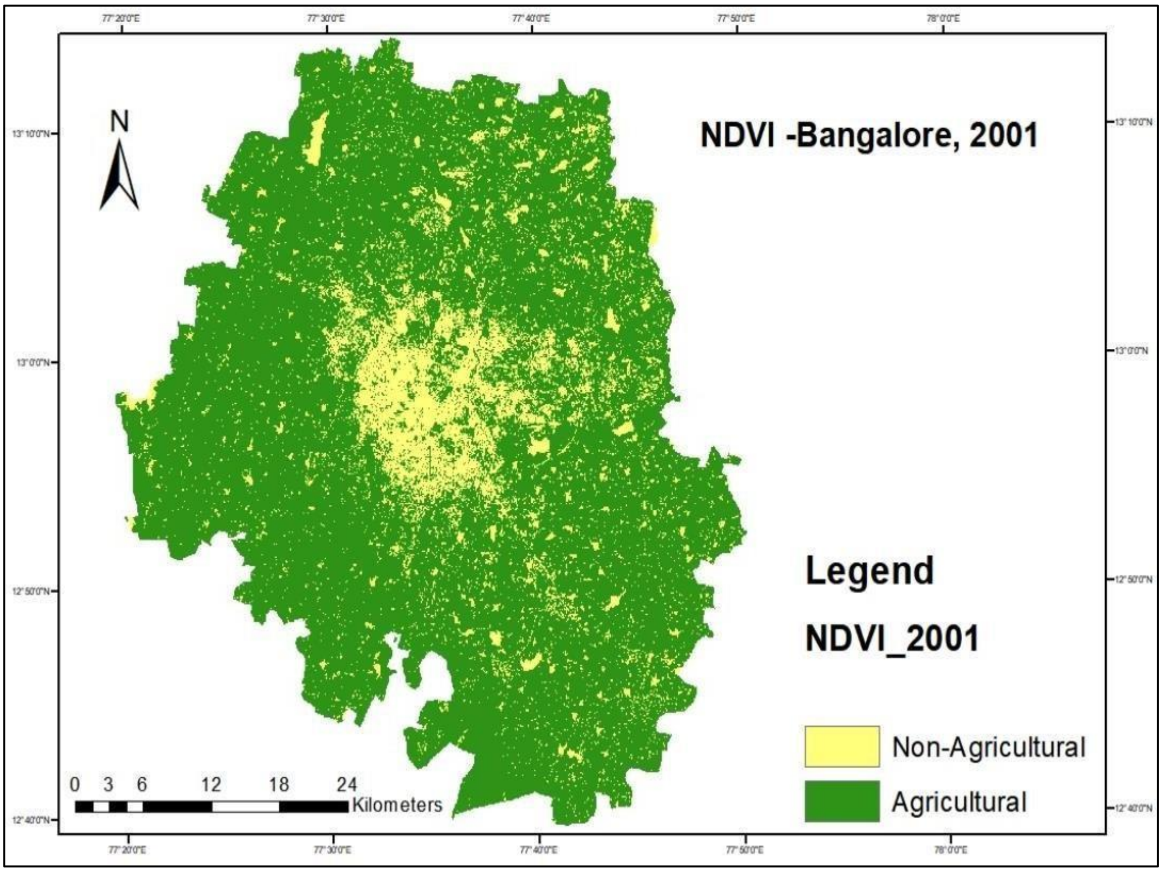

URBANIZATION MAP
2021
N
Legend
Unclassified
Urban area
Arable land/Park
Tree cover/Forest
Water body
0 2.5 5 10 15 20
Kilometers

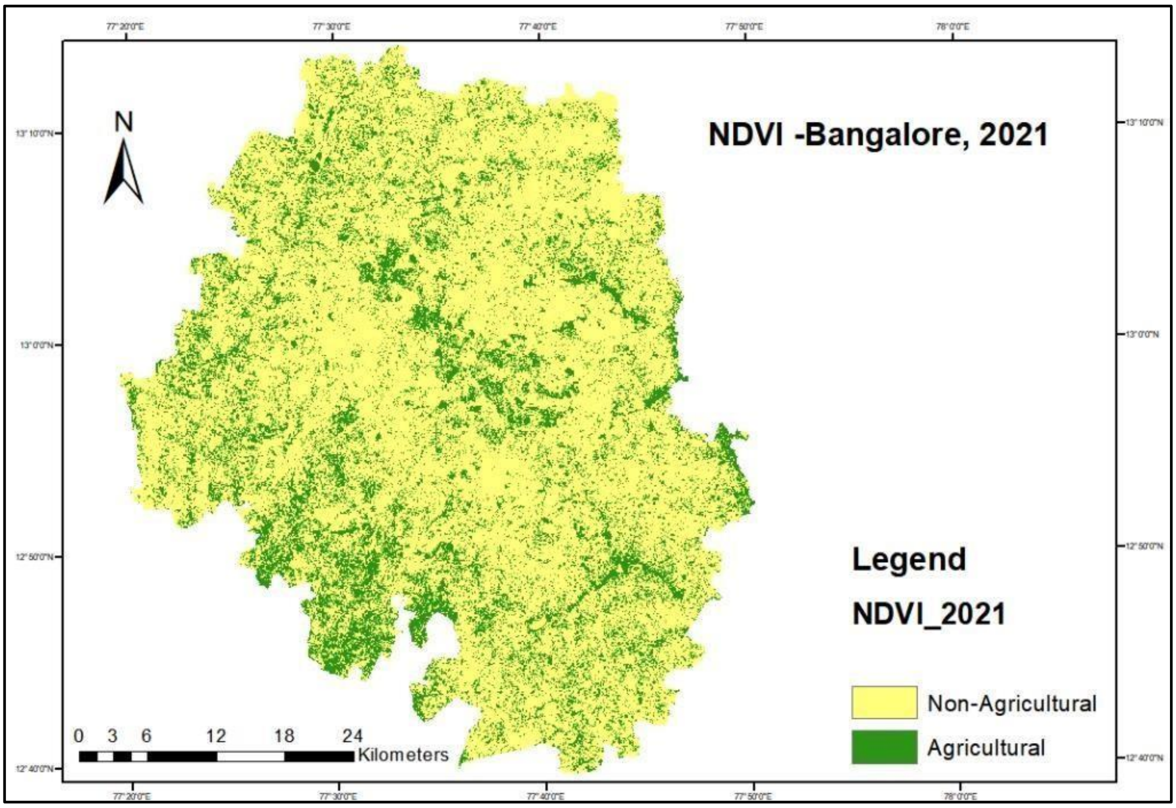
Land use type/Feature	Area Change (sq m)	Percentage change
Tree cover/Forest	-48475800	-14.24200999
Urban Area	409455000	89.69409965
Water body	-260100	-0.594564569
Arable land/Park	-360717300	-26.6178713

Table 1: Area change from 2001 to 2013

Land use type/Feature	Area Change (sq m)	Percentage change
Tree cover/Forest	-66002400	-22.61160735
Urban Area	138663000	16.01269625
Water body	-21185100	-48.71683431
Arable land/Park	-51477300	-5.176447377

Table 2: Area change from 2013 to 2021




NDVI -Bangalore, 2021
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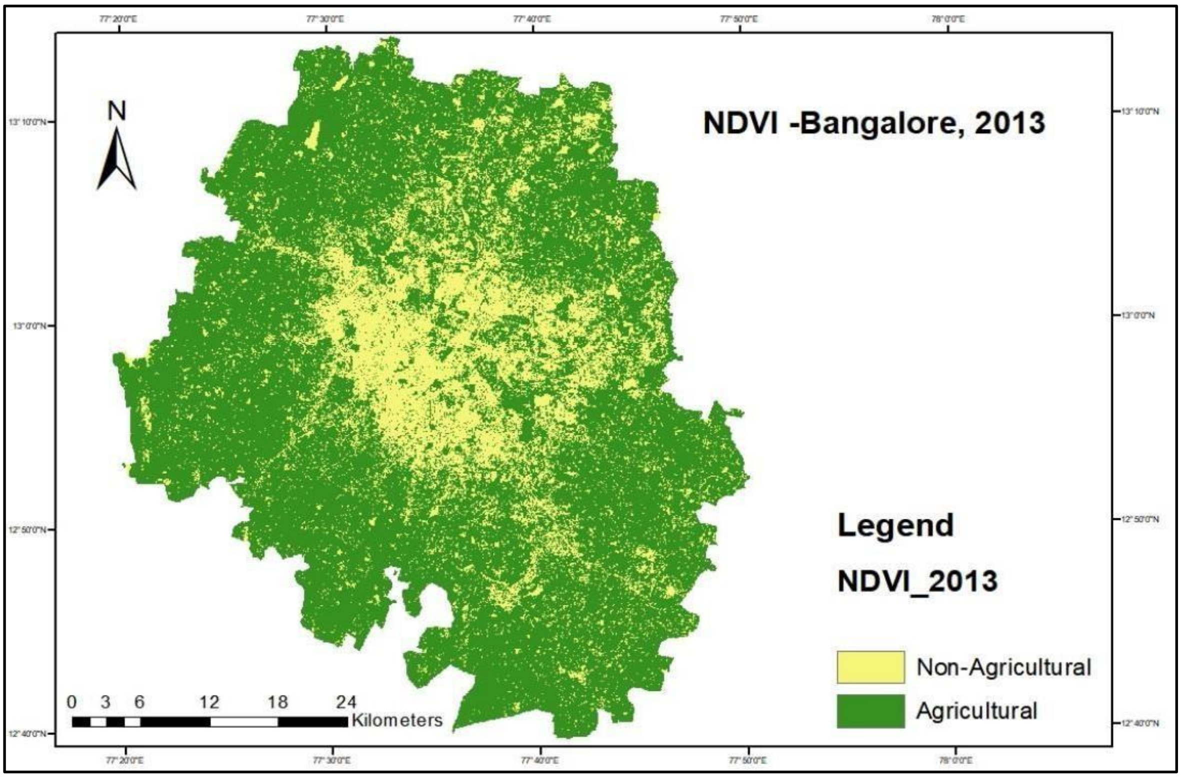
NDVI_2021
Non-Agricultural
Agricultural
0 3 6 12 18 24
Kilometers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Kilometers

Urbanization Affection Other Land use Types

- Between 2001 and 2013, a significant change was observed with the urban area displacing other features. Corresponding decline of water level extent is as a result of indiscriminate water use by households and dumping of industrial and household waste. Many farmers even sold their arable lands to industrialists and other people.
- Though the accuracy of both 2001 and 2013 images are decent with 90% and 87.5% features being classified correctly.
- Between 2013 and 2021, a similar change was observed with water extent decreasing further, much of which was as a result of Eutrophication, where minerals deposit on the water surface, making it look like an arable land from satellite image.
- This reason can be backed with the accuracy of the classified image, which is just 86%. Even much arable land is shown as an urban area.

Population Growth and Population Density

- Bengaluru district recorded a 47.18 per cent growth rate during the decade 2001- 2011. In terms of absolute number, the population increased by 3084427 persons during the decade 2001-2011.
- The density of population is defined as the number of persons per square kilometers. As such, the density recorded as per the 2011 Census is 4,381 persons per sq.km.
- At the taluk level, the density ranges between as low as 601 in Bengaluru South taluk to 977 in Anekal taluk.
- The decadal growth rate in urban areas is more than the rate registered in rural areas, which is 12.16 and 51.91 per cent for rural and urban areas respectively.

There are 3 reasons on which population growth depends:

1. Birth rate
2. Death rate
3. Migration.

Migration is the prominent reason for the increase of 3 million people between 2001-2011 in Bengaluru(urban). It became the prime reason for urbanization in Bengaluru (urban). This led to the change in the economic, social, and ecological life of Bengaluru.

Changes in Water Resources

Ground Water-Related Problems: Groundwater in terms of quality and quantity is the main problem to the district. In the urban area of Bengaluru district, the main problems affecting groundwater are:

a) Sewage pollution and Industrial pollution.
b) High Nitrate concentration in groundwater.
c) Overexploitation of groundwater resources.

This is further attributed to factors like urbanization which has increased rapidly in the last two decades paving way for commercial buildings, layouts and industries. The green cover, tanks and lakes have also diminished leading to depletion in water level. Rapid urbanization, IT boom, related economic activities, trade and commerce have exerted enormous pressure and this has increased the sewage waste into the lakes. Improper environmental planning has given room for the establishment of new residential layouts without a proper sewerage system and even if such systems have been provided, the same has not been connected to trunk sewers of BWSSB.

Factors Responsible for Population Growth

Limitations And Sources of Error

- Accuracy of classified images are 90%, 87.5%, and 86% for the satellite data. So, there are chances of feature mismatch which could affect the final observation.
- Data of Landsat-8 is from 2013 while accurate census data is available of the year 2011.
- Satellite image of 2021 is of summer season when crops are just sown, while the ones of 2001 and 2013 are of November when crops are almost matured.
- Although the topic is related to peri-urban areas of Bengaluru urban, such as Bengaluru rural and Ramanagara districts, we are taking Bengaluru urban since it has significant water and agricultural ecosystems within.
- Spatial resolution of 30 meters tends to loss of features at the expense of other features.

In the upcoming census of 2021, Bengaluru will become the **megacity** (i.e., population greater than 10 million). To control the population pressure andecological imbalance it is needed that other IT hubs needs to be developed to divert the inward migration in Bengaluru. According to the data of ***Census of India,*** Intrastate migration is more than Interstate migration and the major responsibility lies with the Government of Karnataka which can be the better local action for controlling the global challenge (i.e., Migration). For this government can develop their **smart city** project which will provideurban amenities to other districts of Karnataka like Belagavi, Davangere, Hubballi-Dharwad, Mangaluru, Shivamogga, and Tumkur. Between 2013-2021 there was reduction of -21185100 sq meter (48% reduction in this period) thus urban water bodies need to be protected from encroachment, this will result in recharge of ground water resources.

Major Findings

- Bengaluru district recorded a 47.18 per cent growth rate during the decade 2001-2011 The decadal growth rate in urban areas is more than the rate registered in rural areas, which is 12.16 and 51.91 per cent for rural and urban areas respectively.
- Between 2001 and 2013, a significant change was observed with the urban area displacing other features. Corresponding decline of water level extent is as a result of indiscriminate water use by households and dumping of industrial and household waste. Many farmers even sold their arable lands to industrialists and other people.
- Between 2013 and 2021, a similar change was observed with water extent decreasing further, much of which was as a result of Eutrophication, where minerals deposit on the water surface, making it look like an arable land from satellite image.
- Rapid unplanned urbanization near lakes led to decline of surface water extent and deterioration due to domestic

and industrial waste between 2001 and 2013.

- Complete disappearance of Bellandur and Varthur Lake and eutrophication by 2021.

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Geo-Spatial Analysis of Reverse Migrations in India during COVID-19

Amit Kumar

Abstract

In search of livelihood option, a huge number of people from employment deficient areas migrate to places offering job opportunities. The COVID-19 induced the reverse migration due to sudden closure or sudden lockdown across the nation. It deprived livelihood options for the people. During the period of COVID-19, millions of migrant workers were anticipated to be left unemployed in India due to the lockdown and subsequent fear of recession. Many of the migrant workers had returned to their villages. Thus, the worldwide spread of COVID-19 was attributed to reverse migration and mobility of people in India. Reverse migration refers to movement of people from place of employment to their native places. COVID-19 triggered migration in India which was the second largest mass migration in its history after the Partition of India in 1947, where more than 14 million people were displaced and migrated to India and Pakistan respectively, depending on their religious faiths. The present research is humble initiative to trace the size of reverse migrants and analyze the major areas of reverse migration in India during COVID-19. This research further provides some immediate measures and long-term strategies to be adopted by the government of India such as providing support to return migrants to reintegrate them, and also strengthen the database on migration and migrant households. In this study, the statistical and cartographic methods have been used to analyse and map the patterns of reverse migration across the states in India.

Keywords: Reverse Migration, COVID-19, Lockdown, Recession

Introduction

Epidemics not only pose a public health crisis, but often convert into an economic crisis and a migration crisis too. In epidemic conditions, a large number of internal migrant workers are trapped in cities after being laid off due to the measures taken by the government to control the spread ofthe disease. Most of these workers earn little more than a subsistence wage and have no othermeans to protect their incomes if they lose their jobs (Khanna, 2020).

COVID-19 has caused a major havoc in the economic sector, globally. The worst-hit is the poor and developing countries. India ranks 49 in the poverty index. As per the 2011 Census, nearly 22 per cent of India's population is poor. As per the World Bank report of 2012, 1 in 5 Indians is poor,with 80 per cent of the poor residing in rural areas. India is a vast country, and every year a substantial number of people migrate to larger cities of different states for seeking employment opportunities to earn bread and butter for their family (Mukhra et al., 2020). India has been in lockdown on March 25th, 2020 due to COVID-19. During that time, activities not contributing to the production and supply of essential goods and services were completely or partially suspended. Thousands of daily-wage workers suddenly found themselves without jobs or a source of income due to shutting of industries and were stranded outside their native places wanting to get back. So, with the looming fear of hunger, men, women and children were forced to begin arduous journeys back to their villages. But passenger trains, buses and flights were halted which should have carried them home (Stranded Workers Action Network, 2020).

This issue drew attention of the researchers when it was noted that after the announcement of the 21-day-country-wide lockdown due to COVID-19 in India, there was a sudden gathering of tens of thousands of migrant workers from across the city of Delhi, walking towards bus terminals to cross into Uttar Pradesh, Bihar and other states. They gathered in thousands being desperate to reach theirhometowns in adjoining states. With most transport links shut down, many were trying to walk hundreds of kilometers back to their rural homes with their families (Jha, 2020). The government, initially had stopped all the public transportation, and emphasized on ‘remaining at home, had to take the decision to allow people to reach bus terminals and city borders and arranged hundreds of buses into service. Further, the Central government asked State governments to take measures to prevent a mass exodus of migrant workers in the wake of the national lockdown. A mass departure of migrant workers from cities in several states to their villages raised concerns that the COVID-19 outbreak could turn into a humanitarian crisis.

Objective

The present paper attempts to analyse the regional patterns of reverse migration in India during theperiod of epidemic COVID 19. The broad objective has been divided into two, that is:

1. To trace the size of reverse migrants in India during the period of epidemic COVID-19.
2. To analyse the pattern of reverse internal migration across Indian states during the period ofepidemic COVID-19.
3. To analyse the measures taken by the Government of India for the migrant workers.

Research Methodology

The migration is motivated by economic reasons. On the other hand, reverse migration is motivated by epidemic reasons. The data required for the present study have been used from Chief labour Commissioner Office and reported in Lok Sabha, Rajya Sabha across India and state levels. To fulfill the objectives outlined above, statistical and various cartographic methods have been used. Due to data constraints, the analyses of the intra state migration streams and patterns could not be presented. The overall migration scenario in the Indian states which includes inter-state pattern onlyis presented.

