

ROLE OF GIS AND REMOTE SENSING IN STORM WATER MANAGEMENT & URBAN FLOODING

A Presentation by

J.S.Rawat

Former Geospatial Chair Professor

(under Geospatial Programme, DST Government of India)

Former Professor and Head,

Department of Geography, Kumaun University

Former Founder Director

Centre of Excellence for Natural Resource Data Management System in Uttarakhand.

FLOOD DISASTER IN UTTARAKHAND

- **Flood disaster is the most common disaster event of Uttarakhand state which affects the state every year.**
- **The best example of flood disaster in Uttarakhand is of 2013 Kedarnath flood disaster and it is one of the worst Himalayan tragedies in recent years.**
- **The Rishiganga flood tragedy is another example of flood disaster in Uttarakhand Himalaya.**
- **The Joshimath Disaster**
- **Thus, it reveals that the Uttarakhand is very sensitive to flood disaster events.**
- **The average rate of casualties by flash floods/landslides in the State is 74 persons per year with effect of 2013.**
- **Now the urban centres have become the most vulnerable for flood disaster.**

CONTENTS

- 1. GIS & Remote Sensing ?**
- 2. Storm Water ?**
- 3. Urban Flooding ?**
- 4. Storm Water Management ?**
(Application of GIS)

1. GIS ?

GIS ?

- GIS is a Computer based technology which provides information to the users with digital map by clicking few mouse buttons in the computer.
- GIS has enormous capacity of data capturing, storage, analysis, retrieval manipulation, displaying and transforming from one place to another.
- In 1962, *Roger Tomlinson*, known as the “*father of GIS*”, has specified GIS as a tool for computerized mapping to help in producing maps more cheaply and faster.

What is a GIS?

Information System



+

Geographic Position



A means of storing,
retrieving, sorting,
and comparing
spatial data
to support some
analytic process.

Technology up gradation

(20th Centaury to 21st Centaury)

e-Portal to

g-Portal

Information with

Information with

Text/Table /Analog to

Digital Map

IT/MIS to

GIS/Web GIS

Technology up gradation

(20th Centaury to 21st Centaury)

e-Governance

to

g-Governance

Information with

Information with

Text/Table /Analog

to

Digital Map

IT/MIS

to

GIS/Web GIS

DOES DO GIS ???

1. Quick Answer of WHERE ? -Spatial Data
2. Quick Answer of WHAT ? -Non-Spatial Data
Attribute Data
3. Quick Answer of WHAT
SHOULD BE ? –PLANING/DSS

GIS gives answer of

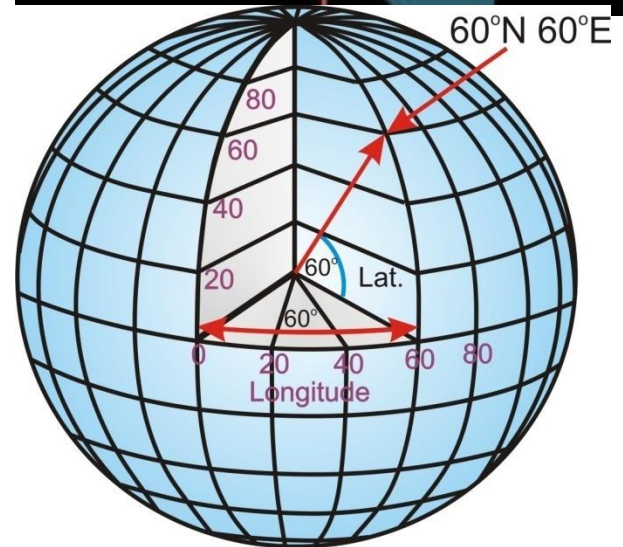
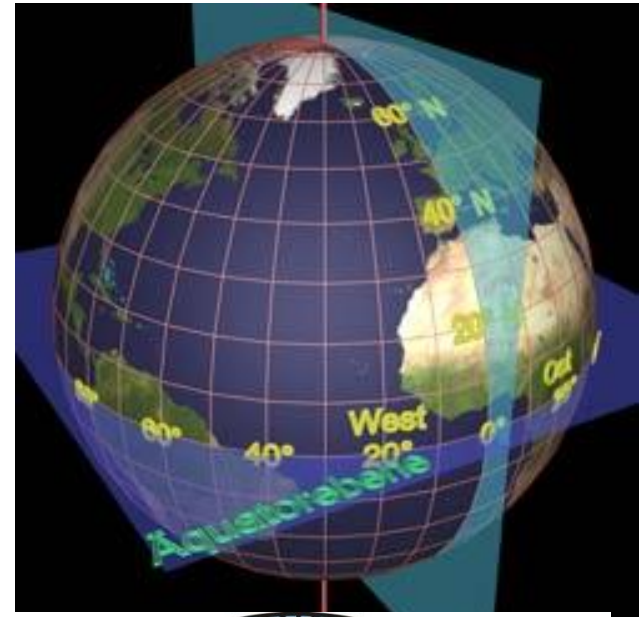
Where ?

Means

Geographic Location

Latitudes 90N & 90S

Longitudes 180E & 180W



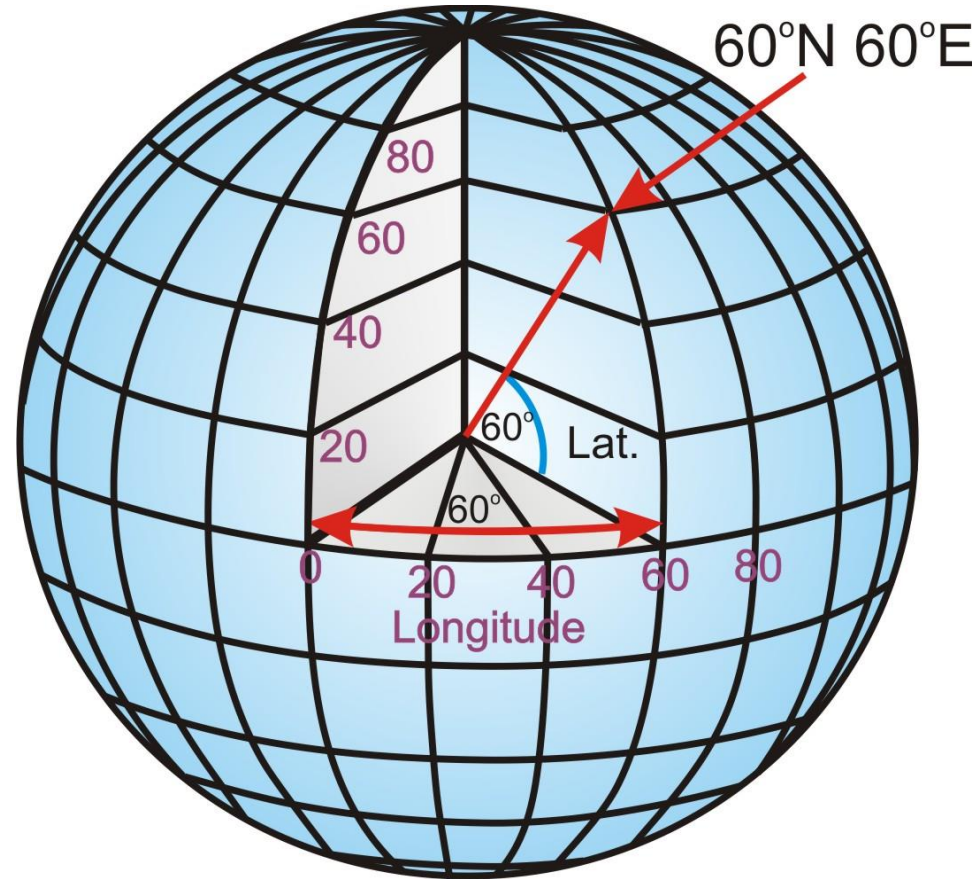
GIS gives answer of the question

Where ?

Means

Geographic Location

(Latitude and Longitude)



**Where is Uttarakhand Academy of Administration,
Nainital?**

Geographic Location of ATI, Nainital

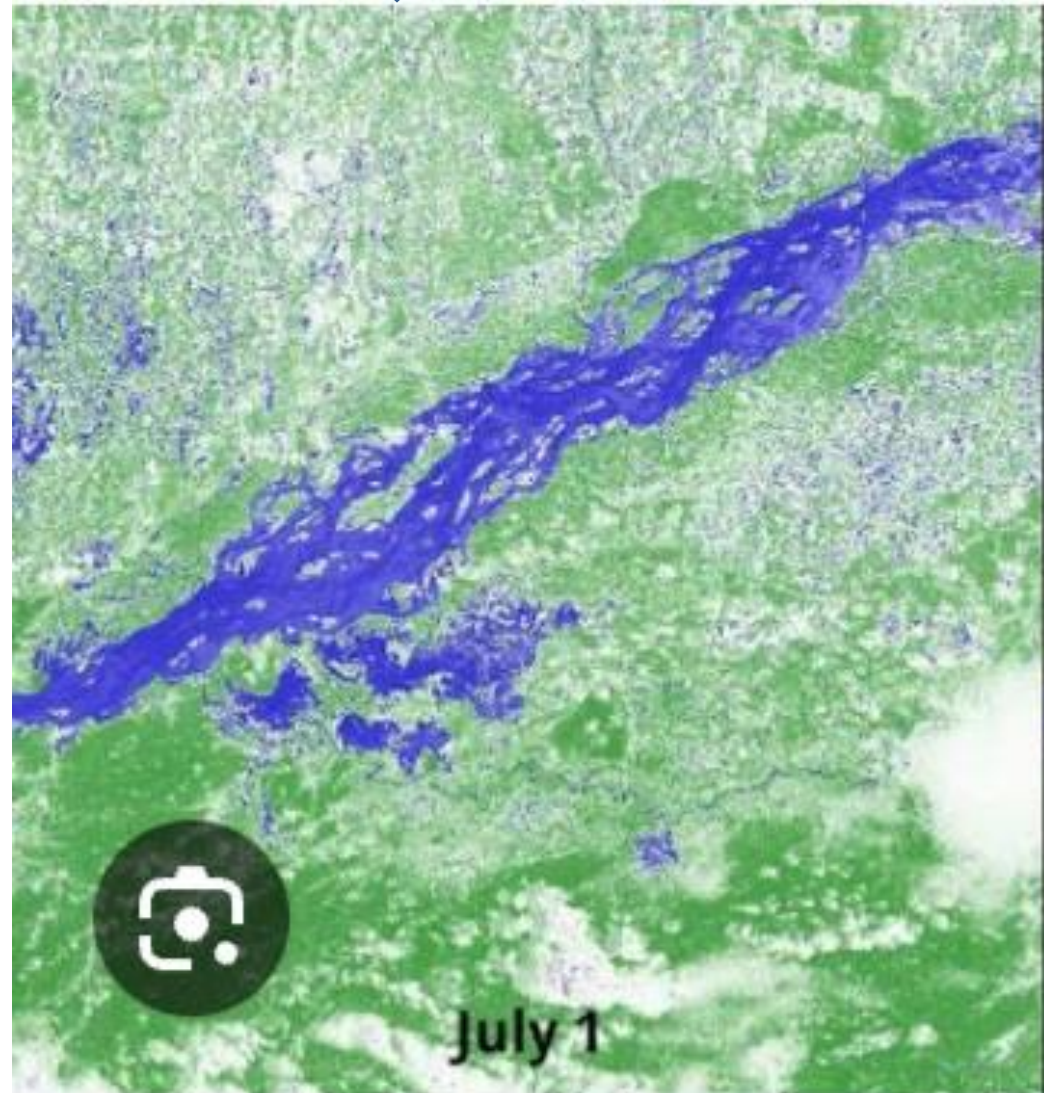


**Geographic Location of
ATI, Nainital**

**29d323m36.39s N
79d36m80.84s E**

Geocoding/Geostamping/Geotagging/Georeferencing

Where is Flooded Area ?



GIS gives answer of

Where ?

What ?



2013 Kedarnath flood
disaster: How a...

[Visit](#)



**Kedarnath Flood Story
And Reasons Behind...**

[Visit](#)

Types of GIS Data

Where ? = Spatial Data

What ? = Non-Spatial or Attribute
Data

What Should be ? = Application

1. GIS ?

2. Storm Water ?

Grade	Rainfall amount of 24 h (mm)
Small rainfall	< 10
Moderate rainfall	10–25
Heavy rainfall	25–50
Storm	50–100
Large storm	100–250
Extreme large storm	≥ 250
Total	

Grade	Rainfall amount of 24 h (mm)
Small rainfall	< 10
Moderate rainfall	10–25
Heavy rainfall	25–50
Storm	50–100
Large storm	100–250
Extreme large storm	≥ 250
Total	

STORM RAIN

Uttarakhand Rain 2022:
आसमान से बरसी आफत.....