Patterns of Reverse Migration in India during COVID-19: An Insight

Migration is the movement of people away from their usual place of residence, across either internal (within country) or international (across countries) borders. In 2011, 99 per cent of total migration was internal and immigrants (international migrants) comprised 1 per cent (Iyer, 2020). Internal migrant flows can be classified on the basis of origin and destination. One kind of classification is: i) rural-rural, ii) rural-urban, iii) urban-rural and iv) urban-urban. Another way to classify migration is: (i) intra-state, and (ii) inter-state. In 2011, intra-state movement accounted for almost 88 per cent of all internal migration (396 million persons).

Table 1: India: Volume of Out Migrants and in migrants, 2011

Sr. No	Name of State/UTs	Volume of Out Migrants	Per cent to total Migrants	Sr. No	Name of State/UTs	Volume of In-Migrants	Per cent to total Migrants
1	Uttar Pradesh	12,319,592	22.70	1	Maharashtra	9,087,380	16.75
2	Bihar	7,453,803	13.74	2	NCT of Delhi	6,330,065	11.67
3	Rajasthan	3,756,716	6.92	3	Uttar Pradesh	4,061,933	7.49
4	Maharashtra	3,068,231	5.65	4	Gujarat	3,916,075	7.22
5	Madhya Pradesh	2,979,492	5.49	5	Haryana	3,626,318	6.68
6	Karnataka	2,502,956	4.61	6	Karnataka	3,247,660	5.98
7	West Bengal	2,405,522	4.43	7	Madhya Pradesh	2,744,332	5.06
8	Haryana	2,315,915	4.27	8	Rajasthan	2,604,298	4.80
9	Andhra Pradesh	2,030,004	3.74	9	Punjab	2,488,299	4.59
10	Tamil Nadu	1,985,157	3.66	10	West Bengal	2,381,045	4.39
11	Punjab	1,740,877	3.21	11	Jharkhand	2,195,521	4.05
12	Jharkhand	1,704,827	3.14	12	Tamil Nadu	1,650,771	3.04
13	Gujarat	1,571,862	2.90	13	Andhra Pradesh	1,591,890	2.93
14	NCT of Delhi	1,556,308	2.87	14	Chhattisgarh	1,267,668	2.34
15	Kerala	1,291,325	2.38	15	Uttarakhand	1,250,575	2.30
16	Odisha	1,271,121	2.34	16	Bihar	1,111,954	2.05
17	Uttarakhand	993,570	1.83	17	Odisha	855,096	1.58
18	Chhattisgarh	693,632	1.28	18	Kerala	654,423	1.21
19	Assam	659,694	1.22	19	Chandigarh	633,966	1.17
20	Himachal Pradesh	535,823	0.99	20	Assam	495,699	0.91
21	Jammu & Kashmir	328,919	0.61	21	Himachal Pradesh	395,504	0.73
22	Puducherry	288,834	0.53	22	Puducherry	339,967	0.63
23	Chandigarh	265,645	0.49	23	Goa	269,689	0.50
24	Goa	106,196	0.20	24	Jammu & Kashmir	155,187	0.29
25	Tripura	85,862	0.16	25	Arunachal Pradesh	136,010	0.25
26	Manipur	75,751	0.14	26	Dadra & Nagar Haveli	135,602	0.25
27	Meghalaya	70,268	0.13	27	Daman & Diu	124,522	0.23
28	Nagaland	45,734	0.08	28	Nagaland	108,020	0.20
29	Arunachal Pradesh	37,368	0.07	29	Meghalaya	107,915	0.20
30	Mizoram	30,365	0.06	30	Tripura	87,378	0.16
31	Sikkim	21,459	0.04	31	Andaman & Nicobar	81,267	0.15
32	Andaman & Nicobar	20,700	0.04	32	Sikkim	61,163	0.11
33	Daman & Diu	18,906	0.03	33	Mizoram	41,380	0.08
34	Dadra & Nagar Haveli	16,635	0.03	34	Manipur	20,100	0.04
35	Lakshadweep	15,680	0.03	35	Lakshadweep	6,077	0.01
	India	54,264,749	100		India	54,264,749	100

Source: Census of India, 2011

Note: The figures are arranged in descending order

There is variation across states in terms of inter-state migration flows. According to the 2011 Census, there were 54.2 million inter-state migrants. As of 2011, Uttar Pradesh and Bihar were the largest source of inter-state migrants while Maharashtra and Delhi were the largest receiver states (Table 1). Around 12.31 million residents of Uttar Pradesh and 7.4 million residents of Bihar had moved either temporarily or permanently to other states. Around 9 million people from across India had migrated to Maharashtra by 2011. There are so many reasons for internal migration and size of migrant labour force (Iyer, 2020).

As of 2011, majority (70 per cent) of intra-state migration was due to reasons of marriage and family with variation between male and female migrants. While 83% of females moved for marriage and family, the corresponding figure for males was 39%. Overall, 8% of people moved within a state for work (21% of male migrants and 2% of female migrants). Movement for work was higher among inter-state migrants- 50 per cent of male and 5 per cent of female inter-state migrants. As per the Census, there were 45 million migrant workers in 2011. However, according to the Working Group Report on Migration, the Census underestimates the migrant worker population (Iyer, 2020). According to the Economic Survey, 2016-17, Census data also underestimates temporary migrant labour movement. In 2007-08, the NSSO estimated the size of India's migrant labour at 70 million (29% of the workforce). The Economic Survey, 2016-17, estimated 60 million inter-state labour migrants between 2001-2011. "Survival and Mobility in the Midst of a Pandemic" (2020) reveals that the magnitude of inter-state migration was approximately nine million annually between 2011 and 2016.

According to the Economic Survey, 2017, workers mostly from the states of Uttar Pradesh, Bihar, Madhya Pradesh, and Rajasthan migrate to states like Delhi, Kerala, Maharashtra, Gujarat, and Tamil Nadu in search of jobs. In cities, usually employed in menial jobs, they lead a precarious existence working long hours for low wages, often in poor working conditions and living in squalid surroundings. These include agricultural labourers, coolies, street vendors, domestic servants, rickshaw pullers, garbage pickers, auto-rickshaw and taxi drivers, brick kiln workers, construction workers, workers in small way-side hotels and restaurants, watchmen, lift operators, delivery boys, and so on.

The available data indicates a widely differing reality about migrants in India. Field realities do indicate that Uttar Pradesh (UP) and Bihar are the biggest source states of migrants, followed closely by Madhya Pradesh (MP), Punjab, Rajasthan, Uttarakhand, Jammu and Kashmir and West Bengal; the major destination states are Delhi, Maharashtra, Tamil Nadu, Gujarat, Andhra Pradesh and Kerala. Another marked change in the migration pattern in the last decade has been the interstate movement to new growth centres, especially in small and medium sized towns and million plus cities. However, the defining feature of who is a migrant is rather flexible, even in official records. Usually, the migrants do get defined on the basis of place of birth or last place of residence and a deviation from it. Hence, such a Characterisation puts severe constraint to understand the issue of migrants in this form of definitional context. Compounding the issue is another limitation in the analysis as the National Sample Survey Office (NSSO) as well as the census fail to capture the short-term seasonal movements, which form a large component of the migration process. Apart from the above, there are other issues too that relate to the problems of data (Dandekar & Ghai, 2020).

In a globalised world, the lockdown is likely to bring an unprecedented breakdown of economic and social system in India. Migrants are most vulnerable to declared epidemics. Realising the gravity of the problem, the government launched a new scheme, namely Migrant Workers Return Registration. This scheme's main motto is to count the number of daily labourers and migrant workers who got stuck in other states, as well as to provide them with 14 days of quarantine facilities and arrangements after they reached their hometowns. State governments across the country launched their portals and accumulated the data of their people (daily labourers and migrantworkers), so that they could be shifted to their hometowns easily.

Table 2: India: Number of Shramik Trains in Month of May, 2020

Sr. No	Date	Number of Shramik Trains forMigrant Workers	Total Passenger returned totheir home states by Shramik Trains (In millions)
1	1st May, 2020	4	0.0036
2	2nd May, 2020	10	0.014
3	4th May, 2020	21	0.062
4	6th May, 2020	64	0.18
5	8th May, 2020	66	0.33
6	10th May, 2020	101	0.54
7	12th May, 2020	104	0.79
8	14th May, 2020	145	1.20
9	16th May, 2020	167	1.64
10	18th May, 2020	181	2.09
11	20th May, 2020	279	2.73
12	22nd May, 2020	255	3.42
Total Trains Till 28 May, 2020		3840	5.2
Total Trains Till 31st August, 2020		4621	6.31

Source: Government of India. (2020). *Media briefing by chairman railway board on the action taken, preparedness, and updates during COVID-19 lockdown, 29th May, 2020*. New Delhi: Press Information Bureau. Retrieved from https://www.youtube.com/watch?v=mrcTWAjB2Wk. Parliament of India. Rajya Sabha. (2021). *Unstarred question no. 1061*. Delhi: Rajya SabhaSecretariat, *253*.

Table 3:India: State-wise Proportion of Passengers in Shramik Special Trains, 2020

Name of State/UTs	Per cent to total Passengers
Uttar Pradesh	42.2
Bihar	36.5
Jharkhand	4.8
Odisha	3.9
MP	3.2
West Bengal	2.3
Remaining States	7.1

Source: Government of India. (2020). *Media briefing by chairman railway board on the action taken, preparedness, and updates during COVID-19 lockdown, 29th May, 2020*. New Delhi: Press Information Bureau. Retrieved from https://www.youtube.com/watch?v=mrcTWAjB2Wk.

Table 4: India: Volume of Migrants Returned to Home States March-June, 2020

Organisation/Institution/Source of Information	Reported Date	Volume of Migrants (in millions)
Solicitor General of India	26 May, 2020	9.82
Chief Labour Commissioner of India	2nd June, 2020	2.61
Chief Labour Commissioner of India	16th July, 2020	9.38
Chief Labour Commissioner of India	29th July, 2020	9.89
Lok Sabha, Parliament of India	14th Sept, 2020	10.46
Rajya Sabha, Parliament of India	21st Sept, 2020	10.64
Rajya Sabha, Parliament of India	10th Feb. 2021	12.37

Source: Supreme Court of India. (2020). *Reportable: Suo motu writ petition (civil) no(s).6/2020.* NewDelhi, p2.

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A large number of buses were arranged for their interstate movement. In the month of May, 2020, total number of 3840 Shramik Special Trains were introduced for the relocation of 5.2 million migrant workers. The number of Shramik Special Trains differs from 4 to 255 per day in the month of May (Table 2). In Feb, 2021 in Rajya Sabha, it is reiterated that the Indian Railways introduced more than 4621 Shramik special trains for the relocation of migrant workers, tourists, pilgrims, students and others. The data of passengers travelled in Shramik Special Trains once again reiterated the data of 2011 census that Uttar Pradesh and Bihar were the largest source of inter-state migration (Table 3). Major Originating states of Shramik Special Trains were Andhra Pradesh, Bihar, Chhatisgarh, Delhi, Goa, Gujarat, Haryana, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Telegana, Tripura, Uttar Pradesh, Uttarakhand. While major destination states of Shramik Special Trains were Assam, Bihar, Chattisgarh, Gujarat, Jammu & Kashmir, Karnataka, Manipur, Odisha, Rajasthan, Tamil Nadu, Uttarakhand, Tripura, Uttar Pradesh and West Bengal.

Migrant workers constitute quite a large proportion of such vulnerable population. It varies from 2.61 million to 12.37 million populations (Table 4). In May 2020, the Supreme Court of India took suo moto cognizance of the migrant crisis that was caused due the COVID-19 lockdown. During the hearing, the Solicitor General stated that over 10 million migrants has been shifted. The regional variations of migrant workers reveal that more than 1 million workers of returned to their home state.

Table 5: India: Volume of Reverse Migrant Workers during COVID-19, 2020

Sr. No	Name of the state	Volume of Reverse Migrants	Sr.No	Name of the state	Volume of Reverse Migrants
1	Andhra Pradesh	32571	19	Lakshadweep	456
2	Andaman and Nicobar	4960	20	Madhya Pradesh	753581
3	Arunachal Pradesh	2871	21	Maharashtra	182990
4	Assam	426441	22	Manipur	12338
5	Bihar	1500612	23	Meghalaya	4266
6	Chandigarh	39230	24	Mizoram	8446
7	Chhattisgarh	526900	25	Nagaland	11750
8	Dadra & Nagar Haveli and Daman & Diu	43747	26	Odisha	853777
9	Delhi	2047	27	Puducherry	1694
10	Goa	85620	28	Punjab	515642
11	Gujarat	0	29	Rajasthan	1308130
12	Haryana	1289	30	Sikkim	33015
13	Himachal Pradesh	18652	31	Tamil Nadu	72145
14	Jammu & Kashmir	48780	32	Telangana	37050
15	Jharkhand	530047	33	Tripura	34247
16	Karnataka	134438	34	Uttar Pradesh	3249638
17	Kerala	311124	35	Uttarakhand	197128
18	Ladakh	50	36	West Bengal	1384693
Total					**12370365**

Source: Parliament of India. Rajya Sabha. (2021). *Unstarred question no. 1061*. Delhi: Rajya Sabha Secretariat, *253*

Table 5 and Fig 1 reveal that the highest number of migrant workers returned to their home state is recorded in Uttar Pradesh (3.24 million) followed by Bihar (1.50 million), West Bengal (1.38 million) and Rajasthan (1.30 million). While more than 0.5 million but less than less than 1 million migrants returned to their home state are recorded in the state of Odisha (0.8 million), Madhya Pradesh (0.75 million), Jharkhand (0.53 million), Chhattisgarh (0.52 million) and Punjab (0.51million). As compared to northern states, the number of migrant workers returned to their home states is less in Eastern States and Southern States of India. There is a significant belt from Rajasthan to West Bengal where huge number of migrant workers returned to their home after losing their livelihood in their destination states. Thus, it can be said that more than 10 million migrant workers returned to their home states during March-June including those who travelled on foot during the Covid-19 pandemic-induced lockdown. This number is very significant.

Measures Taken by the Government for the Migrant Workers

Some of the measures taken by the Government to address their grievances are mentioned below:

1. In order to resolve the grievances of migrant workers during lockdown,

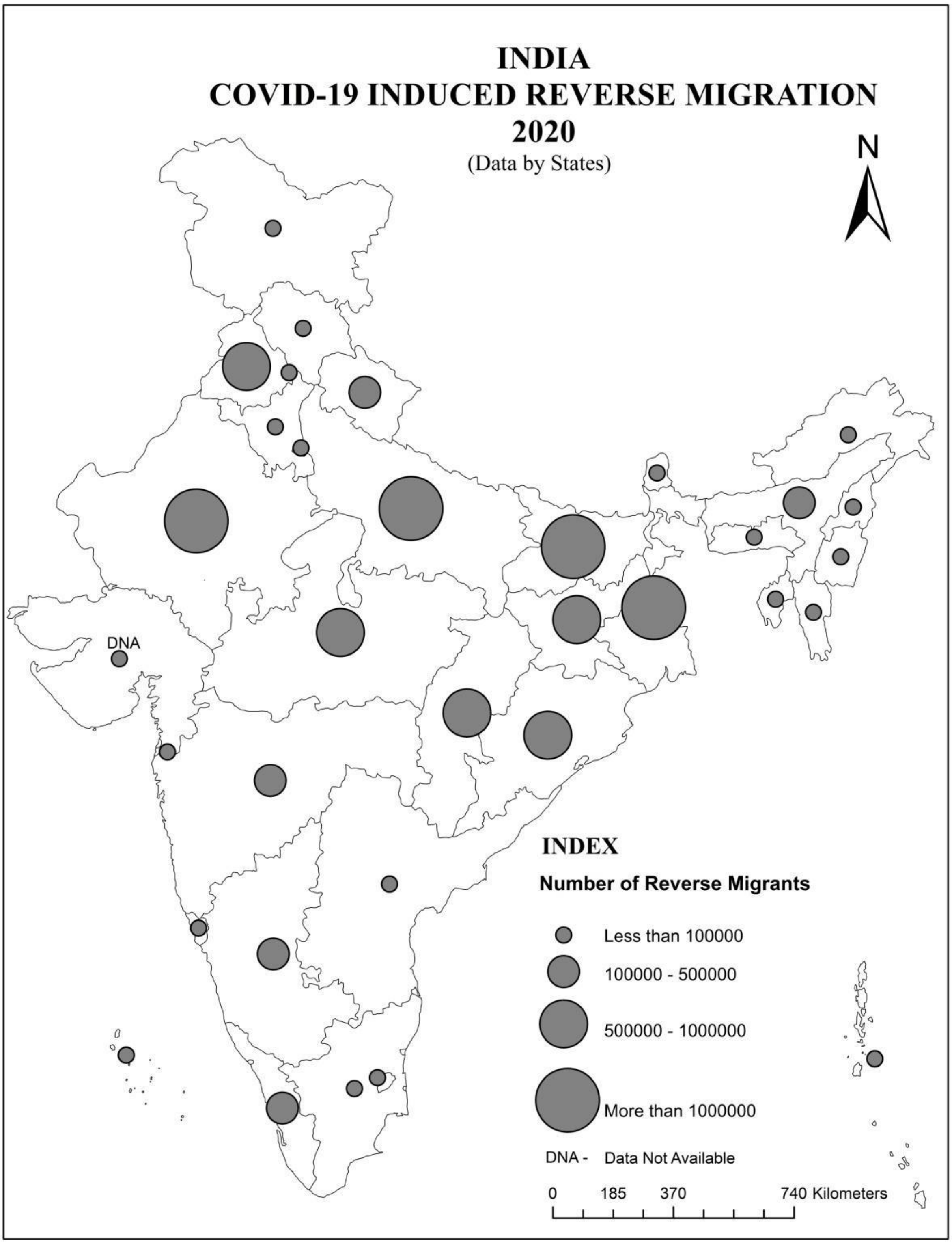

Fig 1

Source: Based on Data retrieved from in Rajya Sabha

Ministry of Labour and Employment set up 20 Control Rooms all over the country. During lockdown, more than 15000 complaints of the workers were resolved through these Control Rooms and due to the intervention of Ministry more than two lakh workers were paid their due wages amounting to about 295 crores.

2. Ministry of Labour and Employment issued advisory to the States/UTs and the Employers' Associations on 20th March, 2020 asking them to extend their cooperation by not terminating their employees, particularly casual/contractual workers from job or reduce their wages.