Visit



मूसलाधार आफत संकट में देश के 6 राज्य

घमोली-बदरीनाथ हाईवे



में हलचल

वसारी

नापचले

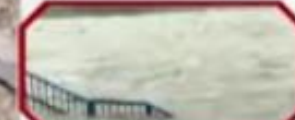
हस्तात

अंधिक्का

में उप्रवास



गुजरात में बढ़ता संकट



उत्तराखंड में उफान, तबाही



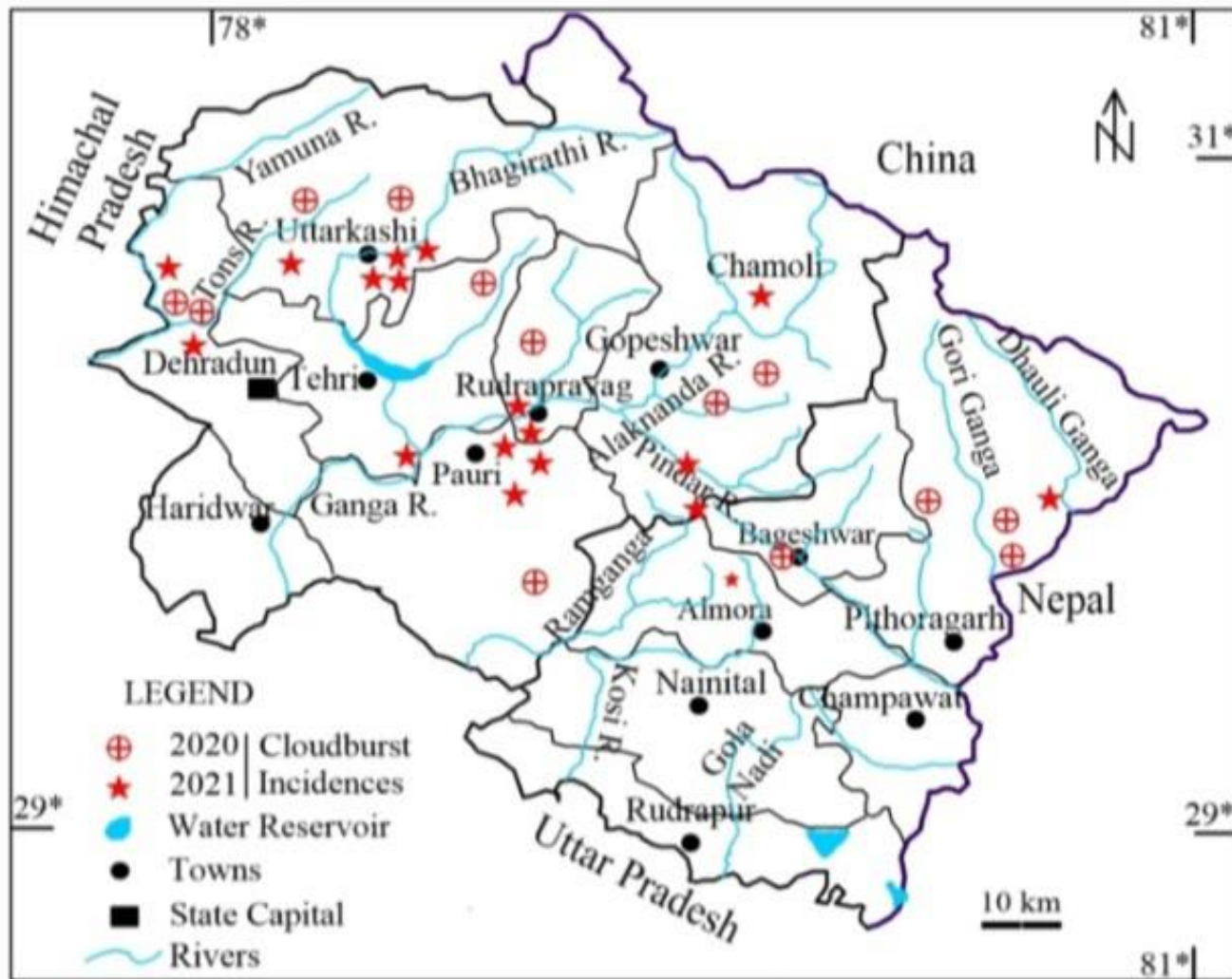
महाराष्ट्र में महामुसीबत

आसमान से बरसी आफत... मूसलाधार मुसीबत



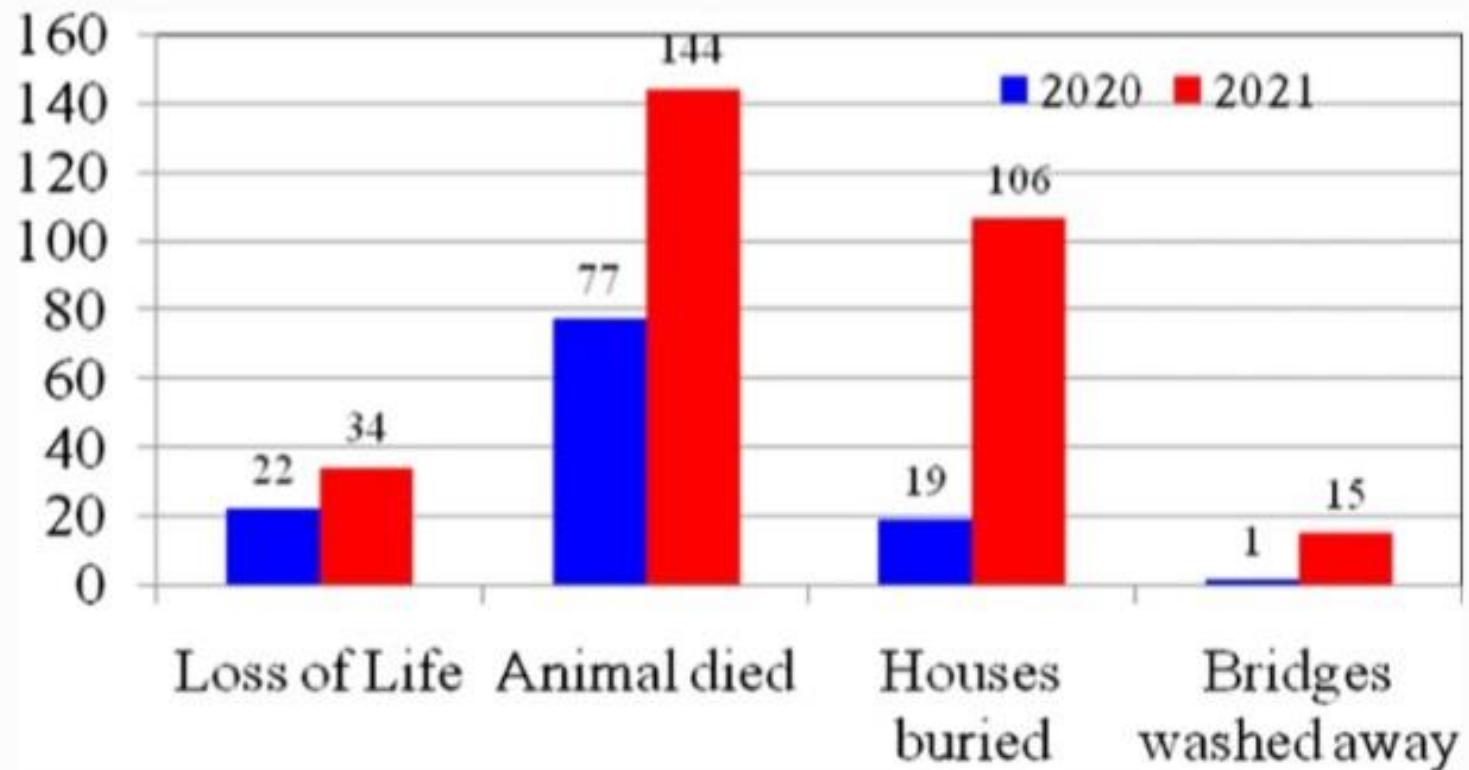
Grade	Rainfall amount of 24 h (mm)
Small rainfall	< 10
Moderate rainfall	10–25
Heavy rainfall	25–50
Storm	50–100
Large storm	100–250
Extreme large storm	≥ 250
Total	

Cloudburst



Location map of cloudbursts hit areas in 2020 and 2021

District-wise major cloudburst events of 2020–2021 are shown in the map of the Uttarakhand Himalaya (Fig. 4). A total of **30 major cloudburst incidences were recorded, out of which, 17 occurred in 2021**. The Uttarkashi district received the highest incidences (07), followed by the Chamoli district (05). 24-Feb-2022



Loss of human lives, livestock, houses and bridges due to cloudburst in Uttarakhand during the 2020 and 2021

1. GIS ?

2. Storm Water ?

3 Urban Flooding ?

Types of Floods ?

Types of Floods ?

1. Meteorological Factors:

Heavy Rainfall, Cloudburst Cyclonic Storm

2. Hydrological Factors:

Overflow Channel Network, High tides impending drainage in coastal cities.

3 Anthropogenic:

Unplanned urbanization,

Urbanization is the key cause for Urban Flooding.



FLOOD HITS NAINITAL



Naini Lake Overflows and floods the streets in Nainital

19/10/21



Watch: Naini Lake
Overflows And Floods...

Watch

Uploaded: 18 Oct 2021

Floods in Uttarakhand, Kerala: Over 70 dead | I...

Visit



Urban flooding - causes and solutions

Visit



Urban flooding - causes and solutions

Visit





**5 bodies recovered from
debris after wall collaps...**

[Visit](#)



Nainital lake overflows
and floods roads,...

[Visit](#)



Army carries out rescue operations in Nainital |...

[Visit](#)

FLOODING IN HALDWANI



Haldwani Witnesses Flood-Like Situation...

[Watch](#)

Uploaded: 10 Aug 2023

100 Views



Manoj Arya

1 d · 🌐

आज से 20 साल
पहले ये रकिसया
नाला क्यों तांडव नहीं
मचाता था, क्यों
हल्दानी की सड़कों पर
नाले जैसा पानी पहले
नहीं बहता था, क्या
कारण होगा?



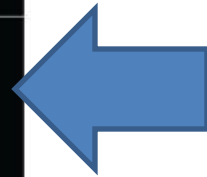


Manoj Arya

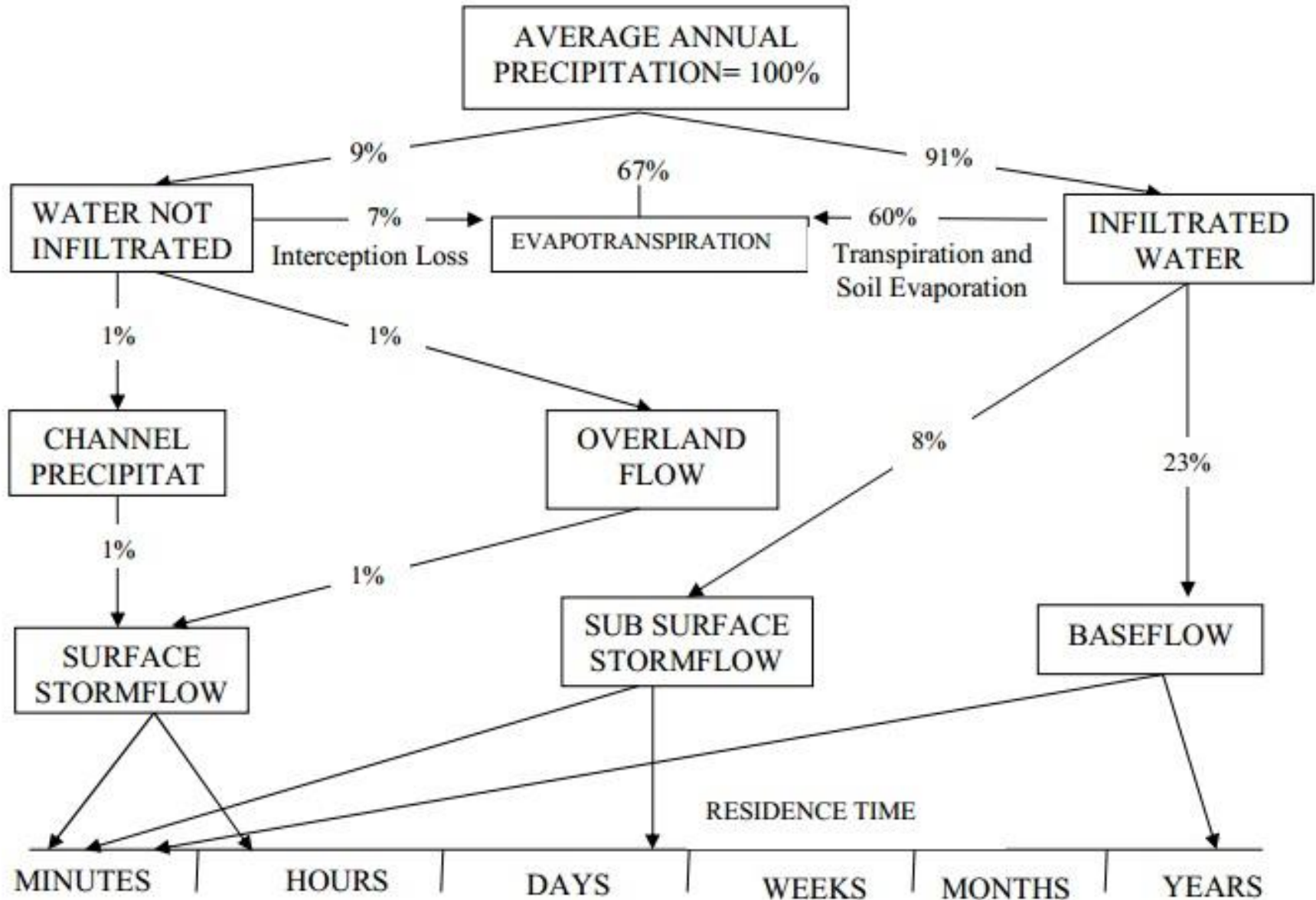
1 d · 🌐

आज से 20 साल
पहले ये रकिसया
नाला क्यों तांडव नहीं
मचाता था, क्यों
हल्दानी की सड़कों पर
नाले जैसा पानी पहले
नहीं बहता था, क्या
कारण होगा?