3. Indian Railways operated 4621 Shramik Special trains between 1st May and 31st August,2020 carrying 6.31 million passengers to their home states. These Shramik specials were organised as "Trains on Demand" as and when State Govt, requisitioned those trains. Special arrangements like enhanced sanitization, special security, medical arrangement, rake sanitization, free meals & water etc. were made for Shramik operations.

4. Ministry of Home Affairs issued order on 29th March, 2020 to States/UTs to ensure adequate arrangement of temporary shelters, and provision of food etc. for the stranded migrant workers and screening & quarantine facilities for those who reached their home states/towns.

5. Ministry of Home Affairs also instructed, in the same order, that the landlords of the migrant workers shall not demand payment of rent for a period of one month and not ask to vacate their premises.

6. In the same order, the Government instructed the industry, shops & commercial establishments to make payment of wages to workers, at their work place, on the due date, without any deduction, for the period of their establishments remain under closure during the lockdown.

7. About 800 million people have been provided 5 kg wheat/rice and 1 kg pulses, with a provision of free of cost food grains to all beneficiaries up to November, 2020.

8. Pradhan Mantri Garib Kalyan Rozgar Abhiyaan, Atmanirbhar Bharat, PM Svanidhi Scheme and Pradhan Mantri Garib Kalyan Yojana and such other schemes have been launched to specifically create employment opportunities for the migrant workers.

9. Ministry of Labour & Employment has also issued comprehensive Advisory Guidelines on 27.07.2020 to all the States/UTs for COVID-19 safety & welfare of the migrant workers returning to their workplaces in the destination states.

10. A Migration Commission is announced for the employment of migrant labourers. It would worktowards mapping the skills of these labourers. This Commission will focus on self-employment and setting up small-scale industries in villages. The Uttar Pradesh government too had announced a Migration Commission to provide jobs and social security to the workers returning to that state.

Conclusion

- The available data of Census 2011 indicates that Uttar Pradesh (22.70 per cent) and Bihar (13.74 per cent) are the biggest source states of migrants in India, closely followed by Rajasthan (6.92 per cent), Maharashtra (5.65 per cent), Madhya Pradesh (5.49 per cent), Karnataka (4.61 per cent), West Bengal (4.43 per cent), and Haryana (4.27 per cent).
- The major destination states are Maharashtra (16.75 per cent) and NCT of

Delhi (11.67 per cent), closely followed by Uttar Pradesh (7.49 per cent), Gujarat (7.22 per cent), Haryana (6.68 per cent), Karnataka (5.98 per cent), Madhya Pradesh (5.06 per cent), Rajasthan (4.80 per cent).

- COVID-19 triggered reverse migration in India. Almost 12.37 million workers returned to their home state during COVID-19.
- It was the second largest mass migration in its history after the Partition of India in 1947 where more than 14 million people were displaced and migrated to India and Pakistan respectively, depending on their religious faiths.
- The regional variation of migrant workers reveals that Uttar Pradesh (3.24 million), Bihar (1.50 million), West Bengal (1.38 million) and Rajasthan (1.30 million) show the highest number of returning migrant workers. These are the biggest source states migrants in India.
- On the other end of the spectrum, Ladakh, Lakshadweep and Haryana present the fewest number of workers returning. Gujarat did not provide any data.
- Health and medical facilities have also been provided and shelter home arrangements for food is also been made by the State Government. But it is harrowing, therefore, to note that at none of these states across the country did not feel the migrant workers "at home" or secure enough to stay on. That is why the reverse migration could not be stopped.
- The data of Chief Labour Commission released on 2nd June, 2020 revealed that Health and medical facilities have also been provided and shelter home arrangements for food were also been made by the State Government. But it is harrowing, therefore, to note that only 10 per cent migrant workers availed the facility of shelter home.
- The objectives and aims of the Migrant Commission at the national as well as state levels must take factors of migrant workers into account. Through the Commission, the states of origin must ensure that their citizens get decent work and are not forced to migrate and workin abysmal conditions.
- In meantime, destination states too must ensure that these workers are not made to feel like helpless "outsiders."
- The Commission may also work for the states having highest number of returning migrant workers such as Uttar Pradesh, Bihar, West Bengal and Rajasthan.

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Application of Cartographic Technique For Flood Risk Analysis of Atreyee River, Westbengal, India

Beauty Das

Abstract

Flood is an overflow of water that submerges land that is usually dry. It is a natural phenomenon that occurs commonly due to the overflow of water, heavy rainfall, etc. One of the World's most flood disaster-prone areas is the Indian Sub-Continent; flood here is a common annual feature in the Ganga-Brahmaputra-Meghna transboundary river system. One of the transboundary rivers like Atreyee, a part of this Ganga -Brahmaputra river system, is facing a big problem due to frequent floods. It creates problems when it inundate cultivated land and rural settlements. Every flood event causes damage and makes the life of people miserable. This paper aims at suggesting some ways and means for streamlining flood problems by using cartographic tools. The flood risk analysis of was done through scientific cartographic techniques by managing hydro-morphological data of the Atreyee river basin. The methodology adopted in this study is based on primary as well as secondary information including hydro-meteorology, morphology, topographical maps, satellite sensing data, and socio-economic data. In last 45 years, Atreyee river keeps on changing its course and bank lines. Spatio-temporal shifting of river channel is an important factor for the identification of flood hazards. After mapping the land use and land cover (LULC), rainfall zoning of the floodplain, and analysing hydro- morphological data, the study offers significant information to understand flood risk vulnerability for flood preparedness and management.

Keywords: Flood-prone areas cartographic techniques, hydro-morphological data, Spatio-temporal, vulnerability.

Introduction

Flood prone areas in India have been increasing dramatically with the rising of population growth. Official records reveal that nearly 42.5% of the land, in the state of West Bengal, are susceptible to devastative flood hazard each year and 22.1 million people are gravely affected (Rudra, 2001) as a result of it. The consequences of flooding include the direct damage caused by flooding and the indirect disruption to society, infrastructure, and the economy (Pender& Faulkner,2011). Floods sometime can be due to excess water carried over from transnational and inter-state borders. It can be said as an example that the most densely populated and the poorest areas in South Asia with the largest concentration of disaster-affected people due to high-intensity floods are located in the eastern part of the Indo-Gangetic Plains (IGP) (Muhammed et al. 2004). Major contributing factors to flood in the northern parts of West Bengal are the local monsoon run-off, discharge from upper river basin areas, and also the outfall condition in the neighbouring countries. The rivers (Atreyee, Punarbhaba) of the district Dakshin Dinajpur, originating in Bangladesh passes through this district and then join the River Ganges-Padma downstream in Bangladesh (Irrigation & Waterways Department). It is noted for all alluvial rivers that river channel change such as bank erosion, river bed accretion, and downcutting are common and natural processes and these incidents may increase the risk of bank erosion, flood, loss of agricultural land, nearby settlements, and developed infrastructures (Zhengyi et al. 2010). These hazards and losses can be prevented and reduced by providing reliable information to the public about the flood risk through flood inundation maps (Dimer,2015). Flood inundation maps are essential for municipal planning, emergency action plans, flood insurance rates, and ecological studies (Goodell & Warren, 2006).

Cartography is the science, technique, and art of filtering and compiling spatial data into map information and communicating complex spatial relationships and interdependences by advanced visualization techniques (Buchroithner et al,2019). Therefore, the benefits of such work are very much effective for the people living in the Atreyee River Basin (ARB) and governmental organizations to reduce flood risks in this study area. However, there is a close relationship between ecosystem for life and natural resources which are sustainable for livelihoods. Since the number of people living in flood-prone areas is increasing, the damages due to flood increase also. It will be a great benefit to the people to implement a flood management program that consists of flood risk analysis, vulnerability, and flood hazard mapping. In the present research, applying cartography helps to collect knowledge about hydro-morphological features of the study area as well as spatial information of landscape in two ways like erosion and deposition utilizing channel shifting for the last five decades. In this study, changing detection analysis is used to explain and measure the quantitatively spatiotemporal pattern of environmental changes of any region of the earth's surface (Das,2015). So, this study is very significant to identify such changes, and monitoring the changing detection with the help of computer-based cartographic technique flood risk of ARB can be systematically assessed to some extent.

Objectives of The Study

Flood hazard poses a regular risk to the life and property of people residing along with the ARB areas in Dakshin Dinajpur District in West Bengal in India. This paper aimed to identify and map areas of flood risk based on several factors that are relevant in the study area.

The present study aims to fulfil the following objectives:

- To explore some of the basic characteristics, causes and controlling variables of flood hazard in the Atreyee River Basin in Dakshin Dinajpur district
- To understand the spatial changes due to channel accretion and erosion with time by the application of GIS using remotely sensed data.
- To determine the flood-prone areas using cartographic technique in the Atreyee River Basin and low-lying areas of the river basin.

he study is carried out in the Upper Brahmaputra River floodplains, focussing on the district of Dhemaji, on the north bank he studies is carried out in the Upper Brahmaputra River floodplains, focussing on the district of Dhemaji, on the north bank

Study Area

The study is carried out in the Atreyee River Basin in Dakshin Dinajpur district, one of the marginal districts in West Bengal. The district Dinajpur is believed to have been actively developed by river Atreyee, Punarvaba, Tangaon, Brahmani, Yamuna, and their many tributaries. The Atreyee river is a part of the Sub-Himalayan river system; consists of a combined catchment area of about 8873 sq. km, which is connected with the Ganga-Padma river system downstream where flood acts as the main carrier of huge sediments and other fluvial deposits (Govt. of W.B. Annual Flood Report, 2016). The part of the study areas of the Atreyee River basin lies between 25^{0}10'N and 25^{0}30'N, and between 88^{0}40'E and 88^{0}50'E longitudes. The Atreyee River runs across in a north-south direction within this study area. The total length of the river is about 340 km, out of which 55 km is within the administrative areas of West Bengal which is selected for this study (Figure 1). It covers an area of about 262.65 sq. km.

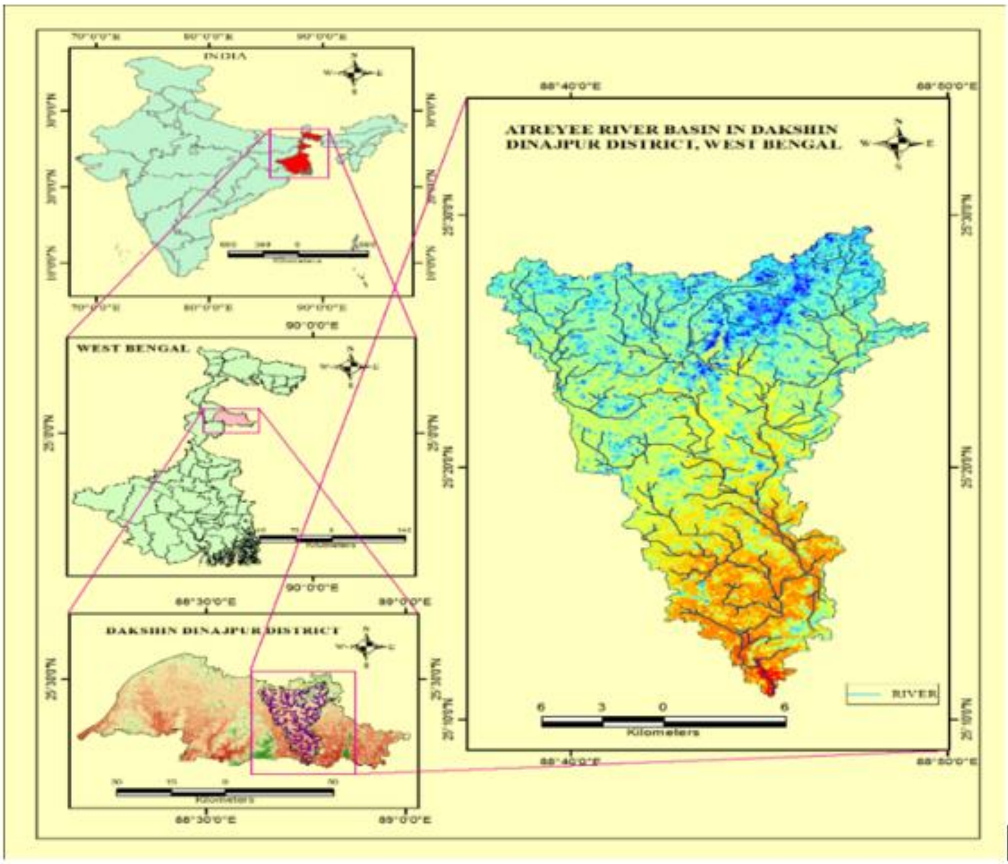

Fig.1: Location of Atreyee River Basin (source: prepared by the author)

Database & Methodology

The study is based on both primary and secondary data. Primary data was collected through field survey and observations, whereas secondary data was collected from various Govt., private, public, and semi-public institutions in the form of charts, maps, diagrams, documents, topographic data, socio-economic data, and satellite data.

The Topographical Maps 78C (1968-69) and & 78 C/11 (1972) of Survey of India, Satellite imageries-series of 7-band Landsat images at 30m resolution for the years 1973, 1987, 2002 & 2018 georeferenced in WGS-84 spatial reference system (the sensor of data are RBV, MSS OLI & TIRS) were used for analyzing and assessing flood hazard risk in ARB. Besides, other associated maps, including administrative map, geological map, geomorphological map, the population distribution was also studied. The methodology framework of this study is shown in Figure 2. It was carried out with a collection of necessary data in the Pre-Field stage and Field Survey stage for picking up the valuable information through field survey with designed questionnaires related to flood and local livelihoods of the people in the study area. In the third phase, post-field stage is carried out through different stages of data processing in the laboratory by using different cartographic, statistical, and GIS techniques to get the result. Finally, based on Hazard and Vulnerability analysis, the Flood Risk analysis was carried out.

Fig. 2: Flow Diagram of the Study -Research Framework(source: prepared by the author)

Physical Settings of The Study Area

The study of the geographical background of any region is important to understand the aquifer system. Physiography originally means the study of natural phenomena. The whole area is featureless, level plain, gently sloping in southward direction. The average elevation is about 25m above the mean sea level. Geomorphologically, the area can be categorized as a fluvial deposited alluvial plain that is composed of deposits on residual soils or highly weathered basement rock. The river Atreyee has been changed its course; its flat topography, heavy rainfall, geographical location, transboundary flows, and the impact of global warming including socio-economic and flood conditions have added to the complications in the ARB flood situation. The climate of this area is characterized by four seasons mainly. Firstly, the Pre-monsoon season extends from March to May, with high temperature and evaporation rates accompanied by thunderstorms. The monsoon season receives maximum rainfall; cloudiness and humidity extend from June to September. Rainfall induced floods occur during this period. The Post monsoon season is from October to November and is characterized by high heat and humidity with decreasing rainfall. Winter season is characterized by dry and cool weather during December to February. The climatic character of the study area have been shown by the graphical presentation of the Ombrothermic diagram (Figure 3). In

Dakshin Dinajpur, annual average rainfall is ranged between 1500 to 2000 mm. The floods in this area mainly depends on heavy rainfall in the North Bengal Hills and occur due to high discharge carried by streams in the upper catchment. It is observed that heavy discharge within a short period of time cause inundation and waterlogging in vast areas. This also leads to riverbank erosion that causes havoc to life and property in the low lying areas in ARB.

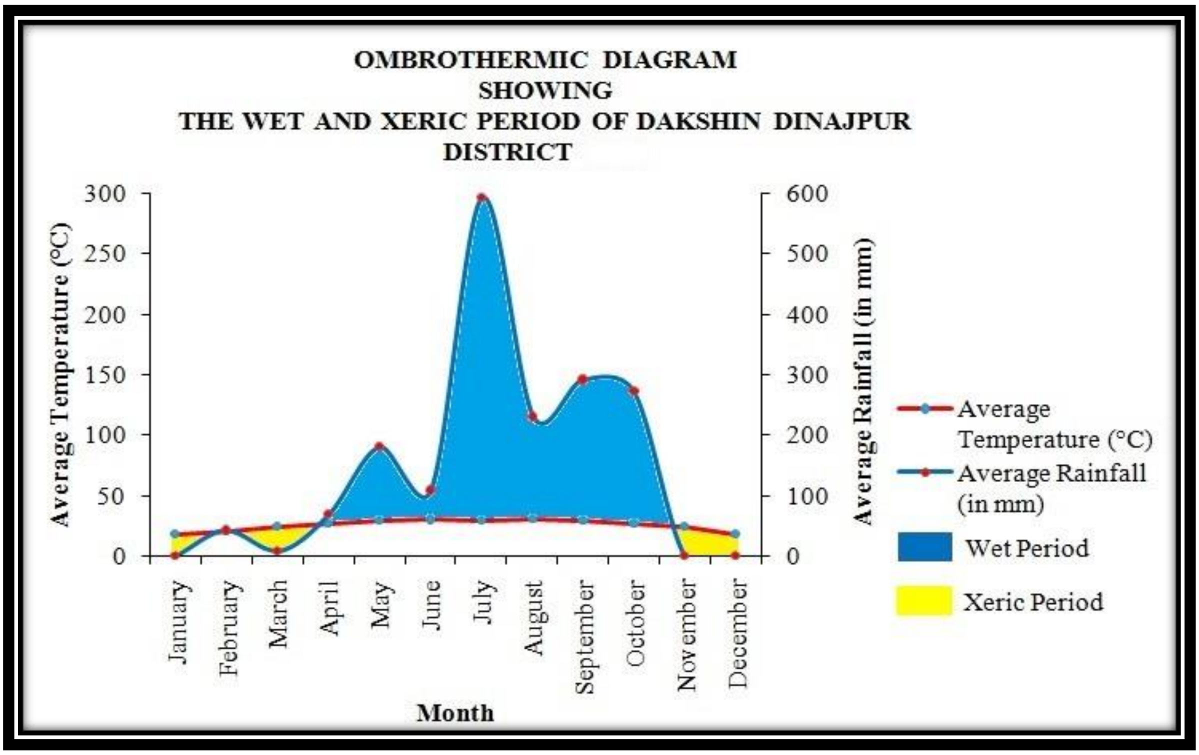

Fig. 3: Ombrothermic Diagram (2001-2020) of the Study area
(Source: Data-IMD, G.O.I., prepared by the author)

Discussion and Findings

To fulfill the aims of the study, flood risk analysis was conducted using hydro-meteorological and human-induced controlling variables in GIS. The Flood is considered to be associated with the accumulation of huge volume of water during the peak discharge period and meandering courses of the river Atreyee. It is observed that flood situation gets aggravated by anthropogenic drivers such as building activity, deforestation, land uses changes, and agricultural practices, etc. According to old records, severe floods occurred in the year 1978, 1987, 1988, 1993,1 999, 2001, 2005, 2008, 2013, 2017 and 2020 (Action Plan Control, Govt. of West Bengal). In this case study, it was found that floods are caused by one or more unfavorable and meteorological and physical factors (Khullar 2008). Almost 1025445 people were affected, 59473.790-hectare crops were damaged, 13 cattle were lost, 10 human lives were lost; 41123 houses were fully and 60599 houses were partly damaged in the district in the 2017 (Bengal Annual Flood Report, 2017). The following cumulative factors cause severe floods in the study area:

- Heavy Rainfall: It is observed that occasional heavy rainfall in the ARB catchment amounting to 500 -700 mm within a minimum of three-day period brings a big problem. It is found that comparatively high discharge of water coming from the upstream segments of Atreyee (Bangladesh) caused devastative loss of crops, human lives, and property in the monsoon period. It is very common in past flood hazards. The analysis of annual rainfall and the months having heavy rainfall shows that the gauge height of the river is increasing. With the help of the Scatter Diagram (Fig.4) based on annual average rainfall of the last 5 years, it is evident that a strong positive relationship between the Atreyee river gauge height (Balurghat & Kumarganj Stations in West Bengal). The degree of correlation is fairly high and the determination value is 0.6557. The value of the coefficient of correlation is 0.809760355 which shows a strong positive relationship.

- In Figure-5, the relation between channel flow and rainfall for September 2020 has been shown. It is observed that most floods in the study takes place during August and September.

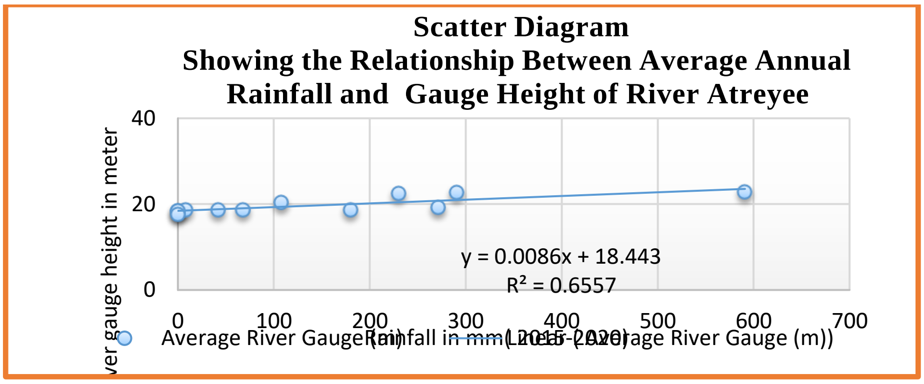

Fig. 4: Scatter Diagram (Source: Data-IMD, G.O.I., prepared by the author)

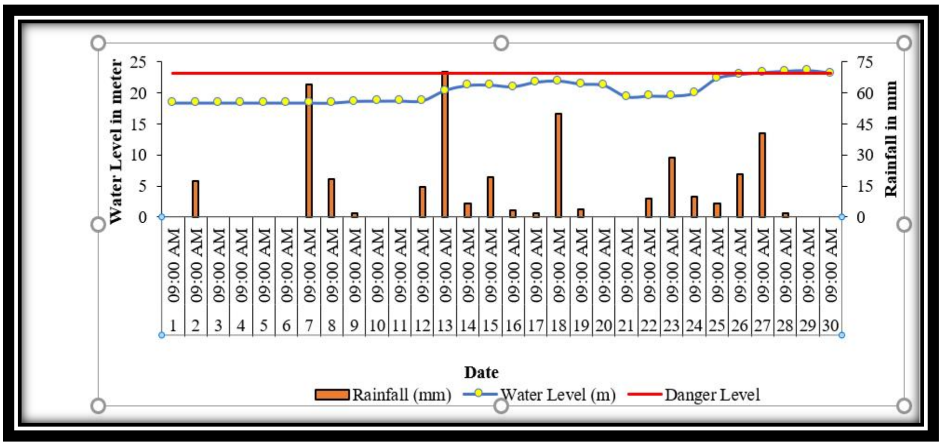

Fig. 5 Graphical Presentation of Relation Between Channel flow and Daily Rainfall: (Source: Irrigation Deptt., G.O.I., prepared by the author)

- Meandering course & river shifting: In the Meandering course, river, erosion take place on the outer parts of the meander bends where stream velocity is highest while sediment deposition occur along the inner meander bends where the velocity is low. Such deposition of sediment results in exposed bars called point bars. It is observed from field that many large longitudinal and transverse sand bars are formed in the river bed extending 30-105 mt. Shifting of the river channel is one of the relentless transformations of landforms that threatens the stability of channel which is also responsible for flooding ((Eaton et al. 2010; Rozo et al. 2014). The physical survey has been done at 23 different sites, cross profiles along the river are prepared and it seems that the base flow of the river is dependent on the alluvial deposits lying on the bed. At the same time, satellite image of the Atreyee River basin is used also to visualize the extent of lateral channel shift, river flow pattern, and its meandering course in this area.

Recorded data reveals that the entire course of old basin of Atreyee has been shifted and changed many times. A highly sinuous and meandering course obstructs the normal discharge of water and thus the velocity is reduced which delays the passage of water resulting in stagnation of water (Singh, 2021). River Atreyee obstructs its normal discharge due to its meander belts which are immediately overflown during the monsoon. In Figure-6, lateral channel shifting of both side banks of five different years has been presented for identification and analyzation the spatio-temporal changes of river Atreyee and it offers significant information to understand the future synoptic view of this river course change. During last few decades, the Atreyee River has been attempting westward push thus causing breaches in left embankments. It is found that the shifting has been taking place due to erosional and depositional activities within the river course. Sites like Safanagar, North Kumarganj, Gopalganj, Kureha, Belterra, and Patiram Prasadpur situated on the left side are found to be highly erosive than the right sides.

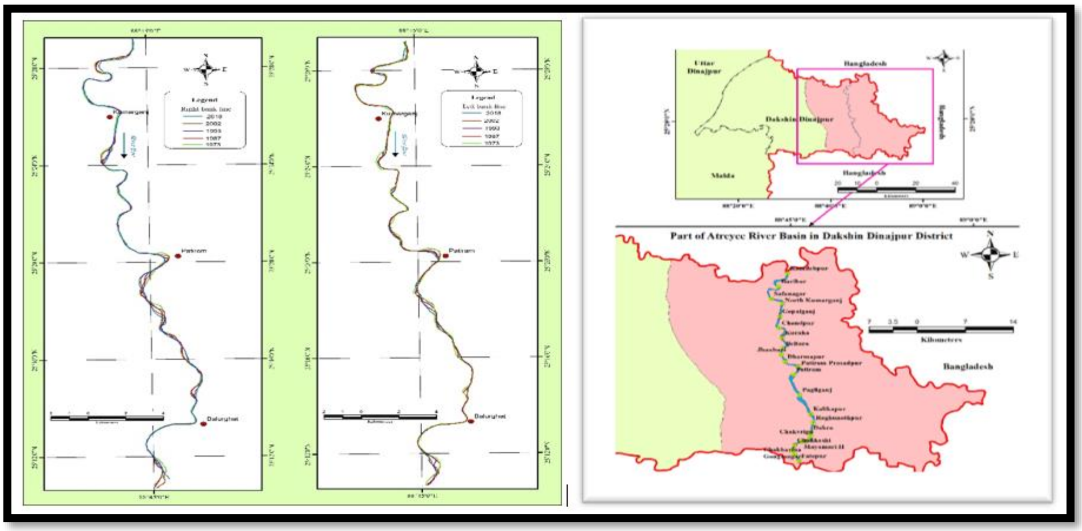

Fig. 6: Lateral channel shift of Atreyee between Kamdebpur (upperside) & Fatepur(downstream)West Bengal, in the year 1973, 1987, 1993, 2002 & 2018

(Source: The author)

From the field survey as well as statistical analysis, topographical analysis, and a cross profiling of all sites on both banks, it is observed that human-induced activities has influenced the channel flow pattern as well as shifting of river course in last few decades in the ARB.

- Population Growth and Human-induced Activities: To understand flood risk, one has to understand the different components of flood hazard and their interrelationships to make informed decisions. The alteration of physical environment, be it through natural processes or human activities, always has some negative impacts. Floodplains are usually very fertile agricultural areas as floods carry nutrient-rich silt and sediment that is distributed across a wide area. It is observed that spatial-temporal pattern of environment and land-use change in flood-prone regions has taken place and such landscape ecology helps to examine how water bodies, forest cover, exposed fallow land, etc. has been converted into agricultural cropland and settlement build-up areas area. From the change detection analysis, it is clear that anthropogenic activities such as building, manufacturing units, channel manipulation through the diversion of the river course, construction of bridges, embankments, agricultural practices, and deforestation, etc. are significant factors of flood risk in the river basin. The study of change detection is used here to explain the spatio-temporal pattern of environmental land use land cover changes due to channel accretion and erosion with time in the study area during past few decades (1973 & 2018). In Figure 7 the map of LULC of the study area has been shown and on the other hand, the year-wise land uses classes data is presented in Table-1. Remarkable changes has taking place in forest cover, build up areas and agricultural land. In the year 1973 the area of forest cover was 220.581 sq.km and it got reduced to 55.5642 sq.km in 2018 due to several anthropogenic activities.

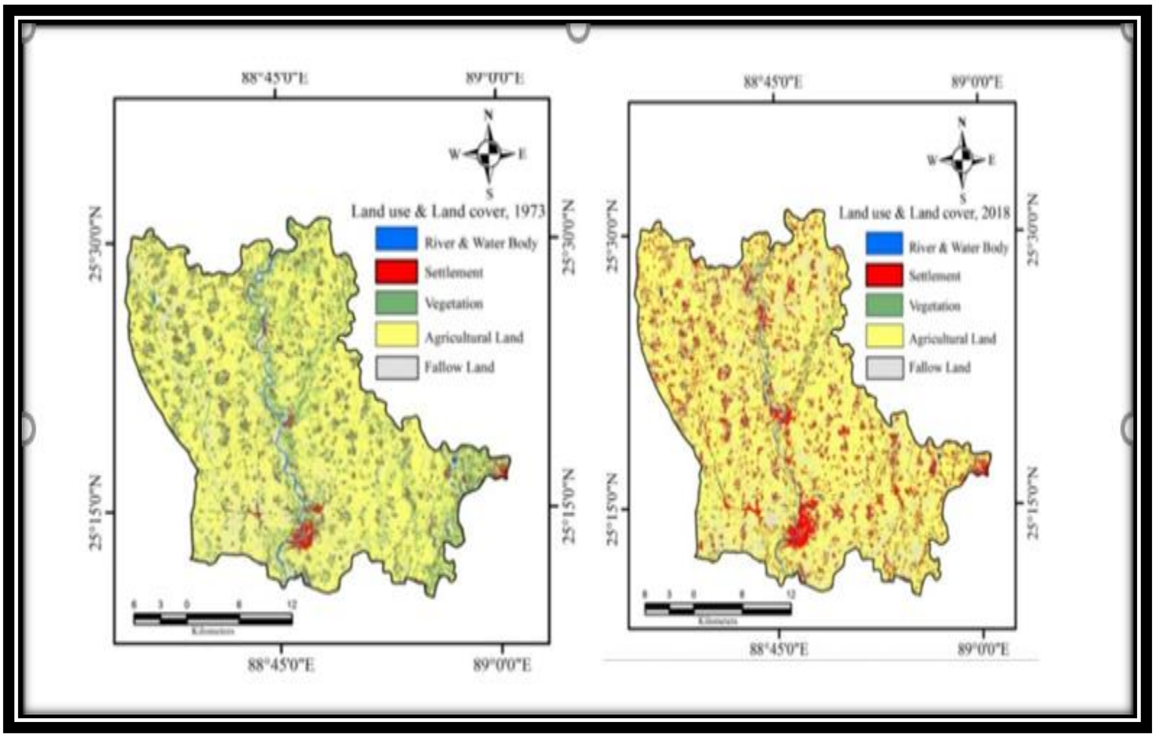

Fig. 7: Map showing Land Use & Land Cover (1973 & 2018 , Source: The author)

1973			2018		
Land-use type	Area Sq. Km.	Area in %	Area Sq. Km.	Area in %	Difference in %
Waterbody	19.1763	2.04	25.7949	2.74	+2
Settlement	39.609	4.21	118.521	12.61	+24
Forest	220.581	23.47	55.5642	5.91	-49.5
Agriculture	597.3984	63.57	677.5893	72.10	+24
Fallow	63.0531	6.71	62.3484	6.63	-0.5
Total Study Area	939.8178	100	939.8178	100	100

Table 1: Table showing the change of areal coverage of different land-use types(1973 &2018) (Source: The author)

Irregular Dredging of Kharies: The irregular dredging of deposited sedimentation from the river adjacent kharies is another important factor of flood occurrence in the study area.

- Faulty agricultural Practices and Deforestation: It is observed from that unchecked population growth not only brings gradual expansion of settlements towards the channel as well as low-lying areas but also helps in increasing deforestation and faulty agricultural practices. These all have a direct impact on flood occurrence in the riverine belts.

Flood Risk Analysis

Flood risk may be generally termed as the possibility of losses, in life, health status, livelihoods, all types of property, and at the same time the consequences that influence local community in the river basin areas. So, the determinants of flood risk are hazard characteristics multiplied by vulnerability and divided by the coping capacity.

Flood Risk = Flood Hazard characteristics X Vulnerability /Coping capacity

Flood hazard characteristics in the study area are refereed to nature of flood frequency, flow and velocity, inundation period, and a maximum height of water level in the river surrounding areas and locality. On the other hand, vulnerability indicates consequences that may be produced due to the damaging effects of flood. There are several types of vulnerability, arising from various physical, social, economic, and environmental factors. Coping capacity is the ability of community people by using available skills and resources to face and control flood hazards. The capacity to cope requires continuing awareness, resources, and good management, both in normal times as well as during hazard periods. Regarding this study, the characteristic of housing that is kachha, Semi-pucca & Pucca are found in study area. Kachha house is more vulnerable to floods.

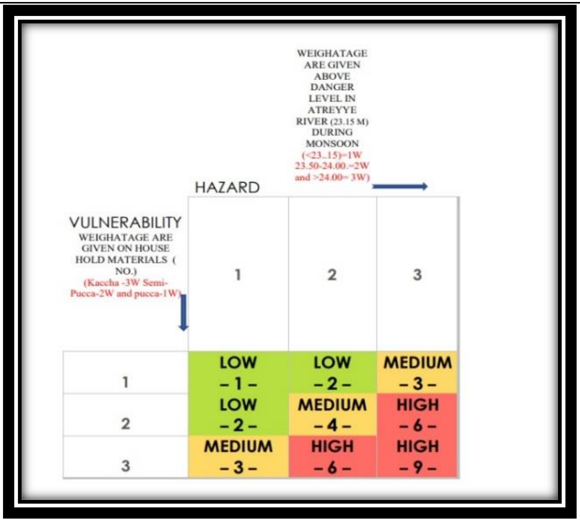

Fig. 8: Flood Risk Matrix

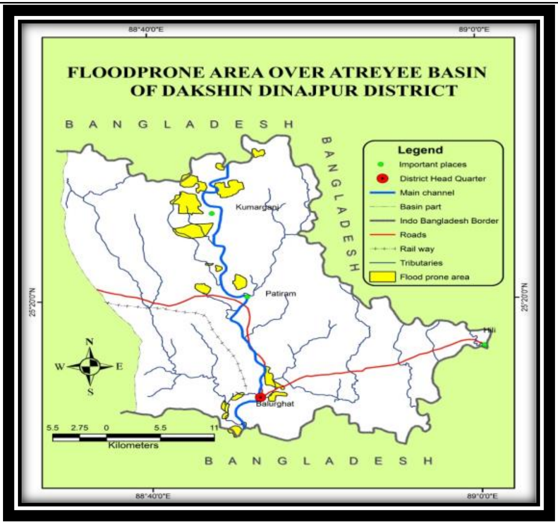

Fig. 9: Map showing Flood Prone Areas

A Flood Risk Matrix based on only two components (weightage value of Gauge Height during monsoon and building types) from field survey data is prepared to show the different zone of flood risk in the study (Ffigure 8). Based on rainfall pattern, water level height, damage records of the last 20 years the flood-prone map has also been prepared (Figure 9).

STRATEGIES: The main objective of the policy of risk reduction is that people living in ARB areas are better protected from risks of disasters and cope with the consequences of flood disasters. The strategies to reduce the risk are following:

1. Effective risk reduction projects should be identified and implemented
2. Improved community capacity in dealing with flood disasters and risks supported by effective, integrated, and people-focused early warning systems to ensure people receive timely warning
3. Increased analysis and evaluation of hazards, vulnerabilities and risks
4. During hazard situations food security should be strengthened and it can enhance community-based disaster reduction initiatives
5. Policy, effective planning, response, and decision-making frameworks are to be strengthened at all levels of Govt.&Non-Govt. organizational, institutional, etc.

Conclusion

It can be concluded that flood risk management is a multi-disciplinary area, covering a wide range of monitoring, evacuation, search and rescue, relief, reconstruction and rehabilitation. Therefore, the identification of erosion prone areas along the Atreyee River through regular monitoring is much needed. Based on this study it can be said that flood risk alysis is a better mitigation tool than flood control. Historical river discharge records alone are not enough to determine flood trends because of factors such as human modification, rechannelling and other changes in river hydraulics as well as increasing sedimentation of riverbeds from deforestation, agricultural activities and other non-climatic factors such as river dredging. All these activities have an effect on the flow regime and river levels (McGuine et al., 2002).

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Morphological Features During Anthropocene of Chilika: India

Kumbhakarna Mallik

Abstract

Escalating pressure due to the combined effects of growth in population, economic development, demographic shift and global climate change poses unprecedented threats to sandy beach ecosystems worldwide. The sandy beach is the representation of a transitional zone between oceanic and terrestrial environment, which always in motion and frequently changes its landform. Conservation of beaches as functional ecosystems and protection of their unique biodiversity requires management interventions that not only mitigate threats to physical properties of sandy shores, but also include ecological dimensions. The coast of Chilika is the conjoint place consists of 860 Ridge with the northern end of the EGB Hills. As a result, the offshore precinct is of shallow zone. It is observed that the coastal topography along the coastline is influenced by wave, tide, wind, and littoral drift, from sea ward. The land ward forces are inland silt transport and water by which deforms the coast and coastal landform and vegetation at uniform interval of time. So, understanding beach morphology with associated physical processes, their variability in spatiotemporal scales is very important for effective inlet management and also conservation of the lagoon ecosystem. The present study is undertaken to understand beach morphological changes in Chilika and the study is a retrospective of some other researchers carried on morphological features of Chilika. The statistical data collected was based on the secondary data which are available in several international and national journals, FAO database, Government gazettes, annual reports and information gathered from authorities in and around the Lake. However, the scientific data and erstwhile information is based on laboratory analysis, personal questionnaires, and local literature related to my study. The findings of this paper will provide baseline data that can facilitate the long-term monitoring of Chilika and its stability.