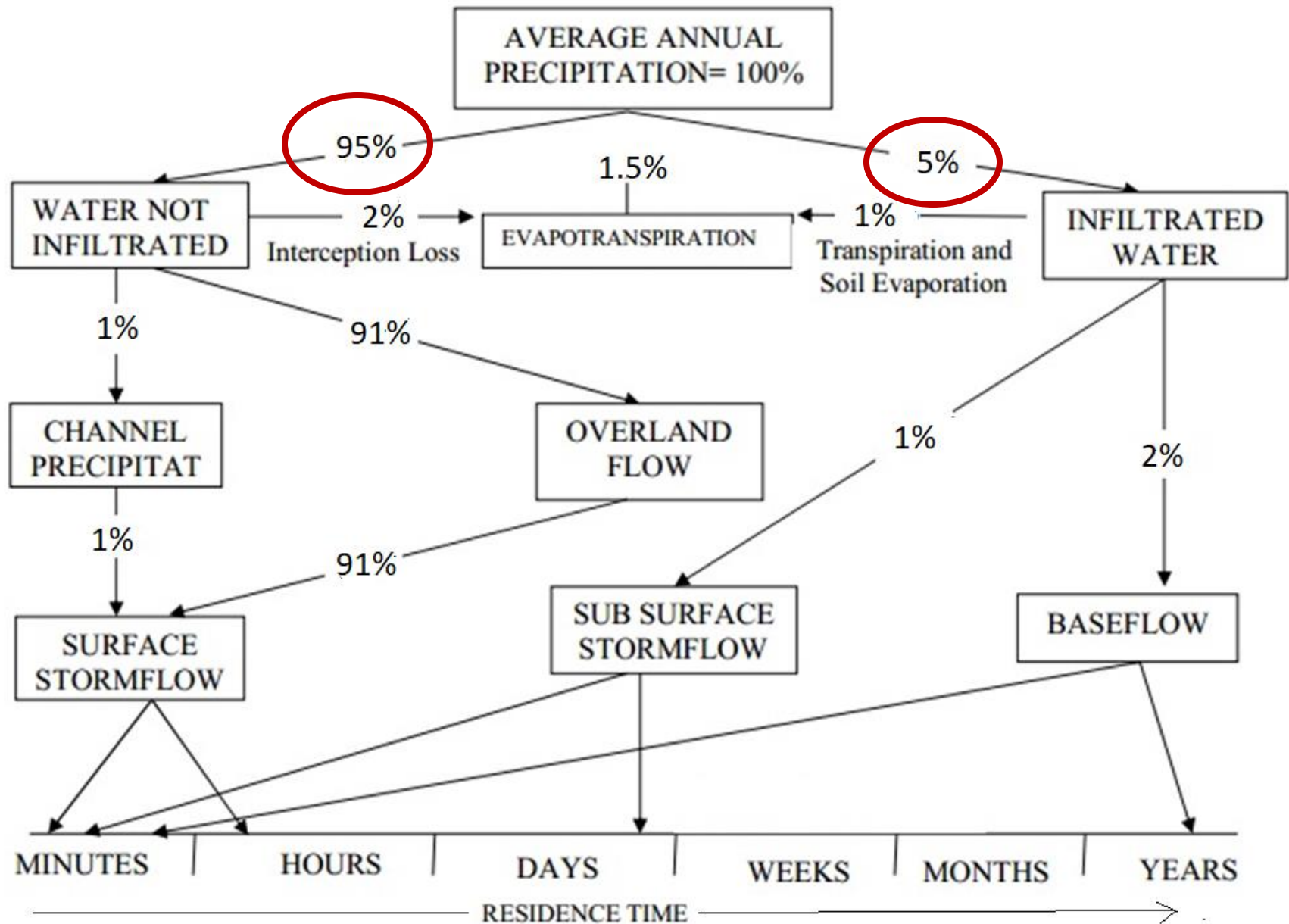
Conversion of
permeable
surface into
impermeable
surface



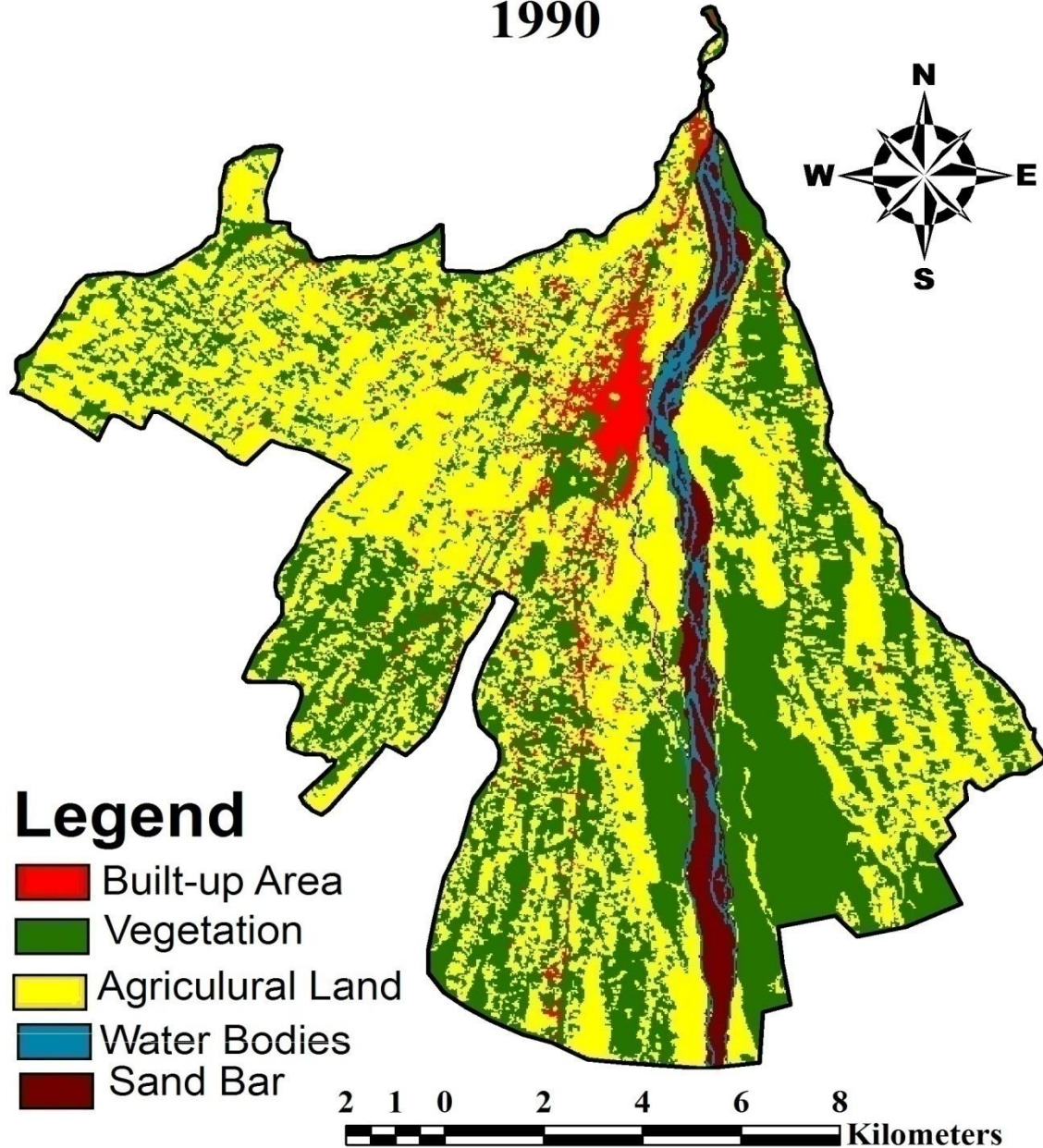
Apportionment of Rainstorm Water Under Natural Condition



In Urban Areas – Impermeable Surface

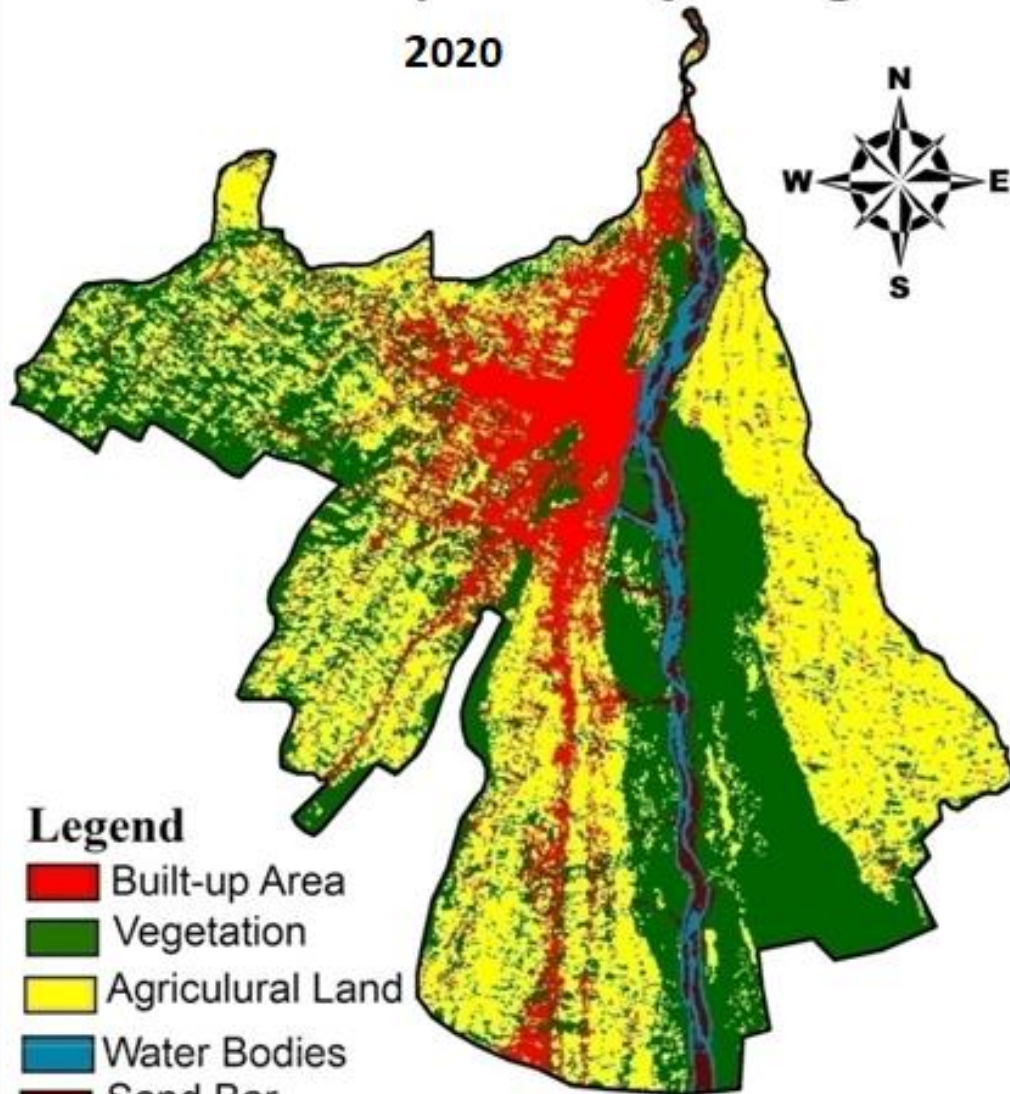


Haldwani City and Adjoining Area 1990



Haldwani City and Adjoining Area

2020



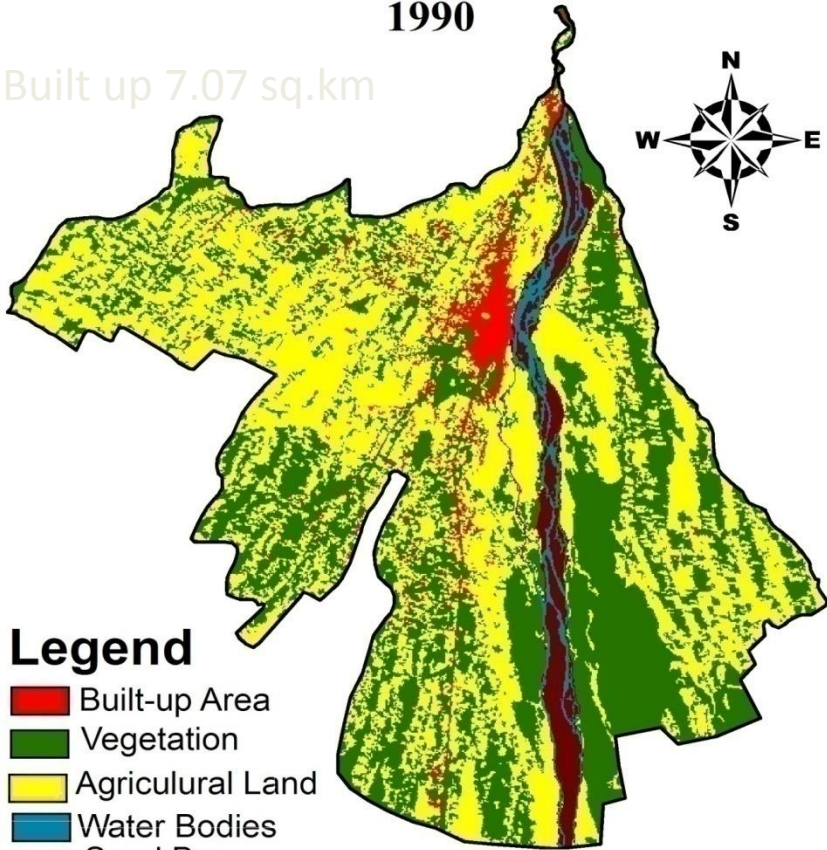
Legend

-  Built-up Area
-  Vegetation
-  Agricultural Land
-  Water Bodies
-  Sand Bar

2 1 0 2 4 6 8
Kilometers

Haldwani City and Adjoining Area 1990

Built up 7.07 sq.km

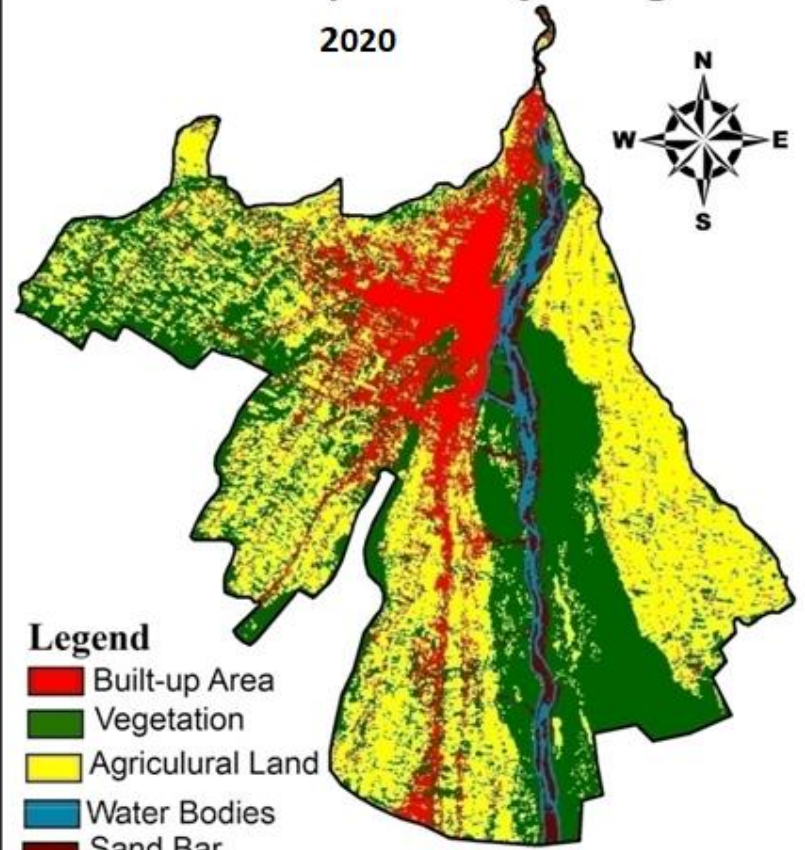


Legend

- Built-up Area
- Vegetation
- Agricultural Land
- Water Bodies
- Sand Bar



Haldwani City and Adjoining Area 2020



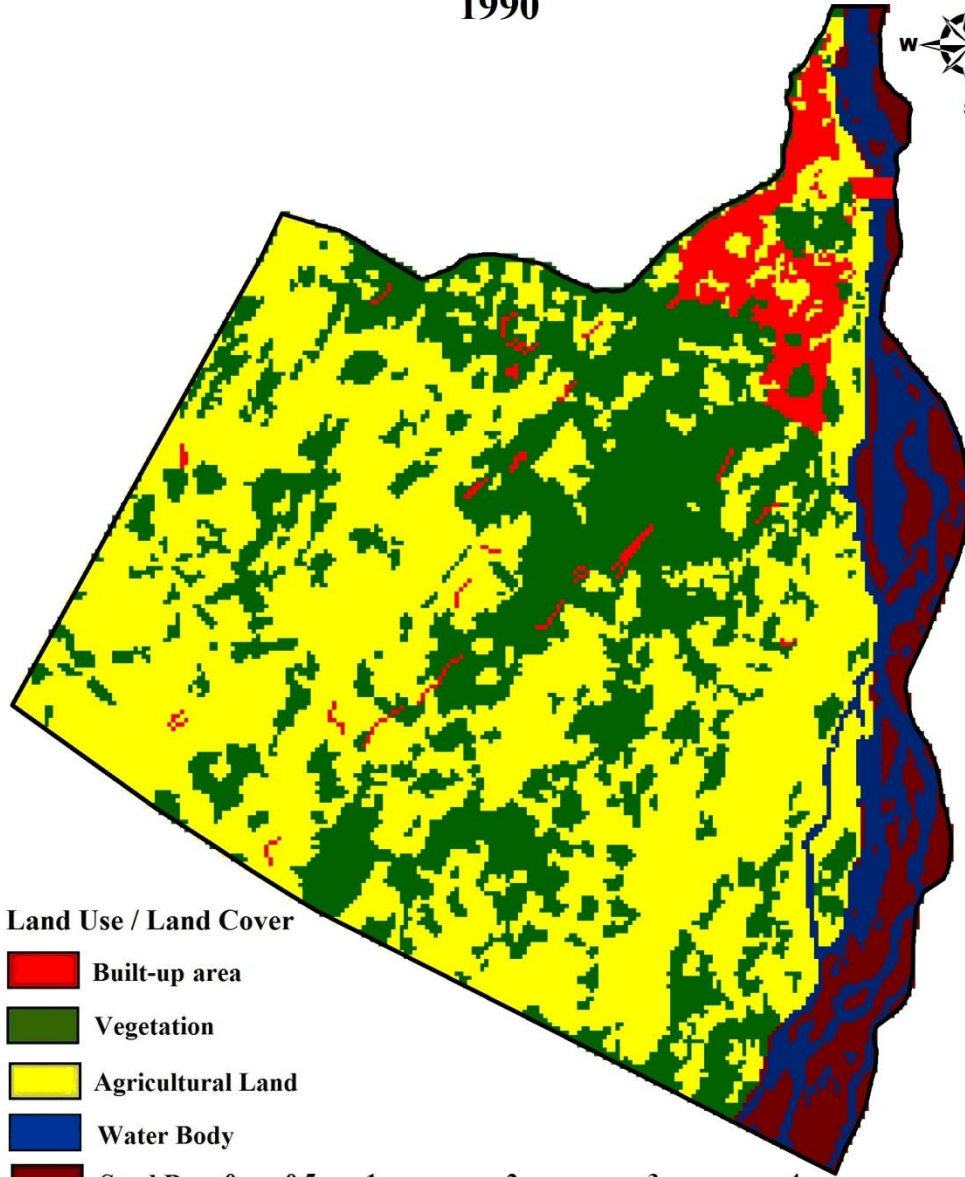
Legend

- Built-up Area
- Vegetation
- Agricultural Land
- Water Bodies
- Sand Bar



RAMNAGAR TOWN AREA


1990



Land Use / Land Cover

 Built-up area

 Vegetation

 Agricultural Land

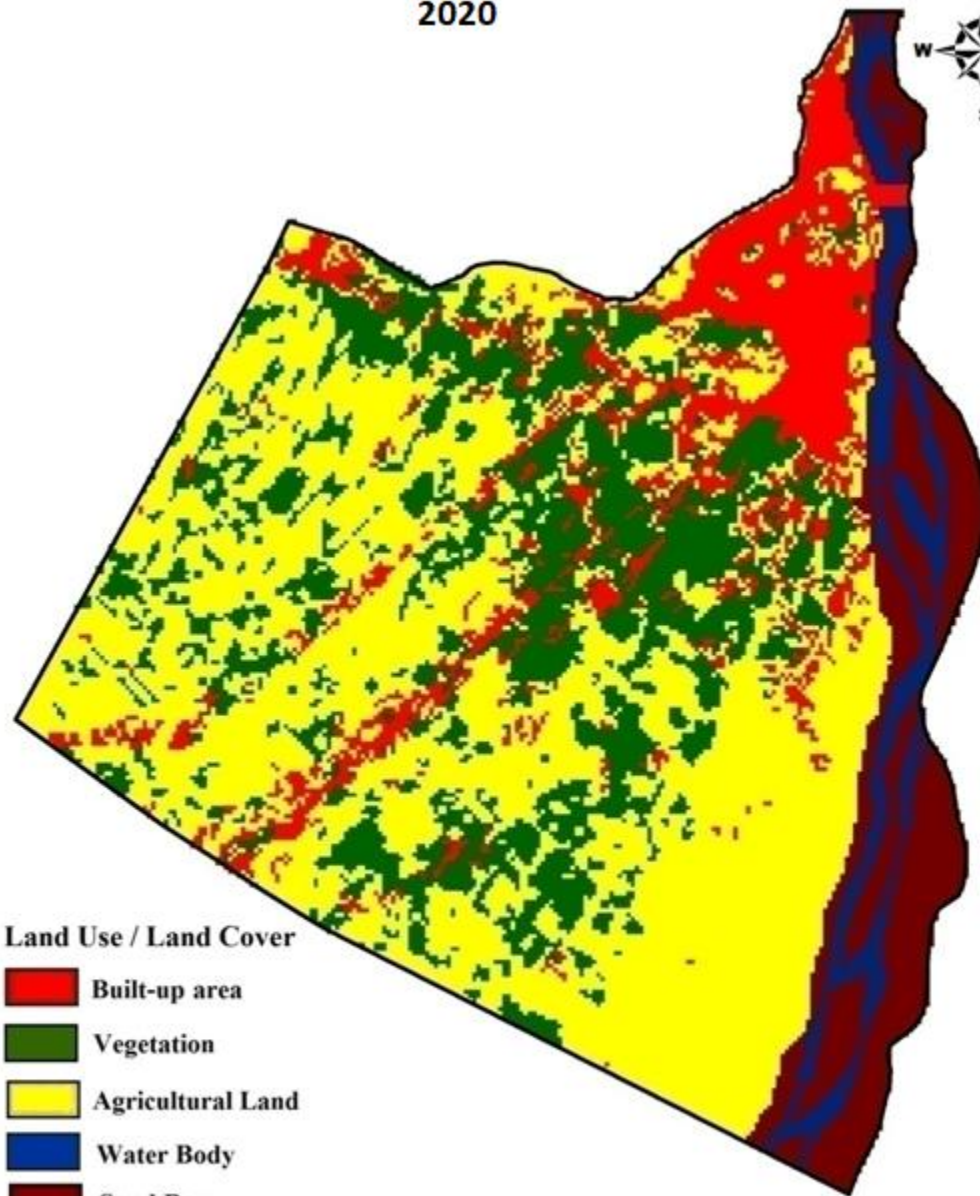
 Water Body

 Sand Bar








RAMNAGAR TOWN AREA

2020



Land Use / Land Cover

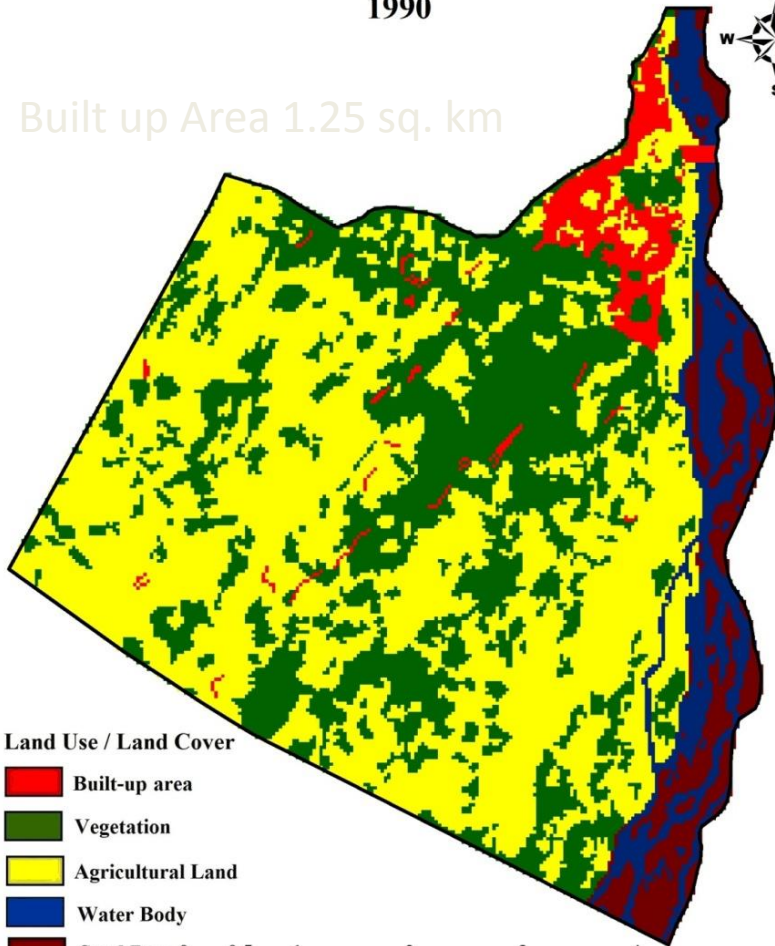
-  Built-up area
-  Vegetation
-  Agricultural Land
-  Water Body
-  Sand Bar