Key words: Ecosystems, Morphology, Spatiotemporal, Conservation, Demographic

Introduction

The Odisha Coastal Plains are the sedimentary landforms of recent origin and stretch from Subarnarekha in the North to Rusikulya in the South. They geologically belong to thePaleogene and Neogene ages, approximately 65 to 2.6 million years ago. Their western boundary is at around 76 meters Eastern Ghats and they have a nearly straight shoreline in east. They are narrow in the north, widest in the middle, broad in the south and narrowest in the lake Chilika coast. The coastal plains are the gift of six major rivers. They bring silt from their catchments and have reclaimed this area from the depths of the Bay of Bengal. Chilika Lake is the largest brackish water lagoon in the Subcontinent along the east coast of India andsecond largest lagoon in the world. Geological data evidenced that the coastal lagoon was part of Bay of Bengal during the later stages of the Pleistocene period. The Lagoon enjoyed tropical climate, burgeoning demography and was running with wide-ranged fiscal growth in past with port, and harbour activities. Coastal environments represent the defensive and most dynamic in terrestrial systems undergo several transformations because of frequent exposure with winds, tides, waves, relative sea level, and high freshwater river discharge. The wave transformations, with its asymmetry caused by interaction with bottom sediment in and around the near shore zone determine the degrees of beach morphology. It also acts as one of the important factors for migration of inlet [1, 2]. The sediment which is bypassing through the tidal inlet and also alongshore sediment transport near coastal lagoon makes the adjacent beach more and more complex [3, 4]. Due to the periodic extreme phenomenon plays a crucial role in the important change in beach morphology. Erosion and coastal accretion are two opposite physical processes in the annual morphological development of beach environment. These changes in morphology may be considered as either addition of sediment resources or withdrawal or of sediment resources because of the activity due to wave, wind, and tide. Presently the lagoon users are running under marring economy, impairing food and water security. It is also facing numerous meteorological extremes and has problems of sedimentation, diminutions and weed infestation. Severe stress on its biome has led to biodegradation, ecosystem services depletion from 1980 to till date. Several studies have been made along the world coastline, among which a few studies are quite relevant to the present study. Long-term and Continuous observation of beach profile would be of immense help in evaluating the accretion and erosion status and longshore sediment transport alongthe coast, which, in turn, would be helpful for successful implementation of the coastal management plan.

Study Area

The Chilika (19° 28′−19° 54′ N and 85° 05′−85° 38′ E), largest brackish water estuarine Lakeof Asia, separated from Bay of Bengal (BoB) by barrier spit starting from Palur Hills(Rambha) to Village Motto (64.3km). The average water spread area of the Chilika lagoon has contracted gradually from 1045 sq. Km. in early 20th century to 770 sq. km. The coastal stretch is reduced from 71 km to 64.3 km during early 21st century, Ghosh A. [20] and Mishra SP. [18]. The pear-shaped wetland has declined its maximum and minimum depth from 4.88m-0.6m [19] to 1.42 m to 0.42 m in monsoon and summer (1995-1996). The barrier spit is stable for 33.3km from south having width 3 km to15 km with densely habituated. The balance 31 km towards north has variable width from 0.15 km to 1.5 km .It isnarrow, dynamic, fragile with all inlet dynamics, path for salinity, sediment transport with mangroves, sand dunes, and, few fishermen hamlets. It is divided into four sectors depending on its water quality, distribution of biotic components and fishery yield, such as Northern Sector, Central Sector, Southern Sector and Outer Channel. Northern Sector receives most of the branches of Mahanadi out of which Daya river is the most important one. Fisheries constitute the most important economic activity of the Chilika Lake, which supports livelihood of 0.2 million local fisher folk.

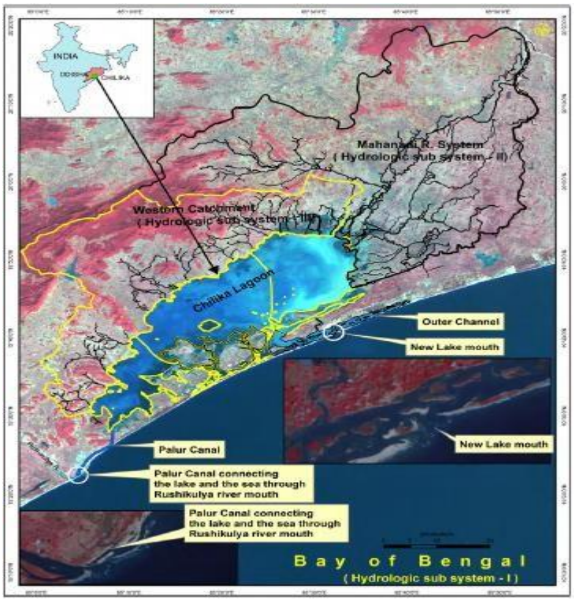


Fig (1) Chilika Lake, With river systems and the Bay of Bengal. Fig. (2) Index map of Chilika during Anthropocene.

Review of literature

The Chilka Lake forms too material a feature in the geography of Orissa, to be passed over unnoticed. The post Holocene research works were scanty and were mainly based on history, Sterling et al. [6]. The dimensions of the lagoon recorded to be 1165 Sq. Km during high floods and 906 sq Km during summer with 71 km coastal length with maximum width of 30 Km [6]. Hydrographical condition of the Chilika lagoon is greatly influenced by sea water intrusion and freshwater influx from the catchment basin. Due to an array of physical processes taking place together, this lagoon environment becomes more dynamic and there exists a greater degree of salinity variations.(13) The sediment inflow through the south Mahanadi deltaic rivers shows that the Chilika Lake is downsizing both in area and depth due to anthropogenic activities and sediment entry from Mahanadi system. The causes are disparity between sediment inflow during monsoon and tidal ingress during non-monsoon period. (14) The foremost environmental threat to the Chilika Lake is pollution. Addition of biodegradable and non-degradable pollutants is in an ascending order because there is no suitable waste management action plan in and around the lake as well as for the urban area wastes which find their way into this lake. Higher levels of heavy metals and pesticides in water and sediments have been reported in recent years (11). Anthropocene studies of geomorphology of coastal systems was originated by Pritchard D. W. [21], by defining inland ocean connected systems like lagoons, estuaries, Fjords etc. The tidal inlets formation occur under high energy and constrict the coastline due to asymmetrical sediment transport at the estuaries head or drowned river valleys with growth of spits and barrier islands, Fitz Gerald et al. [22], Mishra SP. [7]. The closing and opening of tidal inlets in the barrier spit of the lagoon take place by wave action, sedimentation and littoral drift

Mishra SP. [8]. The Chilika lagoon was declared as a Ramsar site number 229, on 1st Oct., 1981, based on Zoological survey report of India 1985-87, placed in IUCN red list in 1993 for its biodegradation and vulnerability of conversion to a sweet water lake, during the golden spike period of the anthropogenic. Sediment bypassing occur due to wave dynamics near the flood/ebb delta complex, tidal influence and migration of islet complex within the channel [23].

Objective

The objective of study is to probe the climatic, on the lake dimensions, ecosystem disparity, salinity, and migration due to economic disproportion during both the pre-anthropocene (1945-1980) and great acceleration period (1981-till date). To suggest some ameliorative measures are to be taken considering threats to the Chilika during early 21st century for defensible and efficient management interventions

Materials and Methodology

This study is based on both primary and secondary data. The base map has been prepared from the Survey of India Topographical map (Topo Sheet), Sheet Nos 64P/13 on Scale 1:50,000 and Open Series Map (OSM) sheet No. F44X13 prepared by Odisha Geo-Spatial Data Center (OGDC) with reference to the new village maps of Chilika Development Authority. For detail study, Topographical maps sheet Numbers 74E/1,74E/2, 74E/3, 74E/5, 74E/6, 74E/9,73E/10, 74E/13 were also collected and utilized to determine the local catchment area of the Daya River, Bhargovi River and other rivers basins and drainage channels debouching to the lagoon. The base TEXAS SURVEY map of 1930 of the same scale is collected and geo-referenced. Comparisons were made with the water spread, forest area between the pre and post anthropocene. The IRS P6 LISS III (1999) and the IRS (Resource-sat 2) and Quick-bird satellite imagery (2013) are downloaded for geo-referencing and detail study. Geo-referenced data are digitized and layers are provided with the helplatest software of Arc Map 10.1.

Results

The Recent Anthropogenic Concerns

From 1950 onwards after Bhubaneswar became the new capital of Odisha the South Mahanadi delta (SMD) is under urbanized with many townships and industries. Due to growth of different institutions like educational, livelihood, tourism, healthcare and transport *etc* many settlements are grown up to accommodate the steep rise in population from the year 1960, along with marginalization of fisher folk and migration from other areas of the state including other states. Construction of Mahanadi Delta stage II and barrages in Mahanadi delta system have converted the flood prone areas to agricultural bumper zone have converted the flood prone area to agricultural bumper zone. The anthropogenic activitieson water, land and ecosystem has transformed many fallow lands and swamps to agricultural land or settlements. The effluents and liquid wastes from thickly populous areas from urban and industries have contaminated regularly the drains, coastal aquifers and the river runoff too. The ground water gradually over exploited to augment the productivity. Therefore, resulted in salinity intrusion of inland aquifers. During summer months the water of the RiverKuakhai is turned off as unfit for human use. More than 50% of the total areas are under cultivation with subsidiary livelihood as fishery. About 50% of the total areas coconut farming in the Chilika and its local Mahanadi basin reported by SREP (ATMA) of Puri District, 2007-08. In the various sectors like Industries, tourism, township with irrigation as well as ameliorated connectivity have curbed the life of the rain fed and water-loggedagricultural workers. They have also engaged themselves for their livelihood activities in developing profitable small scale industrial activities and agriproducts instead of orthodox fishing and farming.

Morphological features during Anthropocene

Changes in landform

The sandy beach areas represent a transitional zone in between oceanic environment and terrestrial, is always in motion and also frequently changes its landform because of the exposure to ocean waves, wind, tide, and river discharge.

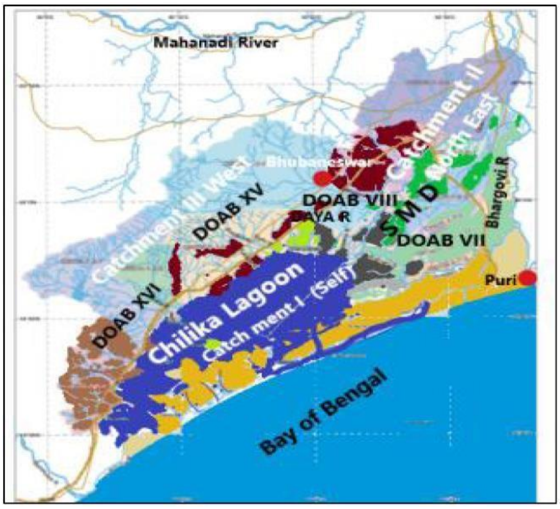


Fig. 3 (a). The 3-D view of the Chilika local catchment Fig. 3(b). Isolating doab wise of the Chilika local catchment (Source modified: http://hdl.handle.net/10603/165773)

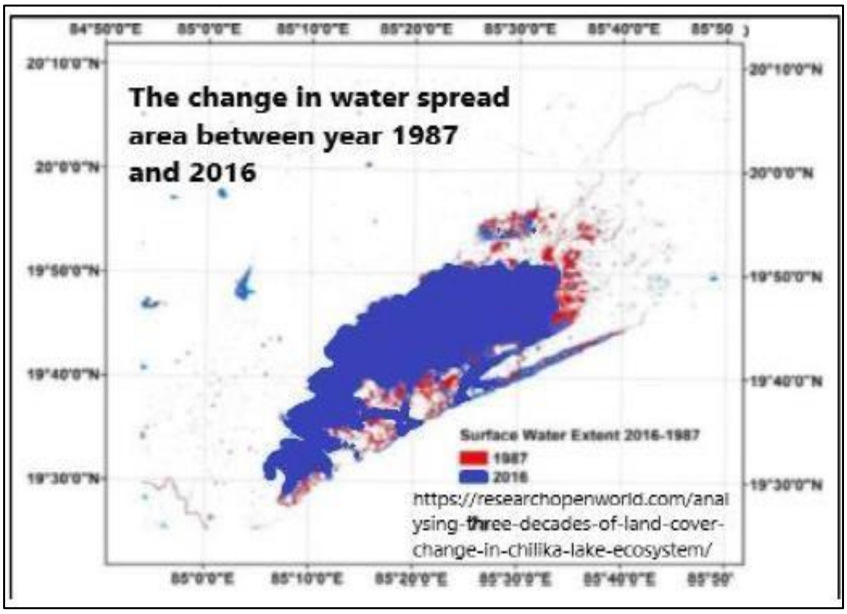


Figure 6. The Change in water spread area of Chilika between 1987 and 2016 (Red)

Coastal topography along the coastline

The Chilika coast is the conjoint place of 850 Ridge and the northern end of the EGB Hills.So, the offshore precinct is of shallow zone. The coastal topography along the coastline is influenced by wind, wave, tide, littoral drift, from sea ward. The land ward forces are water and inland silt transport which deforms the coast and coastal landform and vegetation regularly. The main geological landforms that transforms are: the spit, Barrier Islands.

Bars in the swash zone

Barrier islands or bars in the swash zone are adjacent to coast has developed the beach. They are always fragile based on the actions of wind, waves, tides, and sediment supply. After formation, growth, and attaining stability (whether submerged or emerged), these bars resist the wave action from both the lagoon and sea side of the Chilika. They are constructed due to deposition of sediments from inland or through longshore drifts under low gradient in front of the TIs [25]. Such bars are found along the mouths of past tidal inlets to the Bay of Bengal coast line from Parikud (southern end of the Chilika) to the southern end of SMD.

The spits

The spits are curved towards the land at their extreme end like hooks. The northerly longshore drift of sediment across the Chilika coast, there is accretions and depositions across the shoreline when reaches a bay or form a bend along the seaward shore front. In case of Chilika the main spit is attached to lands of Palur hills near Rambha. The spithad extended up to the Harachandi Temple (71km) and up to mouth the defunct Sunamunhi River with shrinkage of the lagoon. It is presently 64km and of width 0.15 to 2km [92].

Table 1. Major Av. rainfall in mm of seven block headquarters in SMD and Chilika (2000-2016)

Year	DOBA VII (Water Shed -2)							
	Barang	BBSR	Jatani	Delang	B-giri	Kanas	K Prasad	
2000	1572	1136	1064	977	483	1003	750	1590
2001	1861	1929	1439	1812	1737	1761	1883	2521
2002	1884	2005	1462	1977	1766	1835	1939	2629
2003	2785	1718	1367	1189	1657	1302	1443	1997
2004	1169	1330	872	1062	1117	664	1130	1318
2005	1264	1302	730	1712	1078	506	1220	1438
2006	1777	1843	1449	1964	1770	1830	1932	2636
2007	1662	1551	646	1412	1229	1336	1388	1437
2008	1498	1929	398	1504	1497	1157	1534	1884
2009	1183	1084	546	1596	1329	1962	1445	1437
2010	1434	1469	544	1668	1322	1971	1378	1458
2011	1437	1469	890	1616	1287	1881	1432	1408
2012	1377	1694	1800	759	1163	1243	1346	1239
2013	1598	1846	1942	945	1726	1769	1695	1756
2014	1638	1424	1839	1238	1458	1737	1542	1705
2015	969	1151	1287	852	812	1009	1382	1279
2016	1569	1555	1142	1393	1339	1435	1465	1733
av.		1539				1418		

Ref: https://rainfall.nic.in/PubRainChart.asp

Isles and islands

Due to inlet sediment availability, shifting, tidal fluctuations, flood bypassing under the hydraulically inefficient outlet channel, the formation of isles and islands are possible. Leftward migration of swash bars or the mouth bars towards the bank occurred due to unsymmetrical and unsteady flow and low wave energy condition in the OC of

Chilika. As a result, they try to join the shoreline due to up-drift or down-drift. Under less sediment movement to form small shoals, Shoals moving towards the barrier face and encounter more tides within a little time gap between inland waves and tidal current with less sediment movement to form small shoals. This is a continuous process of transformations of flood deltas and ebb deltas in outer channel. The swash zone control flow exchange, north ward movement, closure and opening of tidal inlets of Chilika. Due to the making and breaking of Isles within the outer channel, the Chilika lagoon has a number of Islands. Currently there are205 numbers of islands comprising of area 223 Sq. Km. [54]. the permanent islands with permanent settlements are Malud, Parikud, Nuapada, Kalijai, Garh Krushna Prasad, etc. The Nalabana which is known as Reed Forest, about 1553 hectares is a swamp and also a bird sanctuary within the central sector. Among them few islands are rocky beds in the southern fringe. The northern sector has least number of islands. But it is observed that there are manyisles in the outer channel available too.

The barrier islands of the Chilika

The positioning and dimensions of the tidal inlets shows the geomorphologic character of the Chilika. The barrier islands of the Chilika coast are half stable about 34 km and rest is narrow and unstable spit with an outer channel (14Km). It is accommodating the narrow, fragile, dynamic tidal inlets. TIs are path for transportation of inland and oceanic flow.

Opening of natural tidal inlets

During full solar eclipse opening of natural tidal inlets by the raising waves of bay disturbances are mostly triggered. But during inland drought and flow paucity closing operation occurred Chandramohan et al. [24], Mishra SP. [10]. Unwarranted manual opening of inlet (done in the year 1828 and 2000) had threatened the stake holders in the vicinity of the lagoon under altered geomorphology and hydrodynamics. The types of shifts of the tidal inlets are continuous and northerly. The northern face undergoes erosion and the southern fringes of the TI go through accretion. Due to shoreline progression/recession the bi-way motion occur east–west and the natural shift is at a rate of about 4.60 km has occurred from Sept 2000 to 2020 with an average rate of northerly shift of TI is 242 meter per year.