RAMNAGAR TOWN AREA

1990

Built up Area 1.25 sq. km



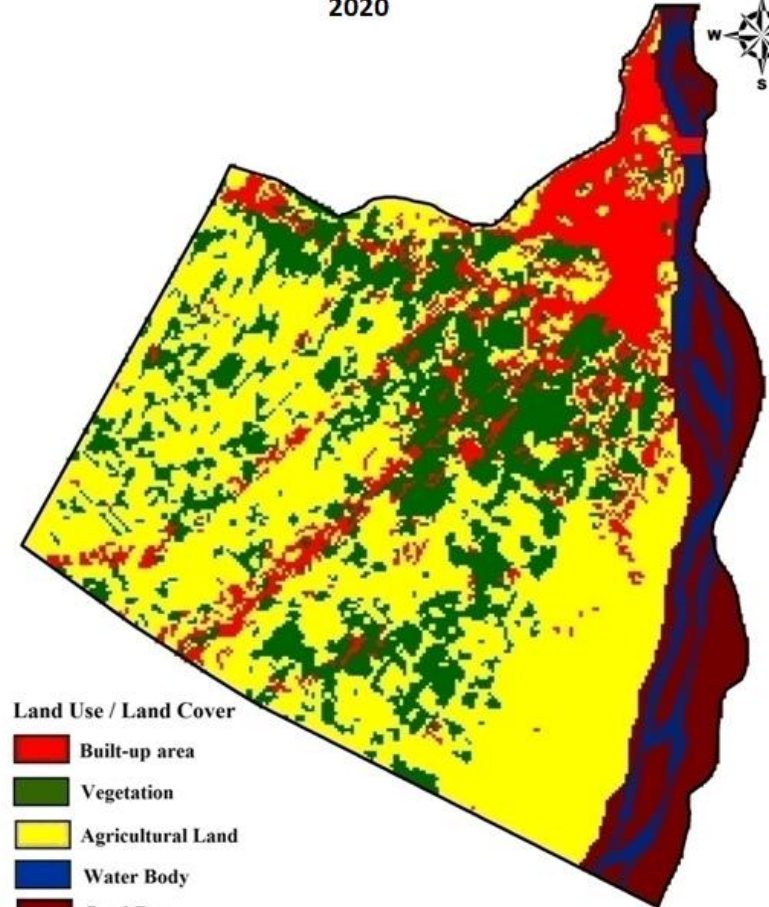
Land Use / Land Cover

- Built-up area
- Vegetation
- Agricultural Land
- Water Body
- Sand Bar

0 0.5 1 2 3 4 Kilometers

RAMNAGAR TOWN AREA

2020



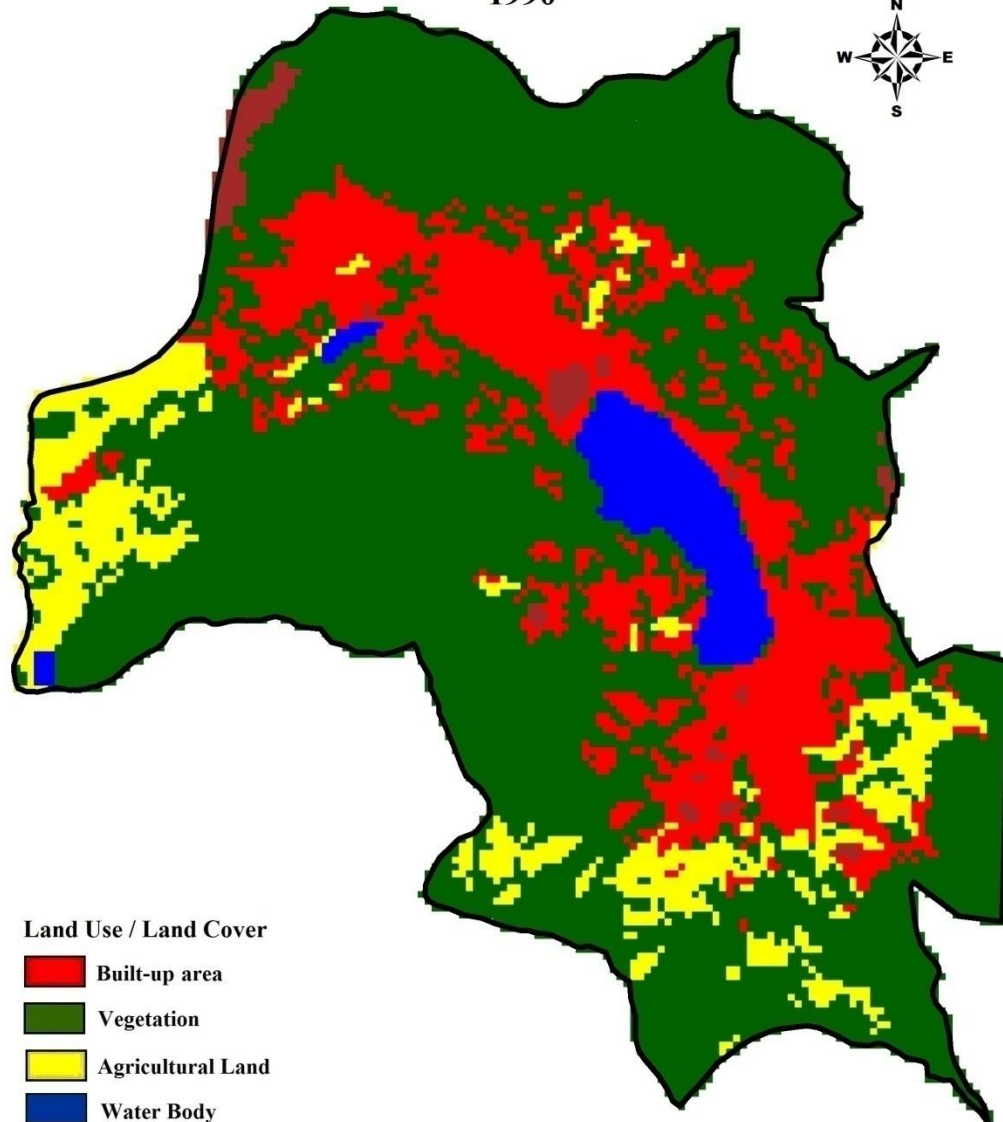
Land Use / Land Cover

- Built-up area
- Vegetation
- Agricultural Land
- Water Body
- Sand Bar






0 0.5 1 2 3 4 Kilometers

Nainital Town Area

1990



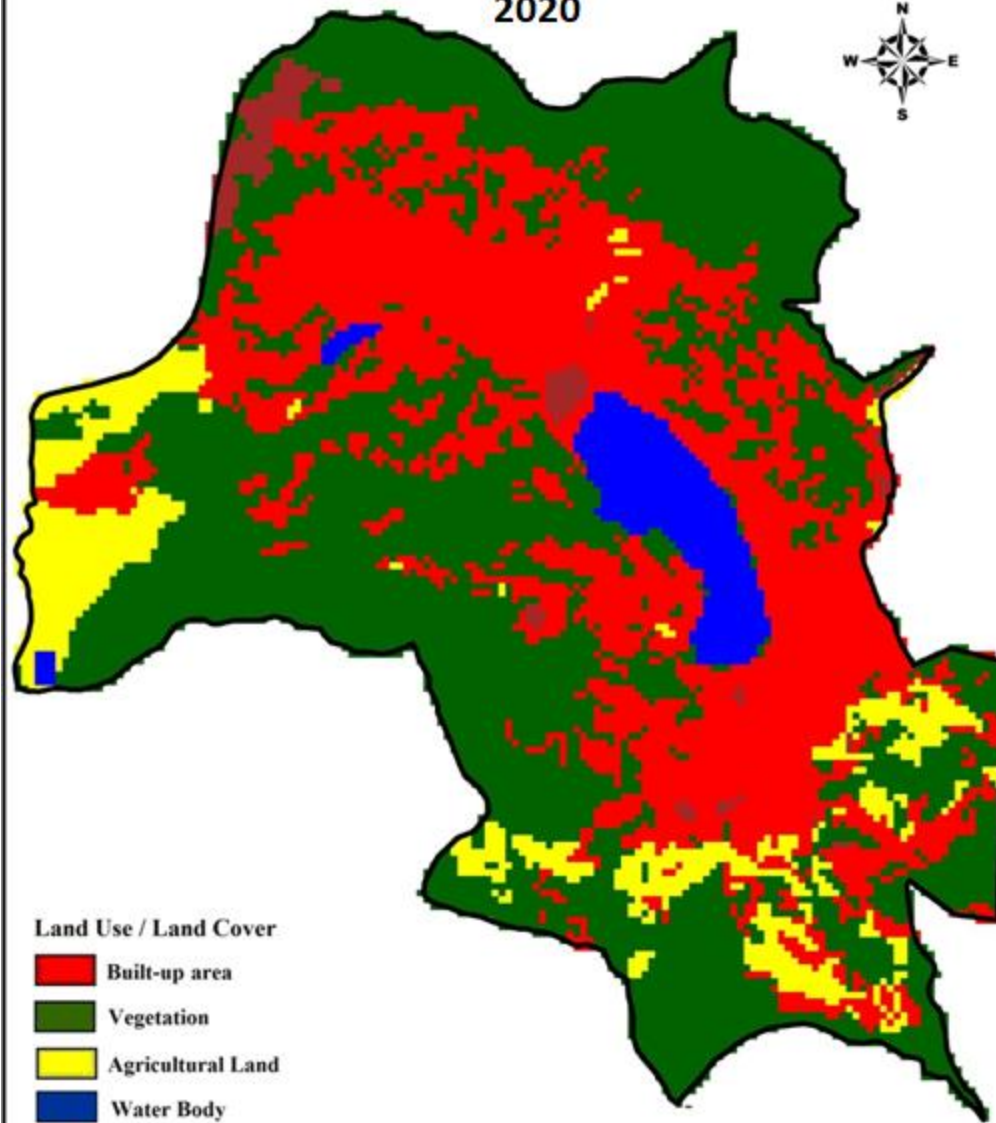
Land Use / Land Cover

-  Built-up area
-  Vegetation
-  Agricultural Land
-  Water Body
-  Open Space







Nainital Town Area

2020



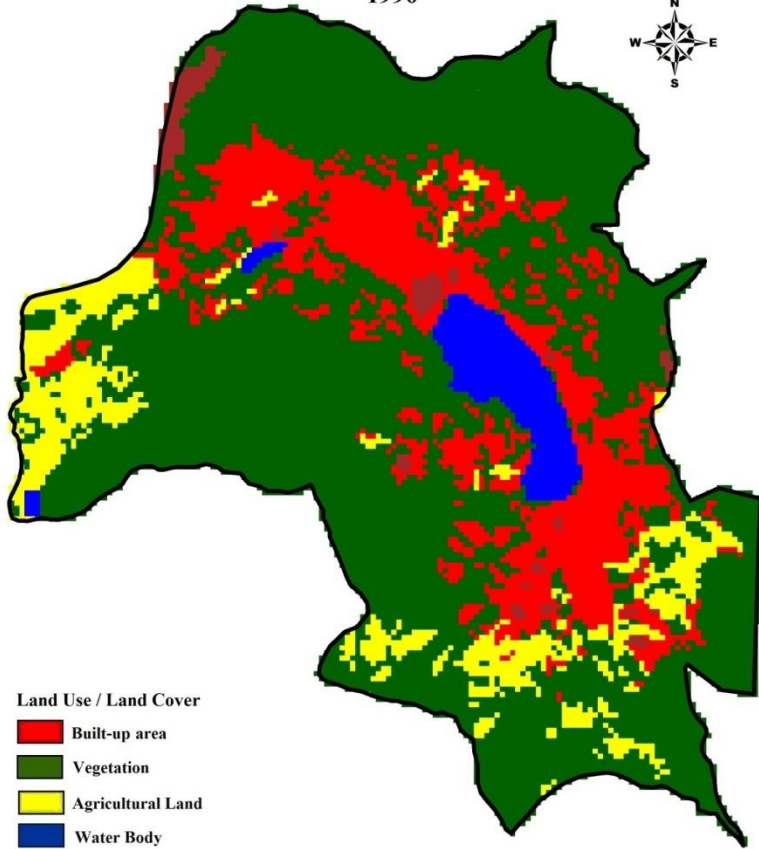
Land Use / Land Cover

-  Built-up area
-  Vegetation
-  Agricultural Land
-  Water Body