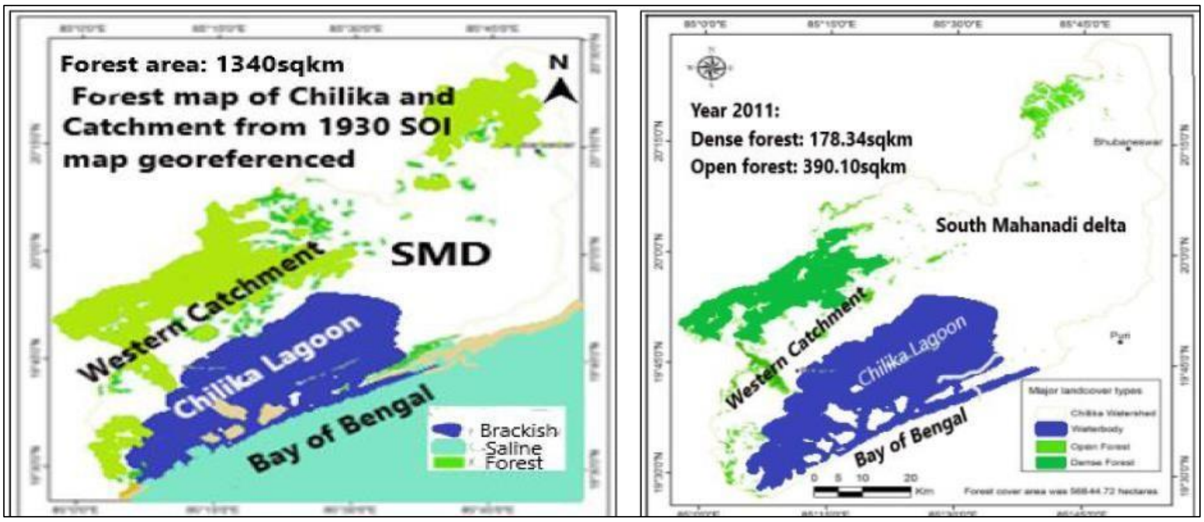
Anthropogenic intervention

It is found from historical records that the first anthropogenic intervention to the natural TI of 1.6 km wide was hydraulically found inefficient in 1780 and was depleting. Gradually the TI was obstructed thoroughfare of the country boats. During 1825 the shallow TI was dredged by the Zamindary which was later closed during the year 1837.

The natural tidal inlets

The natural tidal inlets hover in and around Arakhakuda at the debouching point of the Dahikhia River, which is the second channel after Magarmunhaand, it is connecting the lagoon and the Bay of Bengal. Most of coastal lagoons formed because of the Late Quaternary marine transgression. It begun approximately 18,000 years ago and finished about 3,000years ago, leaving a mean sea level close to the present. Historical data points to rapid shrinking and sinking of the lagoon in area and shallowness, dimension, positioning of the tidal inlets. In the present observation the inlet in 1970 was narrow and was migrated extreme north to Motto village, with an average width 15 meters and depth about 1 meter to 2 meters and with similar mouth positioning even during 1989. During 1933, 1975, 2012 and 2019, three or more TI's were reported, either due to number of BoB strong storms land falling south Odisha coast or/with eclipses with rising tides along the coast [43] beach ridges, estuaries, swale deposits and other land forms. In the N- sector, mudflats indicate about the extensions as greater Chilika of past.

Fig 4(a) Forests in Chilika catchment (1930), Fig. 4(B Forests in Chilika catchment area (2011) after geo-referencing



Source: (Texas Library) and source modified; http://hdl.handle.net/10603/292449)

Foreshore Landforms

Between low tide level and high tide level there exist the foreshore zone. It is influenced by tidal inlets, barrier islands, waves, mangroves, tides, and wind. The beaches, tidal landforms such as flats or mudflats or back swamps, beach ridges, coastal sand-dunes, emerging Islands, Isles, and mangroves are called the physiography.

Sandy Beaches

Sandy beaches are a direct result of the constant erosion of rock in Chilika. Grains of sand are carried by waves and currents and are constantly being removed and deposited on the shore, as sandy beaches. By their nature, sandy shores are constantly changing, and often very mobile especially those on exposed areas of coastline. Stable sandy beach has been developed from Sipakuda to Prayagi (South of the Chilika). Sand may even be held together by the roots of seagrass, helping to hold sand in place and creating an even more stable place to live. With well-built sand dunes and barrier spits running parallel to the coast. In the northern part 32km of the lagoon has coast has perpendicular sand dunes. It is mainly constructed of river, littoral sediments of recent origin about 4 to 5 hundred years BP. During calm sea with riverine inputs like sands, fine/coarse shingles/ pebbles, beaches are constructed Behind the present beach at about 3km inland anther beach profile exists.

It stretches from Satapada to Kushbhadra river mouth.

Vegetation and sea level variations

The main reason for the changed landscape in the recent past is may be due to the introduction of irrigation and hydrological engineering works in the rivers of the Mahanadi delta system, which caused the change in water supply. This resulted in a reduction of water discharge downstream in the river, and at times the eventual cut off of water discharge. Therefore, the recent environmental changes in this area were not due to natural climatic development, but can be attributed to human activities. Moreover, the deforestation of the catchment area allowed an increase in the erosion of the landscape and the siltation of ChilikaLake. Therefore, in Northern Sector the shoreline vegetation has diversified from fresh water plants, to marine flora along the beach line The other coastal areas of the lagoon are amalgamation of brackish, and fresh, saline water vegetation. The beach is mainly influenced by sand dune vegetation. The lagoon's breast water has luxuriant growth of brackish water flora.

Geo -hydrological multiple triple points regular Shift

There is regular shift of triple points which shows the temporal character along coast of the Chilika Lagoon prediction of the age of conversion from gulf to a lagoon can also narrated by the geo hydrological multiple triple points from southern edge propagating from Parikud to Jahnikuda. There are permanent offshore bars along certain stretches of the coasts. These are towards southern fringe of the coast line (Fig 5). Aeolian beach sand dunes of length about 200 m to even 5 km and of height about 2 m to 5 m (even higher) are commonly found along the Chilika coast from Prayagi to Ramachandi temple.

Figure 5. Shift of triple points along coast of the Chilika Lagoon

Discussion

The study reveals that the fundamental about morphology, sediment transport, tidal inlets,and dynamic behaviour of the fragile ecosystem and formation of stable, unstable sand spits,islands, terraces, shoals, mudflats, swamps and flood deltas inside the of the Chilika lagoon. By the mechanics of sediment transport, the Inlet dimensions, erosion, accretion, barrier island breaching, littoral drift sediment imbalance are controlled. From 1987 to 2017 (in three decades) it is noticed that there is remarkable decrease in clean water spread, aquatic vegetation, agricultural land, clean water and beach area. This may be due to anthropogenic activities like building urban infrastructure, settlements, tourism activities and prawn gherries etc. On the contrary the foremost management of the lagoon and its basin has developed seagrasses, dense forest, and floating weeds etc.

Urban settlement in the catchment of the lagoon Chilika

The Puri Town is the only urban settlement in the catchment of the lagoon Chilika, during post Holocene (1901-1941). With shifting of the capital of Odisha from Cuttack to Bhubaneswar, the number of urban areas has increased during pre-Anthropocene (1951- 1971). Due to urbanization, there is loss of forest, latosol cover, loss of green agricultural land in the catchment area of the lagoon.

Anthropocene: Ecology of Chilika and its catchment

Without delimiting the catch, tourists, harvests the lake users had deteriorated the eco-health of the lagoon by performing and using motorized boats, prawn farming, draining urban waste to the drainage channels debouching the lagoon. Hence the ecologically drowning Chilika needs adequate care.

Hydraulic ameliorating measures:

In all hydraulic ameliorating measures, the continuous attempt is to provide the lagoon by intermittent flushing flow. This will maintain hydrologic regime and the user's clean water for aquatic habitats. It is also essential to increase grazing ground for live stocks, planting fast growing mangroves. The watershed and river corridor must be under a forestation. Proper management Programme may be made for protecting natural habitats from poaching, controlling bird flu for preserving biodiversity.

Conclusion

Essential steps may be taken to save the lagoon from ecological and hydrological degradation. The catchment treatment plan is to be encouraged against entry of inland sediment to the lagoon. The proper catchment treatment plan has to be encouraged against entry of inland sediment to the lagoon. There is need for control of weeds, sea grass, water hyacinth, and maintaining the tidal inlets to for salinity, augmenting conducive atmosphere for growth of aqua fauna and tempt more migratory birds to cluster within the lagoon. Provision of solar panels for boat operation and use of bio degradable plastics, training the fishermen for their capacity building against poaching, plantation of mangroves, organic farming in the out skirt and also within the lake islands is essential. The Impact of uncommonly weather events on beach morphology revels that northern spit(s) is highly reactive compared to southern spit. The degree of erosion due to these intervallic and episodic occurrences is quite high compared to seasonal or inters annual variability in beach morphology. The study accredits demanding attention on conservation and stability of north spits for maintaining long-term inlet stability, which, in turn, would be helpful for sustainable management of Chilika lagoon.

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Geographical Study of The Impact of Floods on Society in The Plains of Kosi

Mrinalani Priya

Abstract

The existence of all kinds of facts related to human subsistence is necessary for the basic development of human beings. Otherwise, in the development of civilization, human development of a particular area gets left behind. These types of facts have more impact in the geographical areas having primary activity i.e., agricultural facts form because primary activitiesare directly related to nature. The glory of nature is uncertain and uncontrollable. Man is a slaveto the conditions of nature beyond human comprehension. Who does not know the rough natureof rivers in a region with flat rivers like Bihar. The district of Kosi, known as the mourning of the state of Bihar, is known for its floods. It comes every once in a while, and badly affects the general social structure. The result is that the nature of social ecology becomes permanent. Thepresent research paper is devoted to the effects of Kosi floods on society. In which most of the analysis is written directly based on secondary data. Whereas through the questionnaire methodalso primary facts have been collected from the research area and based on that analysis has beenprepared. So, there is evaluation. The goal of the present research paper is to uncover the socialenvironment of the Kosi plain, how this area is devastated by flood disasters. Low level of sociality is maintained in this area.

Keywords: Kosi flood plain, Social and Economic

Introduction

Considerable areas of the Ganga Plain usually get affected by floods and the People living in the concerned areas face a lot of problems. Sometimes they lose their dwelling, cattle, wealth, standingcrops, and other belongings. More particularly some river basins face more serious problems because of furious floods. Among these rivers, the Kosi plain, Gandak basin, Kamala basin, etc. get the problems of flood almost every year or even more. Certainly, the constructions of the flood protection embankment along these rivers have to a considerable extent only limited Areas get more affected, especially areas existing between the two-flood protection embankment. Only in case of heavy floodwater or damage in flood protection embankment areas lying even outside the flood protection embankment, heavy loss of human life houses, infrastructure, and others get moredamage.

Purpose of the Study

The present paper aims to analyze the impact of the flood on social conditions especially society in the Kosi plain it may be mentioned that the Kosi river before the construction of the flood protection Embankment, used to change its course, and vast areas of Kosi plain had become abandoned due to out-migration of people for the flood-affected area of Kosi plain for other partsof the state, but the construction of flood protection embankment controlled the shifting nature of the river and only limited areas existing between two flood protection embankment remained highly flood affected and vast areas became free from the clutches of flood damage. It is also important to note that due to siltation, areas existing between two flood protection embankments, the land has become a little higher than the outside areas. In case of any damage to the embankment heavy loss occurs in outside areas.

So far as a social condition is concerned both the areas, flood plain lying within the two-flood protection embankment and the outside areas get distinctly affected by the flood, because social conditions are distinctly formed. Areas lying within the two flood protection embankments face more problems because of the occurrence of flood several times in a year, loss of dwelling, cattle wealth, crop, and even human life. As such in different areas only the poorer people or sociallydeprived people remain in a position to live in such difficult areas and more socially conscious people or rich people have moved out from such problem areas. Consequently, the poor people especially belong to less socially developed social groups. It may be noted that such areas have more habitation of people belonging to the Scheduled Castes (SC) community or the backward community.

Study Area

The present study concerns only three districts of the Kosi division Viz, Saharsa, Supaul, and Madhepura. As such only these three districts have been taken into consideration for a thorough investigation. The Area under study extends from 25^0 20 N to 26^0 30 N latitude and 86^0 20 E to 87^0 10E longitudes. If covers and areas about 5900 sq km.

Sources of Data

The present study is based on both primary and secondary data. Primary data have been procuredthrough questionnaires, schedules, and intensive fieldwork. Questionnaires have been framed keeping in mind the effect of floods on different social groups, especially socio-economic conditions. Secondary data have been procured from the census office, Govt. Office and other publications. Both these data have been processed and analyzed.

Methodology

Since the study of their nature concerned the scholars of different disciplines like Geography, Sociology, Economics, Demography, and other Social Science, more attention has been led to the geographical implementation of flood on social category, considering the vastness of the area theflood plain of Kosi River, only six villages located in different areas have been considered to assessthe impact of the flood on social ecology. More attention has been led to the analysis of the damage caused by floods in the selected villagesof the study areas. The main aspects have been the loss of dwelling, cattle wealth, standing crops, and other household belonging, change of residence from the original house to other areas for safety purposes. On the occasion of the occurrence of flood workers from the areas move out for other areas for the livelihood.

Impact of Floods on Social Groups

It has been noted earlier those areas lying between the two flood protection embankments have a severe impact of flood especially on dwelling, cattle wealth, and other household belonging. The villages are located in heavily flood-prone areas like Digrambara, Solone and Piparahi have recorded a heavy loss of property during the flood because these villages experience flood problems almost every year but the villages Dhanauli, Sarbiya, and Fulwariya have recorded relatively lesser damage because these villages are located outside the flood protection embankment. It has been also mentioned that villages located in the highly flood-prone areas have more habitation of scheduled caste people of less socially developed backward communities thesesocial groups mostly have houses built of bamboo stick or asbestos and these houses experience more loss during the flood. People living in such villages either move to shelter provided by Govt. or other relatives living in other areas.

A good number of workers move out for other areas to earn little money for their family members.These villages also get lost in infrastructure and normal social conditions. On the other hand, villages like Dhanauli, Singrauli, Fulwaria located in flood-free areas have habitation of a more socially conscious community and only a limited number of the family have a poor social background. These villages also have better dwellings, road connections, schooling facilities, health facilities, and other fashionable social conditions. In these villages, the impact of the flood is less realized.

Conclusion

It may be concluded that highly flood-prone areas lying within the flood protection embankment have more habitation of less socially developed people. These people experience more damage from the flood. On the other experienced little damage from the flood.

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Geographical review of flood situation and its diagnosis of Mokama Tall

Anil Kumar

Abstract

The relationship between floods and Bihar has been of chauli-daman. The geographical location and surface structure of Bihar attest to this relationship. The condition of the slope and drainage basin of northern India is such that the entire waterof the rivers of Yamuna, Ganga, Gandak, Kosi and Son drainage system is discharged only from Mokama Tall having an area of 2011 square kilometer. In this process of drainage, if Mokama Tall gets flooded every year. There is nothing surprising in this. It is not possible to end this trend of postponement. But it can be banned. There is a needto release government policy and funds. Mokama Tall is looking forward to its future development.

Key words: alluvial structure, drainage system, flood hazard, natural slope, Farakka barrage.

Introduction

The relation of floods with Bihar is centuries old. When there is more rain than normal in the rainy season, then this relationship directly speaks on the screen.The geographical location of Bihar, the nature of the drainage system, the natural slopeand alluvial structure, favors floods. The slopes around Bihar are high and the intermediate region is relatively low for a saucer-like feature. For centuries, silt has beendeposited in the foothills of the Ganges. On the other hand, a dam was built near Farakka in Bengal in the western frontier parts of Bihar just after independence. This dam, popularly known as Farakka, was built after Bangladesh to stop the menace. Indirectly,these two reasons are due to the accumulation of silt at the bottom of the Ganges and the formation of the Farakka Dam. Water logging and temporary floods occur every year in Bihar. In this way, a total of 28 districts of Bihar are flood affected, but there are some areas where there is permanent flood every year. The present study area Mokama Tall is one such area. So many come every year. Situated in the easternmost region of Patna district, denotes the lowest land of South Bihar. Where there is only 35to 40 meters high surface area above sea level. Almost all the water of the southern outer frontier of central Chota Nagpur passes through this Mokama Tall. Whichtherefore joins the Ganges near Balagudar Ghat near Badhi village. A total of seven major rivers flow in this Tall area. In the present research paper, some measures are being suggested on the current status of floods of this Tall area, its causes and also somemeasures to deal with the floods. Prior to preparing the present research paper, the fieldwork included the flow basin of rivers, linkage of feed and pan with rivers, study of slopes in surface sheet 72 G and analysis based on the facts that emerged after lookingat the bird's eye view of floods in the rainy season has been written. Although the first Sumill related to the diagnosis of floods in Bihar was organized in 1769 AD under the chairmanship of the Governor of Bengal, Warren Hastings. At present, under the joint tally scheme of the Government of India and the Government of Bihar, a two-cropping proposal is proposed for the area.

Research Objectives:

1. The main objective is to show the updated status of floods in Mokama Tall andto tell the solution of the flood problem.
2. To show the destruction of life and property due to the horror of flood in Tall.
3. The aim is also to draw the attention of the government to the flood situation of Mokama Tall.