-  Open Space



Nainital Town Area

1990



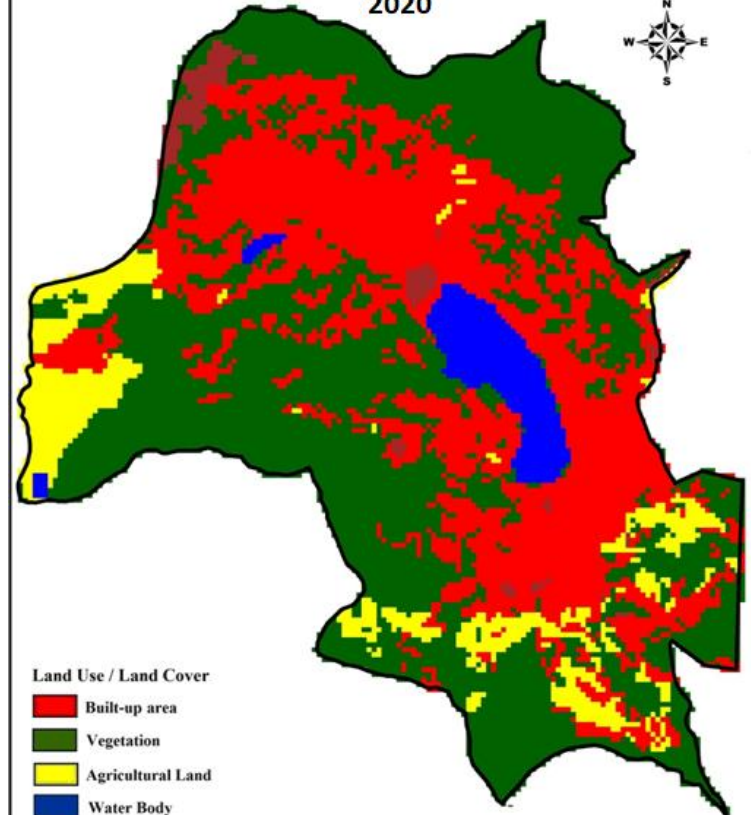
Land Use / Land Cover

- Built-up area
- Vegetation
- Agricultural Land
- Water Body
- Open Space



Nainital Town Area

2020

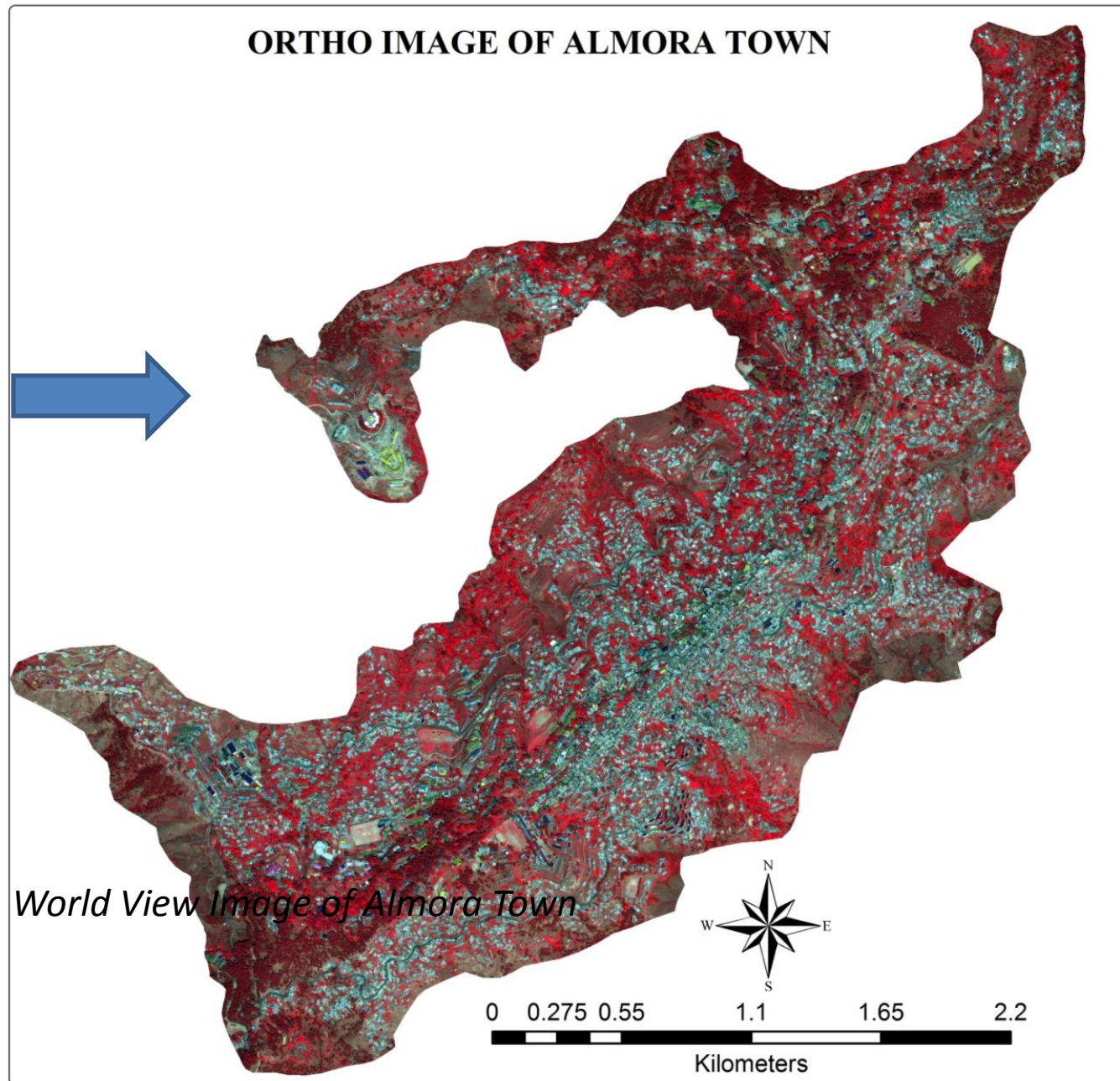


Land Use / Land Cover

- Built-up area
- Vegetation
- Agricultural Land
- Water Body
- Open Space

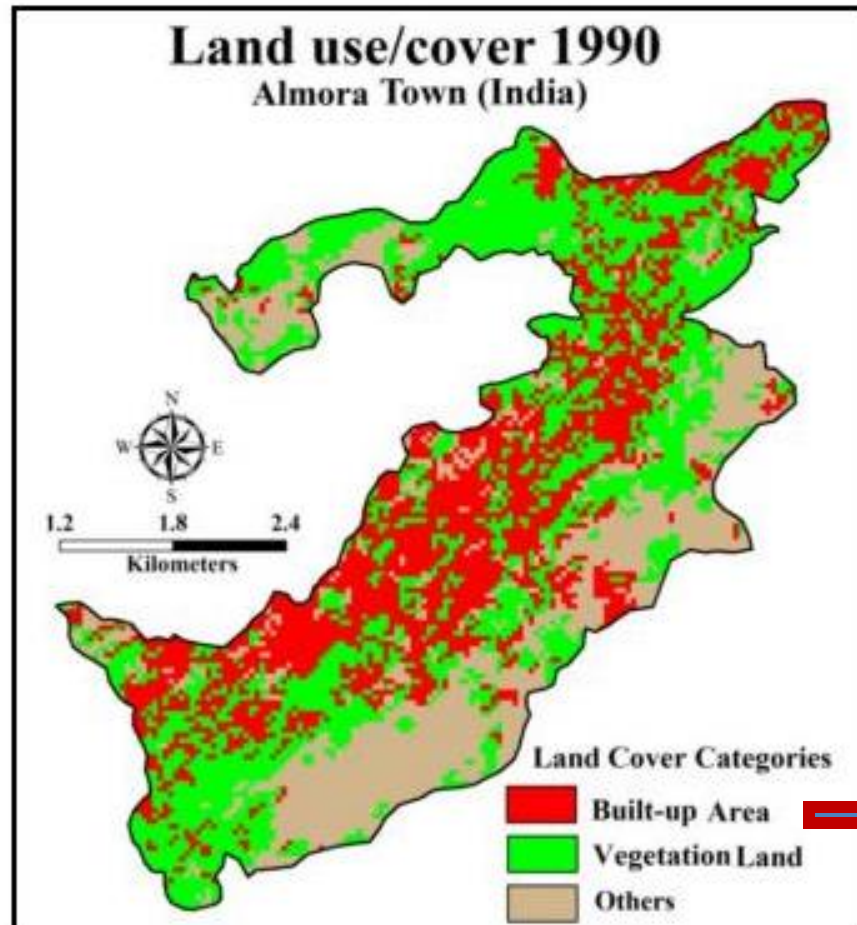


GIS of the Almora Town Area



Spatio-Temporal Dynamics of Almora Town Area, India

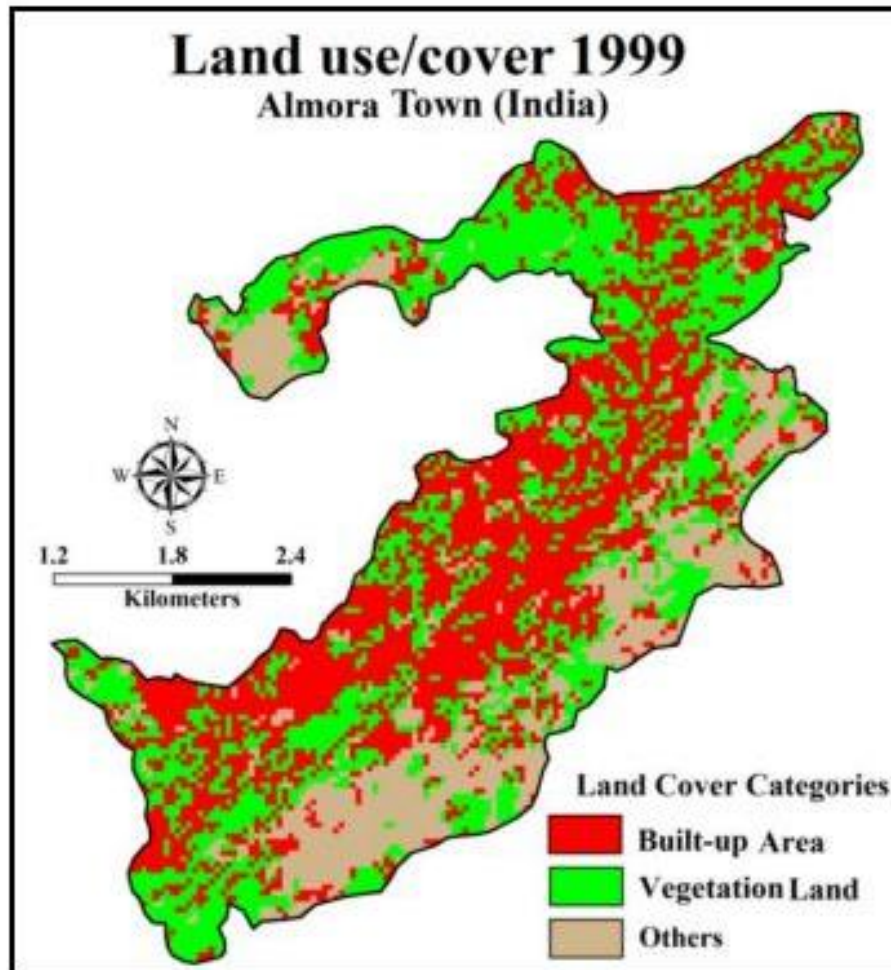
J.S. Rawat¹, Manish Kumar¹, and Ravindra Nath Pathak²



Built up Area
2.30 sq.km

Spatio-Temporal Dynamics of Almora Town Area, India

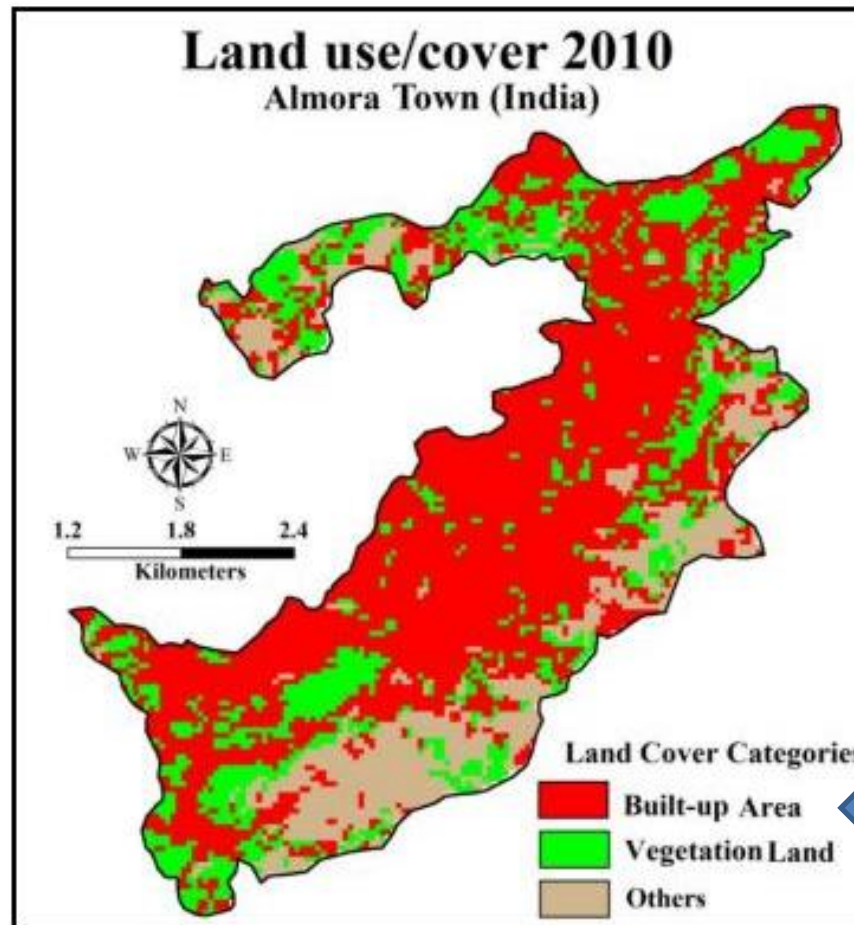
J.S. Rawat¹, Manish Kumar¹, and Ravindra Nath Pathak²



**Built up Area
2.80 sq.km.**

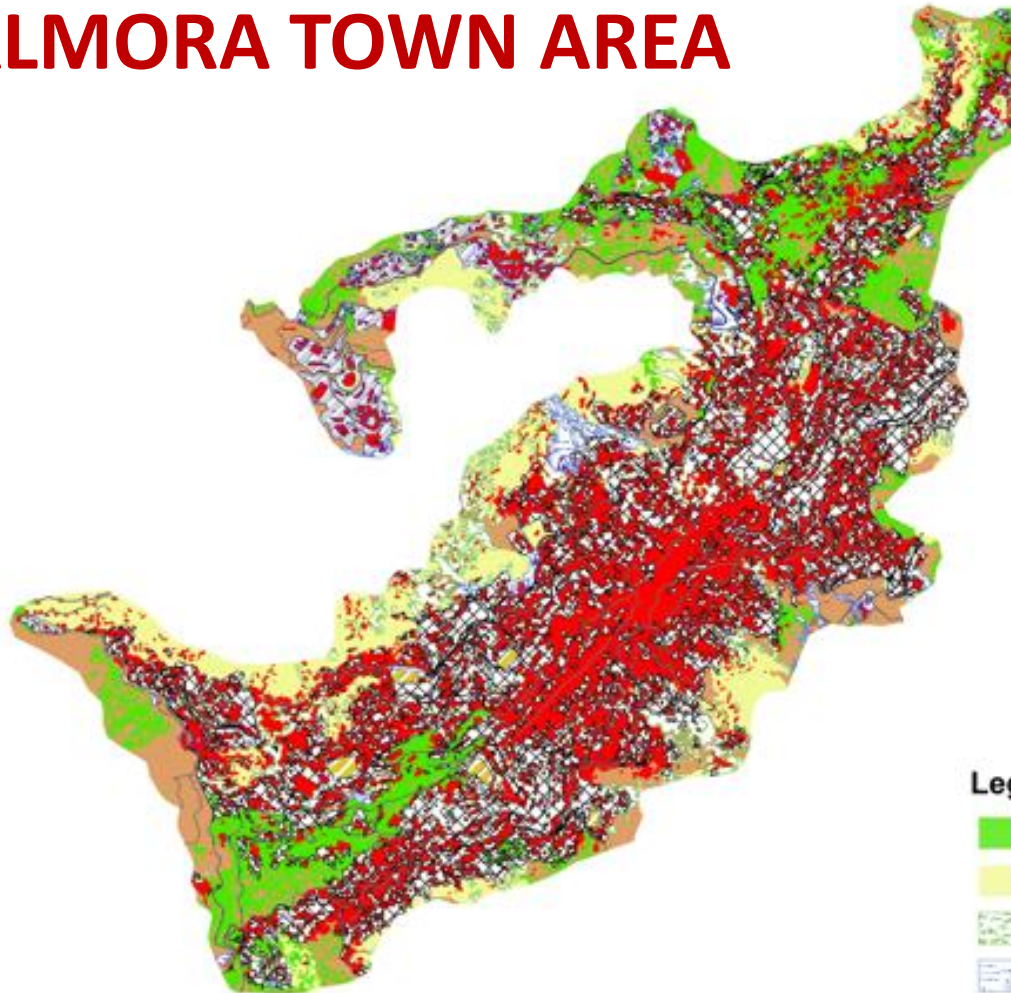
Spatio-Temporal Dynamics of Almora Town Area, India

J.S. Rawat¹, Manish Kumar¹, and Ravindra Nath Pathak²



Built-up Area
3.30 sq.km

ALMORA TOWN AREA

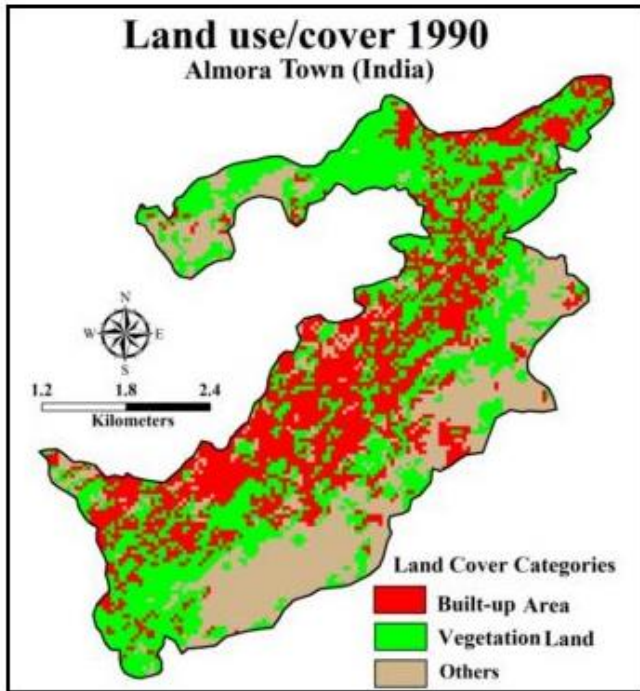


Legend

- | | |
|--|---|
|  Forest |  Barren Land/Open Land |
|  Agriculture |  Vacant Land |
|  Grassland |  Open Land |
|  Scrub |  Play Ground |
|  Orchard/Plantation |  River/Waterbody |
|  Built-up |  Road |

Kilometers
0 0.325 0.65 1.3 1.95 2.6

Built-up Area -4.50 sq km



Built-up Area

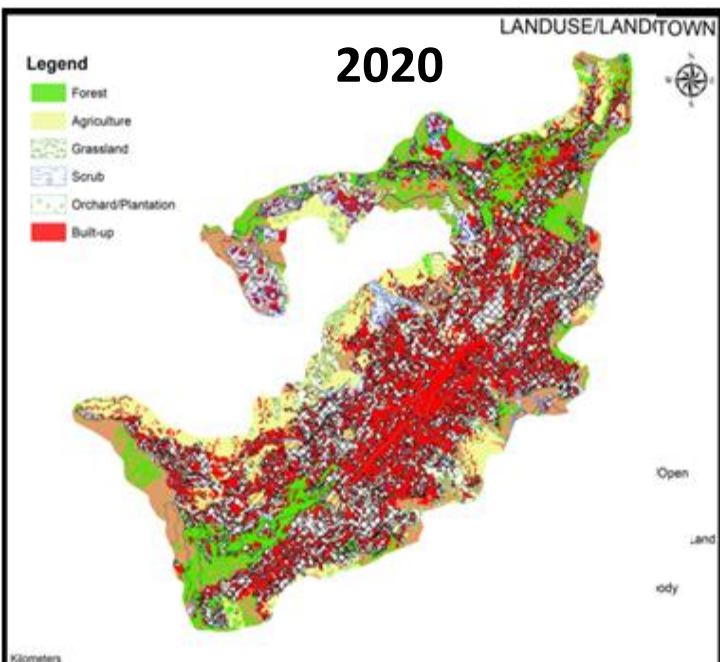
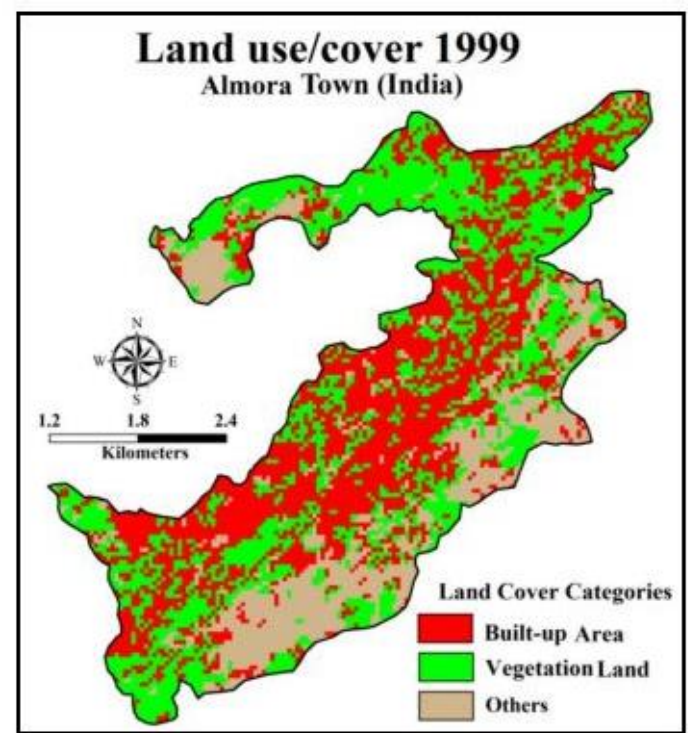
Yr -sq.km

1990-2.30

1999-2.80

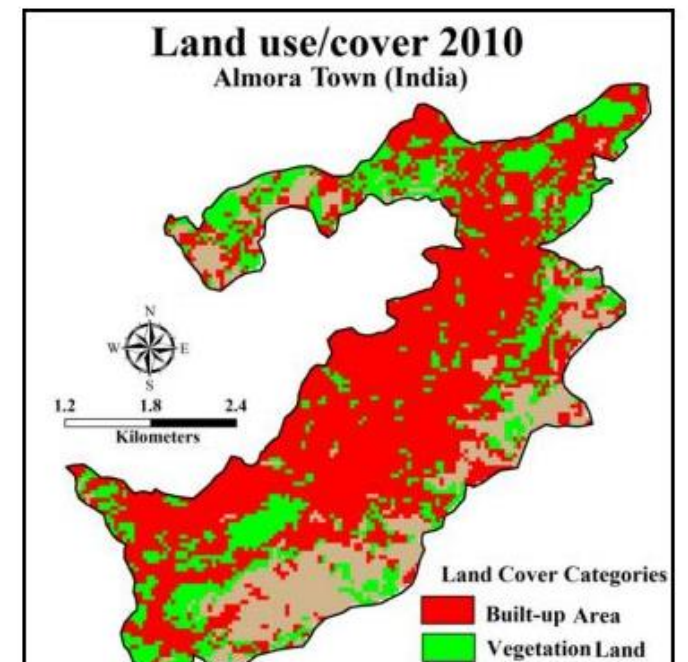
2010-3.30

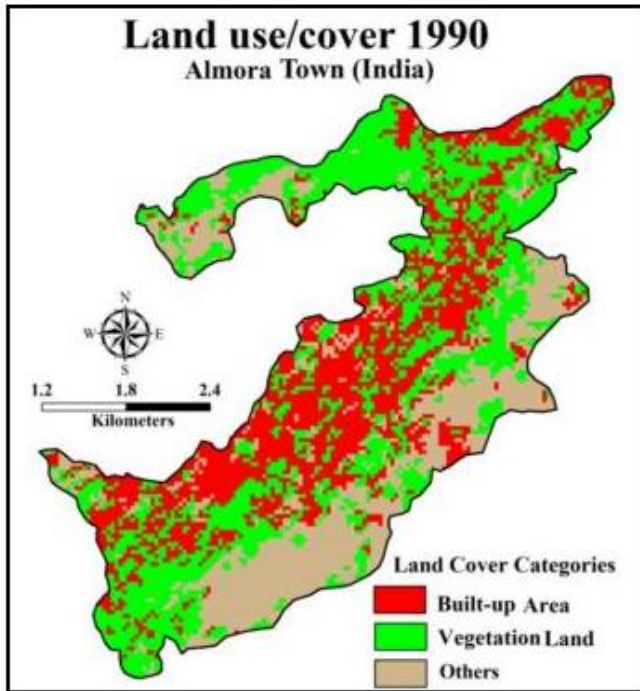
2020-4.50



With in 3 Decades

2.20 sq.k.m





**Built-up
Area**

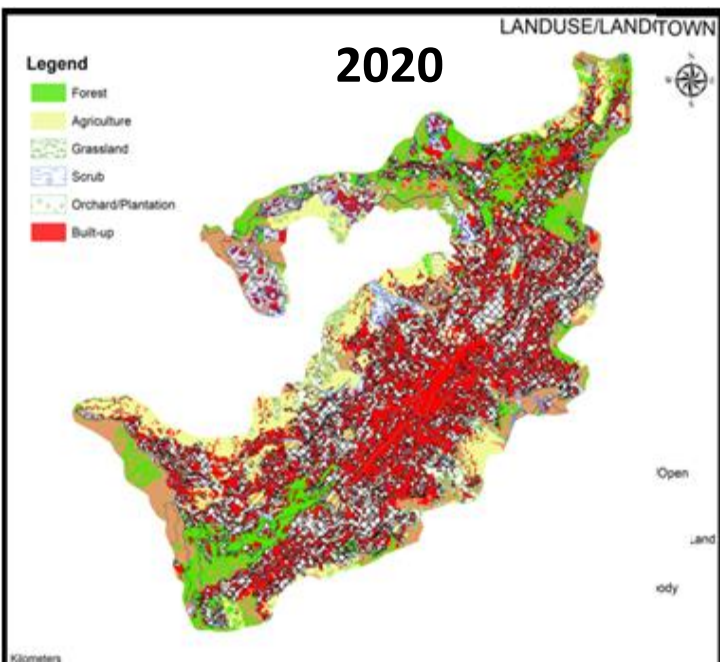
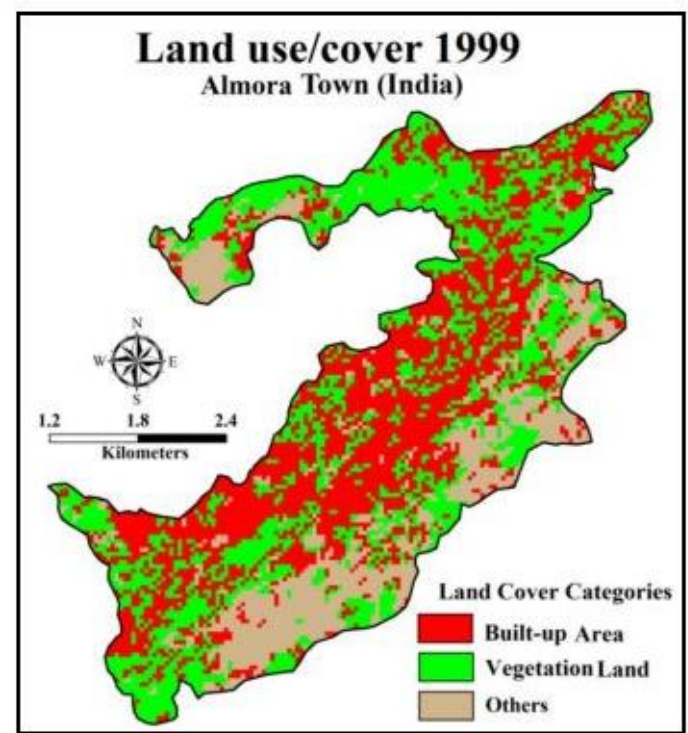
Yr -sq.km