Research Hypothesis

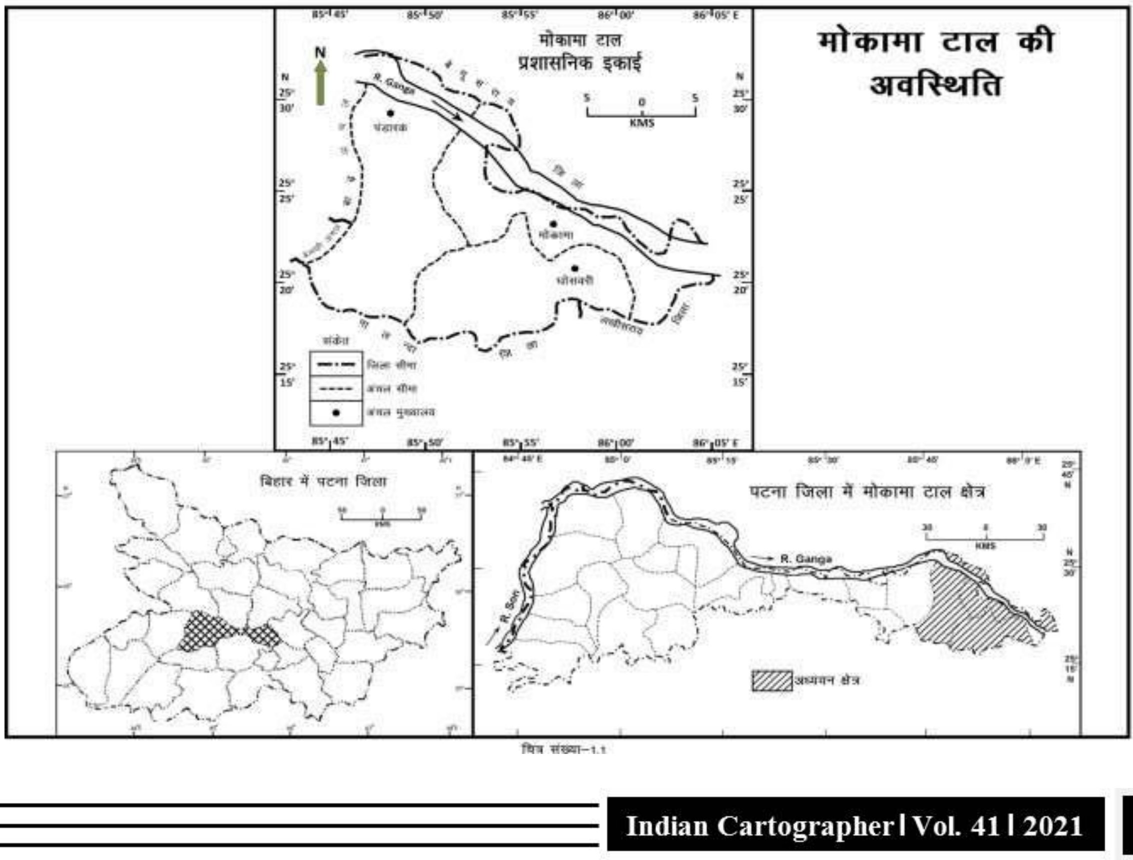
1. Mokama Tall's gradient is quite slow. Due to which the speed of flowof water decreases and flood situation arises.
2. Due to the Pradhan Mantri Gram Sadak Yojana, the profile of the natural slopein the area has been broken.
3. From the month of July to September, there is a deluge scene in the Tal area.
4. If the feed and pan are deepened and connected with the rivers, then partial solution of the problem of flood is possible.
5. The surface structure of Mokama Tall supports the flood.

Importance of research

The importance of the present research paper lies in the fact that the real cause of the floods of Mokama Tall will be known. To get rid of the flood, the solution will be known and the message of the destruction of the flood will be known.

Research Method

Before preparing the present research paper, the area was surveyed from the pre- flood, contemporary and post-flood period and the effects of floods were studied by questionnaire, then the research analysis was prepared. The present research paper is mainly based on secondary data only.



चित्र संख्या–1.1

Research Area

The present study area is located in Central South Bihar. This area is known as Mokama Tall. Under this, the eastern sub-division of Patna district, three blocks of the eastern region of Barh come. There are 15, 15, 8 Panchayats in these three blocks namely Pandarak, Mokama and Ghoswari. Their range is between 25°16' to 25°35' North latitude and 85°44' to 86°05' East longitude and is 413922 as of 2011. Its total area is 545.52 square kilometer. It covers 17.03% area of Patna district and 7.48% population of Patna district in this area. This area has 98.88% rural population and 1.12% urban population. The urban population is in the northern part on the edge of theTall area. Part of the area is of rural population, there are villages located far and wide.Which becomes like an island in the rainy season. Certainly, due to the development ofNational Highway 31 and 82, State Highway and other rural roads, some traffic has increased in the area, but most of the area was accessible only by ferry during the rainyseason.

Research Analysis

As far as the area of Mokama Tall is concerned, it is a combined area of three blocks. Whose slope is from west to east and from south to north. As far as the networkof roads was laid under the Pradhan Mantri Gram Sadak Yojana in the entire village level in the updated time, 70 years ago, which used to be the natural slope of this area. He's completely broken. Every year water comes in the rivers, but it is stopped due to obstruction in the way. As a result, scientifically water logging gets done locally. This local water logging only shows the scene of the flood for 3 months of the year. On the other hand, the shape and structure of this area is like a saucer. Water comes from the southern parts, but the northern border area is surrounded by the southern natural embankments of the Ganges River. This region is relatively higher than the central region. As a result, the intermediate area becomes a victim of temporary water logging, although all the water eventually has to drain into the Ganges. But with rivers parallel to the Ganges such as the Mhane, Hadohar, Khedupokhar and Dhanain flowing from west to east, the water flows simultaneously from west to east. This valley, coming into the river area, almost attains its base level near Trimuhan village. Due to which the siltthat brings with it gets deposited in its bottom itself. The result is that the river bed hasrisen above its adjoining area. When the river is in spate during the rainy season, it spreads water on both its banks. Because both the banks are lower than the river bed, that water cannot reach the river bed immediately again. The water slowly reaches the river through small meals and pans. Thus, the duration of flood erosion is increased. Update For 5 years, J.C.B. The river bed is cleaned with a machine. Then the water comes out from this area. When the Ganges starts flowing very high above the danger mark, then the flow of the river reverses from the side of the Ganges. The flood situationgets worse, due to three reasons.

1. Reversing the flow of the river from the flow side of the Ganges from east to west.
2. The flow of water from the plateau part of Chota Nagpur from west to east.
3. Under the third reason, there is continuous rainfall. Like in 2021, the rain which has started from 9th May. This continued till the last week of September. A similar situation was present at that time in 2019. Due to heavy rains in the year, excessive water came from Punpun and Son rivers.

Measures for the Diagnosis of flood

As mentioned earlier, the natural profile of the slope of this area has been brokendue to the Pradhan Mantri Gram Sadak Yojana. So that if an attempt is made to bring itback, then the connectivity of the village will be broken by road. As a result, the frequency of artificial development will end. There are mainly three or four ways left for diagnosis from floods:

1. The area under the path should be gradually collected and dug out of the pan andfeed and connected to the main rivers.
2. Under the water harvesting in the entire area under the road, fisheries should be done by making big pond-shaped pits and collecting water.
3. Work is going on the way. Under which flood water is being collected andused in Dhiwar Super Thermal Power Station.

Since only flood management policy can be adopted in this area. Under this policy,one aquatic crop in a year can be done in the entire area. Because floods cannot be stopped.

Evaluation

If we look at the above discussion, then the flood of Mokama Tall becomes a natural sight. The management of which would require a lot. Which is possible only with the cooperation of the Central Government and the World Bank. Here in recent years, there has been talk of breaking Farakka. So that the flow of Ganga will be faster and the period of water logging in Mokama Tall will be reduced. For which the Government of India will have to talk to the Government of Bangladesh. The future ofthe updated flood situation in Mokama Tall does not seem to be resolved at the moment.In the entire Tall, 1 lakh 40 thousand hectares of land is affected by floods.

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Speckle Filtering of SAR Imagery throughNon-local Means Filter

Neelima R and Ashish Joshi

Abstract

Synthetic Aperture Radar (SAR) is an active sensor used in diverse remote sensing applications. SARimages contain the backscatter energy information of the features and can be used in target detection.It has very accurate geolocation which makes it ideal for cartographic applications. SAR is the coherentimaging system and speckle is an inherent granular pattern found in SAR imagery, which is perceivedas noise. Many methods have been proposed in order to remove the speckle in the SAR images whichwere based on the local statistics of the image like Boxcar filter, Lee filter, Kuan filter, Frost Filter, and Gamma-map filter. But these filters do not show good results in preserving the finer details in theimages and most of these filters cause blurring in the SAR image. Non-local means (NLM) filter is anadvanced edge-preserving speckle filter that uses the concept of self-similarity. In the NLM filter, it considers a patch surrounding each pixel and search for the most similar patch in the neighbourhood area of the pixel, and uses its central pixel with a weighted function to remove the noise. In this paper,speckle noise in space-borne SAR images is removed through a non-local means filter and a comparative analysis of NLM filter with other speckle filters is done by evaluating the speckle index of the SAR images. Non-local means filter is applied to Sentinel-1 (C-Band) and Chandrayaan-2 Dual-frequency SAR (DFSAR) (L&S band) images. The effect of various parameters of the NLM filter onthe speckle removal is analysed to find optimum filtering parameters. NLM filter appears to be effective in removing speckle while preserving the finer details of the SAR imagery.

Keywords: SAR, Speckle, Non-Local Means (NLM) filter, Sentinel-1, DFSAR

Introduction

Synthetic Aperture Radar (SAR) is a popular technology in the world of remote sensing. It transmits coherent microwave radiation (wavelength range: 1cm to 100 cm) to the earth's surface in a directionperpendicular to its movement and receives the backscattering. Microwaves can penetrate through clouds and rain which makes the SAR an all-weather surveillance system. The backscattering from thetarget is a resultant of the surface roughness, structure, orientation, dielectric properties, etc. of the target along with the sensor properties like wavelength, polarization, and angle of incidence. Despite these unique qualities, SAR image interpretation is a challenging task. One of the prominent problems that one faces while dealing with a SAR image is Speckle [1]. Speckle is an outcome of backscattering from many scattered elements with random distributions within a resolution cell [2]. Constructive anddestructive interference of coherent waves results in bright and dark granular patterns in the SAR imagery which makes it more complicated and difficult to interpret [1].

Many consider speckle as a noise. But according to Woodhouse, it is not a noise but an unavoidable and repeatable phenomenon [1]. Speckle removal is an important and tricky step in SAR image post- processing. Speckle removal methods often degrade the quality of the image. In order to remove speckle, many methods have been put forward [5,3]. In the past 40 years, there have been various kindsof research in order to create an effective SAR speckle filter. There are plenty of speckle filters available which are based on local statistics such as mean and standard deviation of the image [7,8]. Lee, Median, Kuan, Frost, and Gamma-map filters are some of the popular classical speckle filters [3,5]. Basically, these filters will have a kernel or window, which moves through the image pixels, make some calculations and replace the values of the central pixel as it moves over the image [3, 9, 10]. Classical filters were created for low-resolution SAR imagery. They work well in the homogeneous patches of the image. But when it comes to areas with high spatial variation, they show poor results. This problem is amplified with the advancement in sensor technology and the availabilityof high-resolution SAR images. So there arose a need for speckle filters that preserves the finer details along with despeckling the image. Buades et al. came up with the idea of a non-local means filter in 2005. The Non-local means filter employs the self-similarity concept to preserve the finer details of the image [8]. Unlike local filters, they do not assume that the closer pixels are similar. Instead, they search for like pixel-patches not only around the pixel under consideration but in the whole image [11,12]. The NLM filter then compares these patches and assigns some weights to them according to how far these patches are alike [12,13,14]. Various researches have shown that the NLM filter can be modified to incorporate various speckle models if provided with appropriate distance measurements for the weighted function [12].

Dataset

In the study, Sentinel-1 (C-band) and Chandrayaan-2 DFSAR (L&S Band) data are used as input images to perform speckle filtering. Sentinel-1A is the first of the Copernicus programme satellite constellation conducted by the European Space Agency and launched on 3 April 2014, and Sentinel-1B was launched on 25 April 2016.Sentinel-1A ground range detected (GRD) Interferometric Wide (IW) Swath image of Kochi area was downloaded from https://scihub.copernicus.eu/dhus/.

Chandrayaan-2 Dual Frequency SAR (DFSAR) moon mission was launched on 22nd July 2019 by theIndian Space Research Organization (ISRO), India. DFSAR utilizes the L-band and S-band to provide enhanced capabilities compared to the Chandrayaan-1 missions S-band mini-SAR instrument. It has aslant range resolution ranging from 2 m to 75 m. The DFSAR data was downloaded from the ISRO website https://pradan.issdc.gov.in/. In this study, map-projected Seleno-referenced image (Level-2 data) L-band (North Pole), and S-band (South Pole) SAR images are used as input for despeckling. The table-1 below shows the details of the datasets used in the study.

Table -1: Details of the datasets used

Sn	Dataset Id	Date of pass	Satellite/ Sensor	Area	Pixel Spacing
1	s1a-iw-grd-vh-20210501t004100-20210501t004125-037687-047261-002	01/05/2021	Sentinel-1	Kochi	10 m
2	ch2_sar_ncxl_20191014t190846230_d_fp_d18	14/10/2019	Chandrayaan-2 (DFSAR)	North Pole	25 m
3	ch2_sar_ncxs_20190919t200712532_d_fp_d18	19/09/2019	Chandrayaan-2 (DFSAR)	South Pole	25 m

Methodology

Non-local means (NLM) filter is an advanced edge-preserving speckle filter that uses the concept of self-similarity. NLM filtering algorithm considers a patch surrounding each pixel and search for the most similar patch in the neighbourhood area of the pixel and use its central pixel with a weighted function to remove the noise [10-15]. These similarity patches (or similarity windows) are searched within a search window as shown in figure 1. Choosing a search window smaller than the image effectively reduces the computational cost [13]. By adjusting the size of the search window and similarity window we can find optimal window size for the input image.

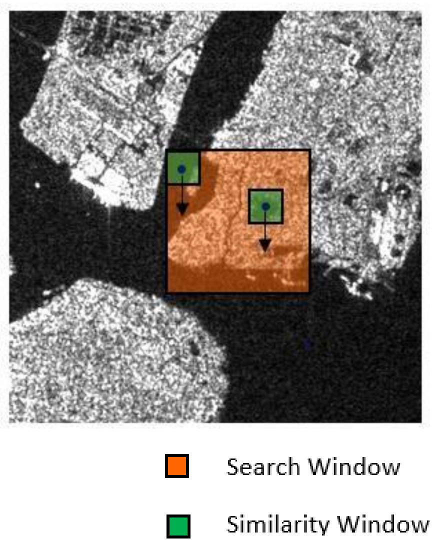


Figure 1: Basic elements of Non-local means algorithm

For the Noisy Image,

$u = \{(i) \mid i \in I\}$…………………(1)

The estimated value 'NL(u) (i)' is computed as a weighted average of all the pixels in the image [11] and is given by equation 21.

$NL(u)(i) = \sum_{j \in I} w(i, j)u(j)$ ………………………….(2)

Where the family of weights w (i, j) depend on the similarity between the pixels 'i' and 'j', and satisfy the usual conditions $0 \leq (i, j) \leq 1$ and $\sum w(i, j) = 1$. The similarity between two pixels 'i' and j depends on the similarity of the intensity gray level vectors u (Ni) and u (Nj), where Nk denotes a square neighbourhood of fixed size and centered at a pixel 'k'. The pixels with a similar grey level neighbourhood to the have larger weights in the average, these weights are defined as [11],

$(i, j) = \frac{1}{(i)} e^{-\frac{\|u(N_i)-u(N_j)\|^2}{h^2}}$ …………………………………….(3)

Where Z(i) is the normalizing constant [11] and is given by equation 4

$(i) = \sum_j e^{-\frac{\|u(N_i)-u(N_j)\|^2}{h^2}}$ ………………………………………….(4)

Here, 'h' is a parameter that decides the degree of filtering. Its value lies between 0 and 1. NLM filter parameters like search window size, similarity window size, and degree of filtering can affect the despeckling of the SAR images. This paper focuses on analysing the various parameters of the NLM filter for SAR images. Using different NLM filter parameters, the SAR images of Sentinel-1 and DFSAR (Chandrayaan-2) are despeckled.

The speckle in the SAR images are estimated by computing the speckle index which is given by equation 5

$$Speckle\ inde\ = Standard\ Deviation/Mean \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Search window Size	Speckle Index
9	0.1504
11	0.1321
13	0.1172
15	0.1081
17	0.1014
19	0.0998
21	0.0979
23	0.0948
25	0.0929
27	0.0912
29	0.0897
31	0.0890
33	0.0886
35	0.0889
37	0.0892
39	0.0886
41	0.0887

Standard deviation and mean are calculated over a small area of the homogenous region.

Results

Non-local mean filter (NLM) analysis for different parameters

The NLM filter is applied on the Sentinel-1 image with various parameters. The performance of the NLM filter is analysed by calculating the speckle index on various parameters of the NLM filter. NLMfilter is applied on the image with a constant similarity window of 3*3 and search window size is varied from 9*9 to 41*41. The figure 2 above shows that the speckle index and hence, speckle reduces as the search window increases. The NLM filter stabilizes at a search window of 21*21 and no further reduction in the speckle is observed. The degree of filtering is taken as 0.05. The input image and NLM filtered image at various search window size is shown in figure 2

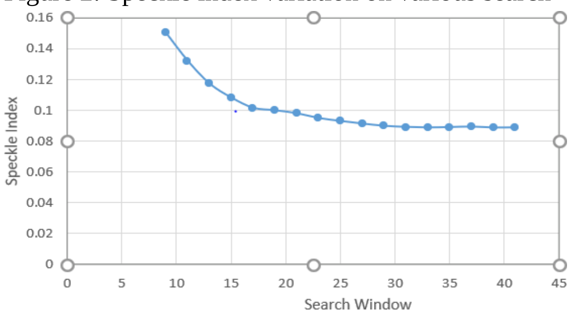


Figure 2: Speckle index variation on various search window in the NLM Filter

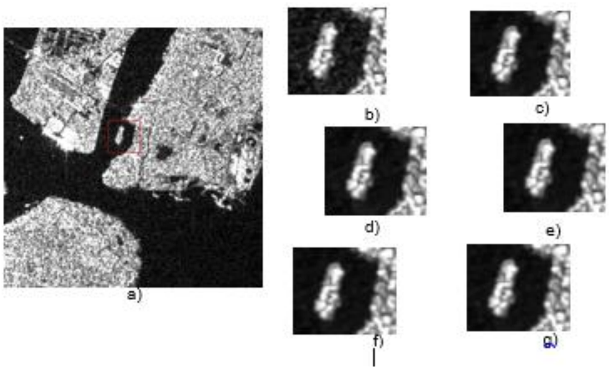


Figure 3: a) Input Ground range Sentinel-1 image, zoom area of b) Input image c) NLM filtered with search window size (9*9) d) NLM filtered with search window size (15*15) e) NLM filtered with search window size (21*21) f) NLM filtered with search window size (29*29) g) NLM filtered with search window size (41*41). Similarity window is 3*3 for all images

Similarly, analysis has been done by varying the similarity window from 3*3 to 9*9 and the NLM filter is applied on the image by varying search window size from 9*9 to 41*41. It is observed that as the size of a search window and a similarity window increases, the speckle index decreases. It is observed that the similarity window of 9*9 and the search window of 21*21 shows the optimum results. The figure 4 and 5 shows the effect of the speckle in the image at various search windows in the NLM filter.

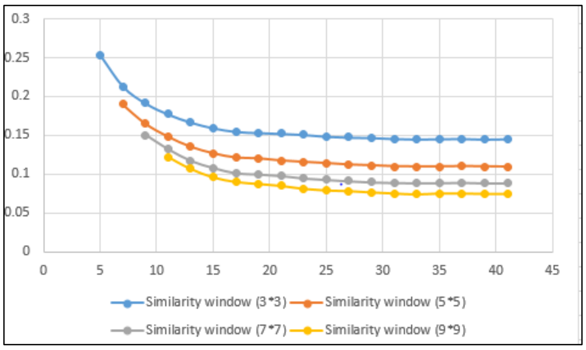


Figure 4: Variation of speckle index with respect to Search window and Similarity window

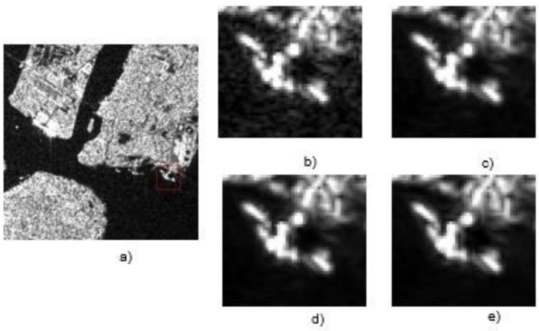
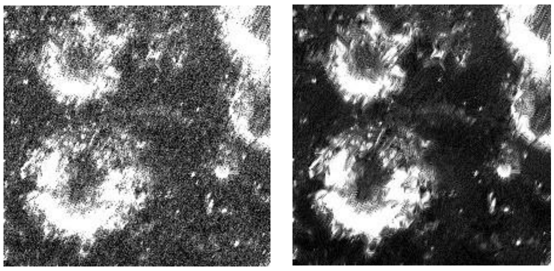


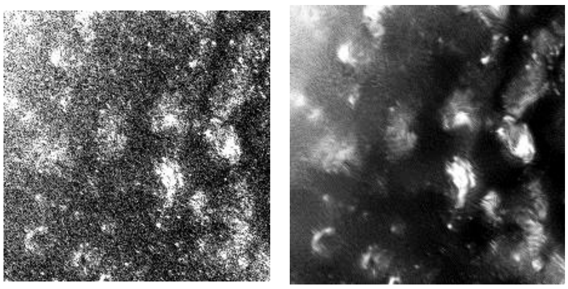
Figure 5: a) Input Ground range Sentinel-1 image, zoom area of b) Input image c) NLM filtered with similarity window size (3*3) d) NLM filtered with similarity window size (5*5) f) NLM filtered with similarity window size (9*9). Search window is 21*21 for all images

The NLM filter is also is applied on the Chandrayaan-2 Dual-frequency SAR (DFSAR) images for L- band and S-band data. The figure 6 shows the DFSAR L-band image and NLM filtered image and figure 7 shows the DFSAR S-band image and NLM filtered image. A significant reduction of speckle was observed in both L and S frequency band images of DFSAR data.



a) b)

Figure 6: DFSAR L-band image a) Input image b) NLM filtered image



a) b)

Figure 7: DFSAR S-band image a) Input image b) NLM filtered image

Comparisons of Non-local means filter (NLM) with other speckle filters

The performance of the NLM filter is also compared with the Boxcar filter, Lee filter, and Gamma- map filter. Sentinel-1 and DFSAR images are despeckled using Boxcar filter, Lee filter, Gamma-map filter, and non-local means filter. The speckle index has been calculated for each of the filtered images. It has been observed that NLM filters have the least speckle index and it also preserve edges in the SAR image. However, in the Boxcar filter and Gamma-map filter, blurring is observed at the edges in the SAR image. It has been observed that images processed with the Lee filter have less blurring. The speckle index for various filters is given in below table 2. The figure 8 and 9 shows the comparisons of NLM filter with other speckle filters for Sentinel-1 and DFSAR image respectively.

Table 2: Speckle index values of Different filters (Sentinel-1)

Speckle filter	Speckle Index
Input	0.3511
Boxcar Filter	0.2844
Lee Filter	0.2101
Gamma map Filter	0.2755
NLM filter	0.0381

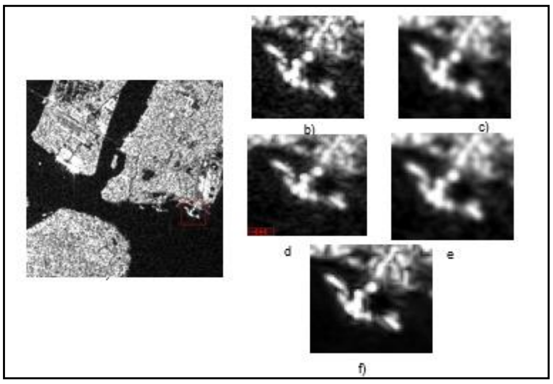


Figure 8: a) Input Ground range Sentinel-1 image, zoom area of b) Input image c) Boxcar filtered image d) Lee filtered image e) Gamma-map filtered Image f) NLM filtered image

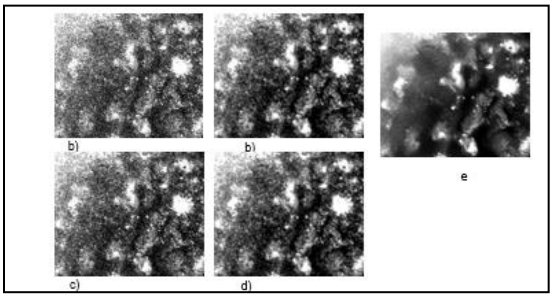


Figure 9: a) Input DFSAR image b) Boxcar filtered image c) Lee filtered image d) Gama-map filtered image e) NLM filtered image

Conclusions

The NLM filter was applied to Sentinel-1 and DFSAR images, and various parameters of the filter were examined. An NLM filter that has a 21*21 search window and a 9*9 similarity window was found to be the most effective for reducing speckle in Sentinel-1 and DFSAR images. The performanceof the NLM filter is also compared with the classical speckle filters like Boxcar, Lee, and Gamma- map filters. Compared to classical filters, an NLM filter significantly reduced speckle in Sentinel-1 images and DFSAR images without causing blurring while also preserving the edges.

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Geographical Study of Status of Industrialization and UrbanizationIn Aurangabad City of Bihar

Sahzad Alam

Abstract

Industrialization and urbanization complement each other. These features canbe clearly seen in the study area. The locally available agricultural and industrial resources have been extensively used in the study area. In which Sher Shah Shuri Highway, Grovod Cord, Rail Road and local power house have supported. It is expected that the various city and industrial schemes of the Government of Bihar and Government of India will further develop this area.

Key Words: Urbanization, Industrialization, Primary Activity, Industrial Activity,Industrial Development, Traditional Urbanization.

Introduction

Industrial activity is a direct indicator of urban activity. As we all know. Fromthe primary activity, every second activity, tertiary activity and fourth activity, we keep the settlement in the city. Industrial activity is an indicator of secondary activity. On the basis of which, being influenced by the effect of which the tertiary activity, the fourth activity naturally develops automatically. After the last bifurcation of Bihar, the mineral rich areas went to Jharkhand. It is known that mineral wealth is the basic basis of industrial development. Although in Bihar in theninth decade of the twentieth century agriculture and concurrent sectors were also given the status of industry, the districts of southern Bihar bordering Jharkhand stillstand out in direct and indirect industrial activity.

The study area is an integral part of South Western Bihar. Where the conditions of basic and agro-based industries are common. There is agricultural land around the study area. Whereas deposits of minerals like limestone, pyrites, sandstone, quartz are found in the radius of only 100 km. At the same time, the high-quality road is connected to the distant big markets and the rail route is related to the most important mineral areas of India. Energy management is local, while India's major industrial focus has traditionally been on this sector. It is natural for the development of urban activity in the area where there is positive strong land for such industrial activity. The research paper has been prepared by studying the primary and secondary data relatedto the field. In which maps have also been used.

Research Objectives

1. To show the trend of urbanization of Aurangabad city and its surrounding areas.
2. To study the city-like activities developed in the East and West frontier areas due to industrial development.
3. To describe various markets and work places in the city.

Research Hypothesis

1. The trend of industrial development and urbanization has increased in thelast two decades.
2. Traditional development of industrialization and urbanization took placein the study area.
3. The old cities appear to be in an unplanned state while the newindustrial area has a planned development which has a modern trend.

Research Method

Before writing the present research analysis, data were prepared from field work, field survey, questionnaire. The research analysis is presented with the help of some secondary data.

Importance of Research

The industrialization and urbanization of the study area has its own uniqueness. These features attract other geographical areas of Bihar that the development of urbanization has been possible in harmony with the industrial conditions.

Study Area

The study area is located from 24° 44' North latitude to 24° 47' North latitude.It is located from 84° 20' East longitude to 84° 25' East longitude. The study area isspread over a total area of 21.33 square Kilometer. The total population in the studyarea is 102244 as per 2011 census. The study area is the district headquarters town.The population of this city has grown rapidly in the last two decades.

Different forms of Research Analysis

The industrial trend of Aurangabad city has been traditional. Which basicallystarts from the time of Sher Shah Shuri. Sher Shah Shuri, the emperor of Delhi, hadestablished a state of peace and prosperity in the whole of northern India for trading activities. From Macedonia to Dhaka, there used to be a trade of essential goods. War horses of the Anatolia Couch breed were also sold from this area. The local public got involved in this commerce trade. And gradually the industrial trend came into the pool among the local population. Local use of mineral resources found in the neighborhood started. After 1874 AD, when the expansion of modern canals started in the local areas, the branch of production increased in this district with relatively less rainfall. Due to which agricultural inflows increased. The excess production of agricultural productivity played an important role in the flourishing of agro-based industry in this region. In today's background, the basic industries in thecity, agro-based industries and other sahib rathi industries are intertwined in the industrial ecology and have built industrial complexes. Because industrial activity isan employment-generating activity and it is a God-given employment for human beings. This creates a personal identity of a human being. Workers coming for employment in this sector take out some part of their wages and spend it in the markets. Due to which the market trend is born in a particular area. Intra-city turns into activity. This particular trend of urbanization is called urbanization. For the last two decades, the shadow of a government in Bihar with efficient leadership and political stability of system management has also fallen on the study area. That is the total number of industries as on date. These

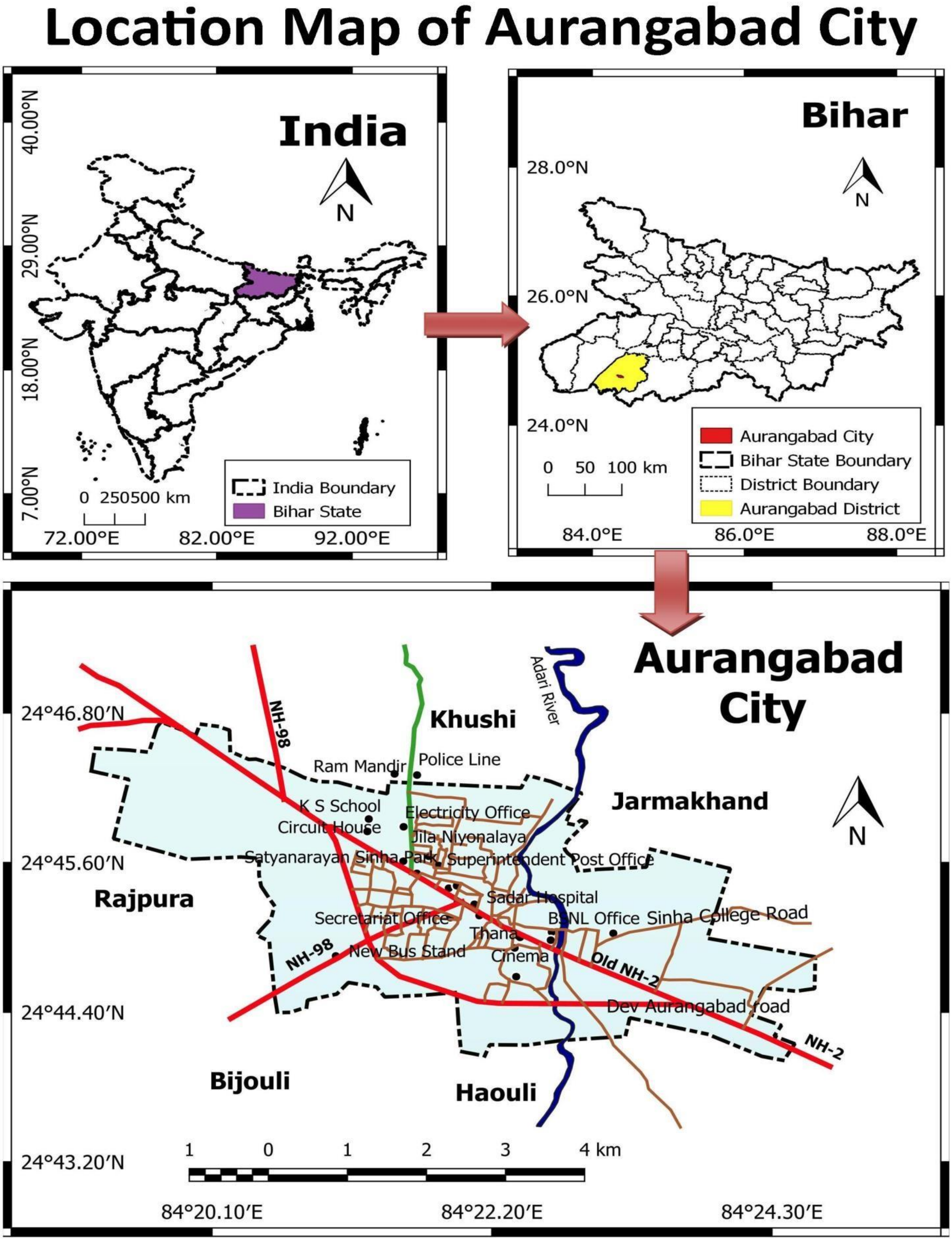
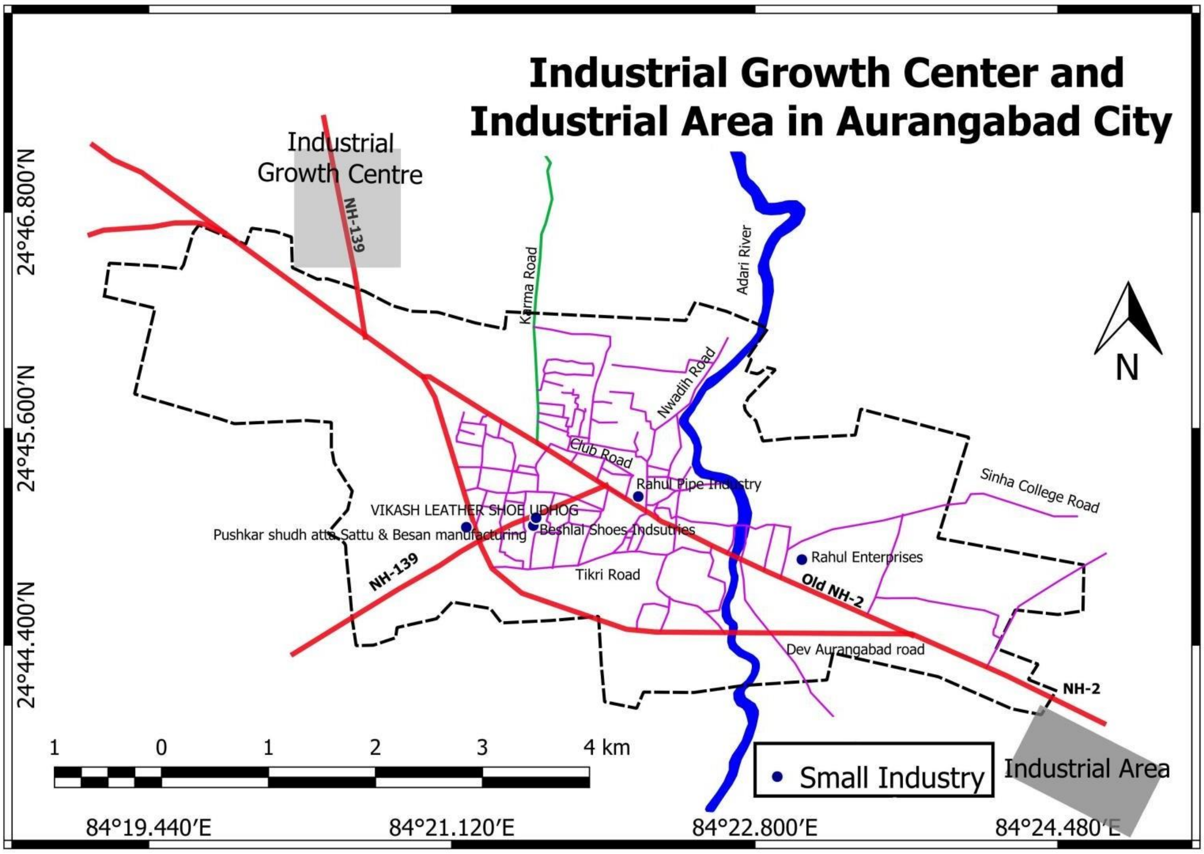


Fig.1

industries were interconnected with each other and have a commensurate relationship according to the need and the samefact has been on the urbanization of this area as well. The cities of this region, theseconditions also interact with the surroundings. Forms a balanced integrated city. In the time of Aurangzeb 400 years ago, this city was in the analogy of a big village.



When Aurangzeb's regional subedar Dawood Khan expanded this area from villageto sarai (since it was located on G.T Road) it developed from sarai into trading townsand became a subdivision of Gaya district after independence. Finally, Aurangabad district was formed on 10-10-1973. The then Chief Minister Abdul Ghafoor unveiledthe district.

If we look at the trend of population of Aurangabad city, then in 1931 AD the population of the city was 47792. Whereas in 2001 AD it became 79351. In the same2011 AD, the population of the city reached 102244. If the trend of increasing population is observed carefully, then it is found that the population has doubled in the last two decades. The process of setting up industries in Aurangabad city started from the 21st century. That is, almost all the industries here have been set up after 2000 AD. As we know that the 74th Constitutional Amendment was imposed to strengthen the municipal bodies in the cities. So that civic amenities are provided incities and work can be done in all areas As far as urbanization and industrialization in the study area is concerned. Both walk side by side. Wherever there is industrialization, there will be urbanization. Therefore, the study area has also not remained untouched by it.

Evaluation

The beginning and end of the story of Aurangabad urbanization and industrialization is clear from the above-mentioned facts. It is clear from the analysis that as urbanization and economic activities changed. According to the above activities, the city developed, which was sometimes in a stage of peak developmentand sometimes in a stage of medium development. There have been three basic urbanization revolutions in India so far. In which the first revolution took place 600 years ago in the time of Mahajanapada. This region could not bear witness to it. Thesecond revolution of urbanization of which it is a direct witness and from that time the goals of urbanization started appearing in this area. Whereas the third urbanization revolution happened after independence. Which is updated till the time and the practice continues. The biggest city of this city, this revolution has been possible in the updated time.

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