1990-2.30

1999-2.80

2010-3.30

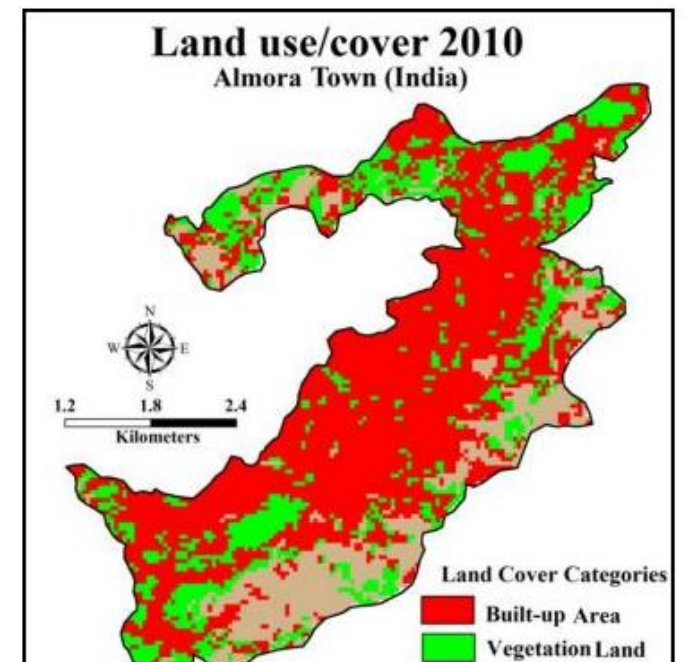
2020-4.50



**0.11
sq.km/yr**

OR

**1.10 lac
Sq.m/yr**



**ENCROACHMENT OF RIVER
RESIDENCE AREAS
River Terraces**



**वर्षा ऋतु की परिभाषा:
नदियों द्वारा अपनी
जमीन, जोकि मानव
द्वारा हथिया ली गई थी,
पर खुद के स्वामित्व की
पुनर्स्थापना के काल को
वर्षा ऋतु कहते हैं।**

140

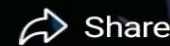
25 comments



Like



Comment



Share

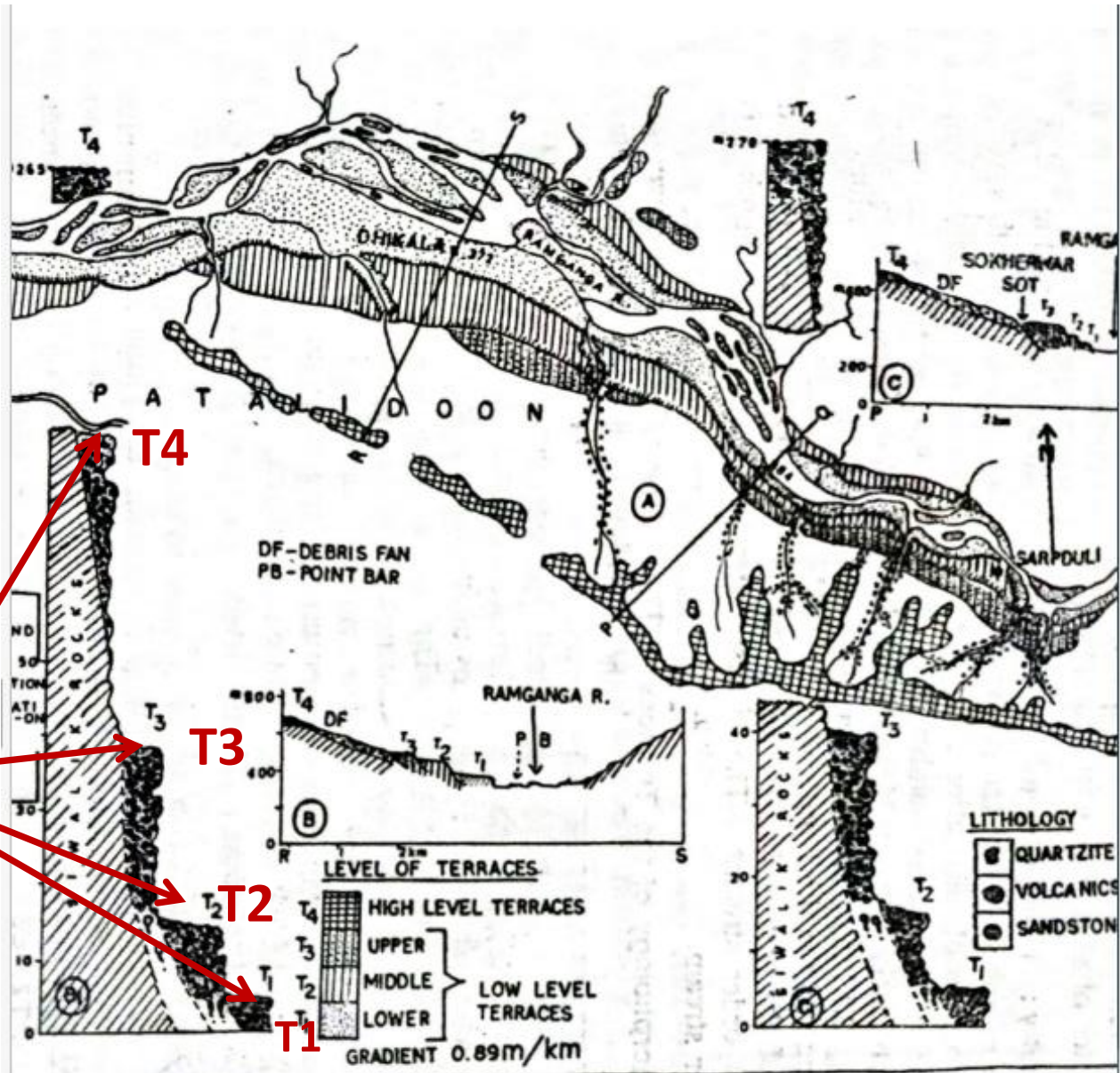


ENCROACHMENT OF RIVER RESIDENCE AREAS

River Terraces

T1 – 5m	Khadar
T2-10m	
T3-50m	Bangar
T4-100m	

**Flood
Plains**



Encroachment in River Path –T1



Encroachment in River Path –T1

(Tectonic Geomorphology)



Four dead, 20 rescued as

[Visit](#)

T1 to T3 (Tectonic Geomorphology)



60,000 stranded in
Uttarakhand - The Hindu

[Visit](#)

Buildings –T2

(Tectonic Geomorphology)



**Buildings
on
Alluvium**

Buildings on T-1

(Tectonic Geomorphology)

Uttarakhand Floods: 20+
Dead as Heavy Rains Hit...

Visit



Buildings on T-1

(Tectonic Geomorphology)

Worst of the Uttarakhand
floods: a compilation of...

Visit



Buildings on T-1

(Tectonic Geomorphology)

Worst of the Uttarakhand
floods: a compilation of...

Visit



Buildings on T-1

(Tectonic Geomorphology)

Worst of the Uttarakhand
floods: a compilation of...

Visit



Buildings
on
Alluvium

Worst of the Uttarakhand floods: a compilation of...

Visit



Uttarakhand Floods: 20+ Dead as Heavy Rains Hit...

Visit



Worst of the Uttarakhand floods: a compilation of...

Visit



12:54 139

85%




**वर्षा ऋतु की परिभाषा:
नदियों द्वारा अपनी
जमीन, जोकि मानव
द्वारा हथिया ली गई थी,
पर खुद के स्वामित्व की
पुनर्स्थापना के काल को
वर्षा ऋतु कहते हैं।**

 140

25 comments

 Like

 Comment

 Share



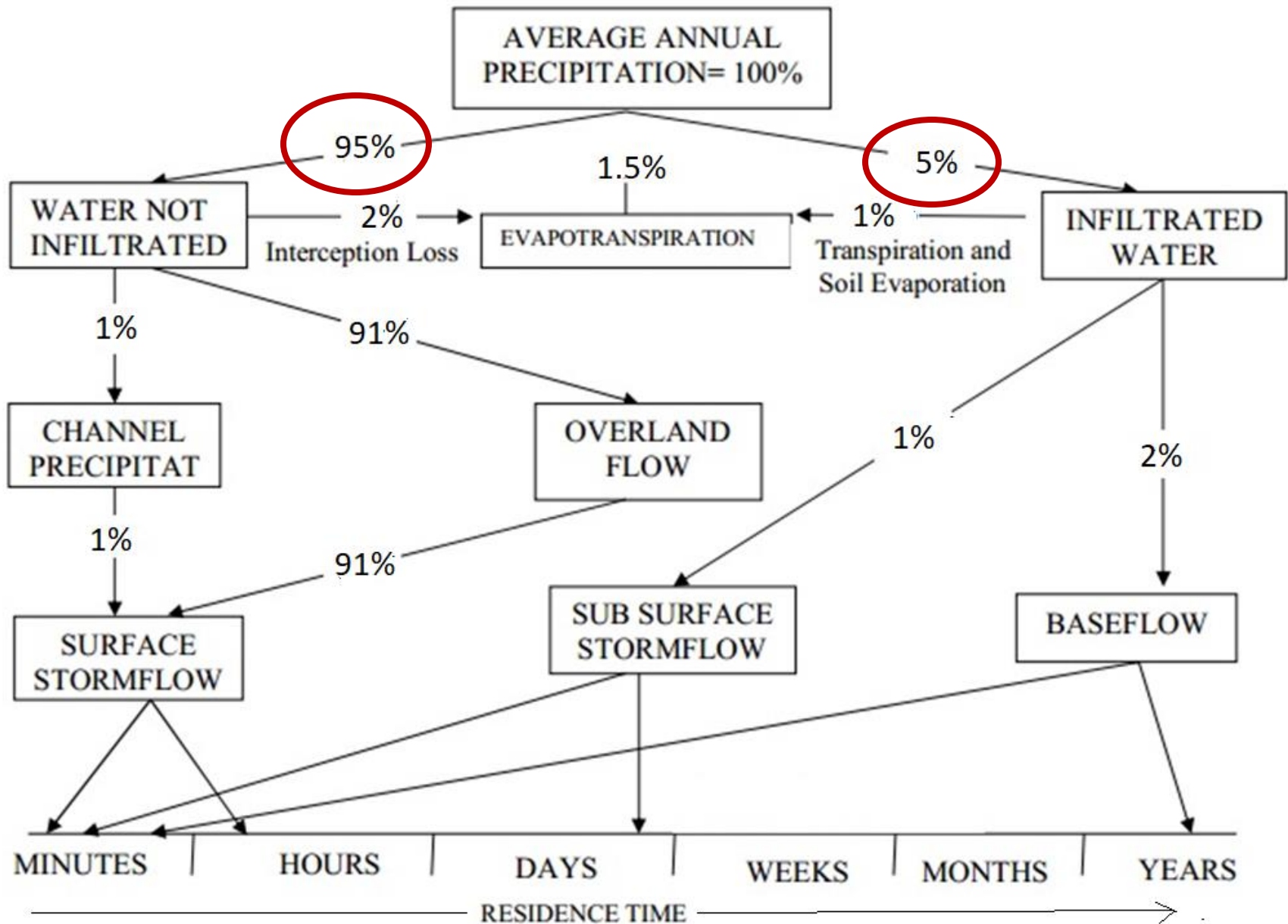
1. GIS ?

2. Storm Water ?

3. Urban Flooding

4. Storm Water Management

In Urban Areas – Impermeable Surface



3. Drastic Decrease in Rainy Hours

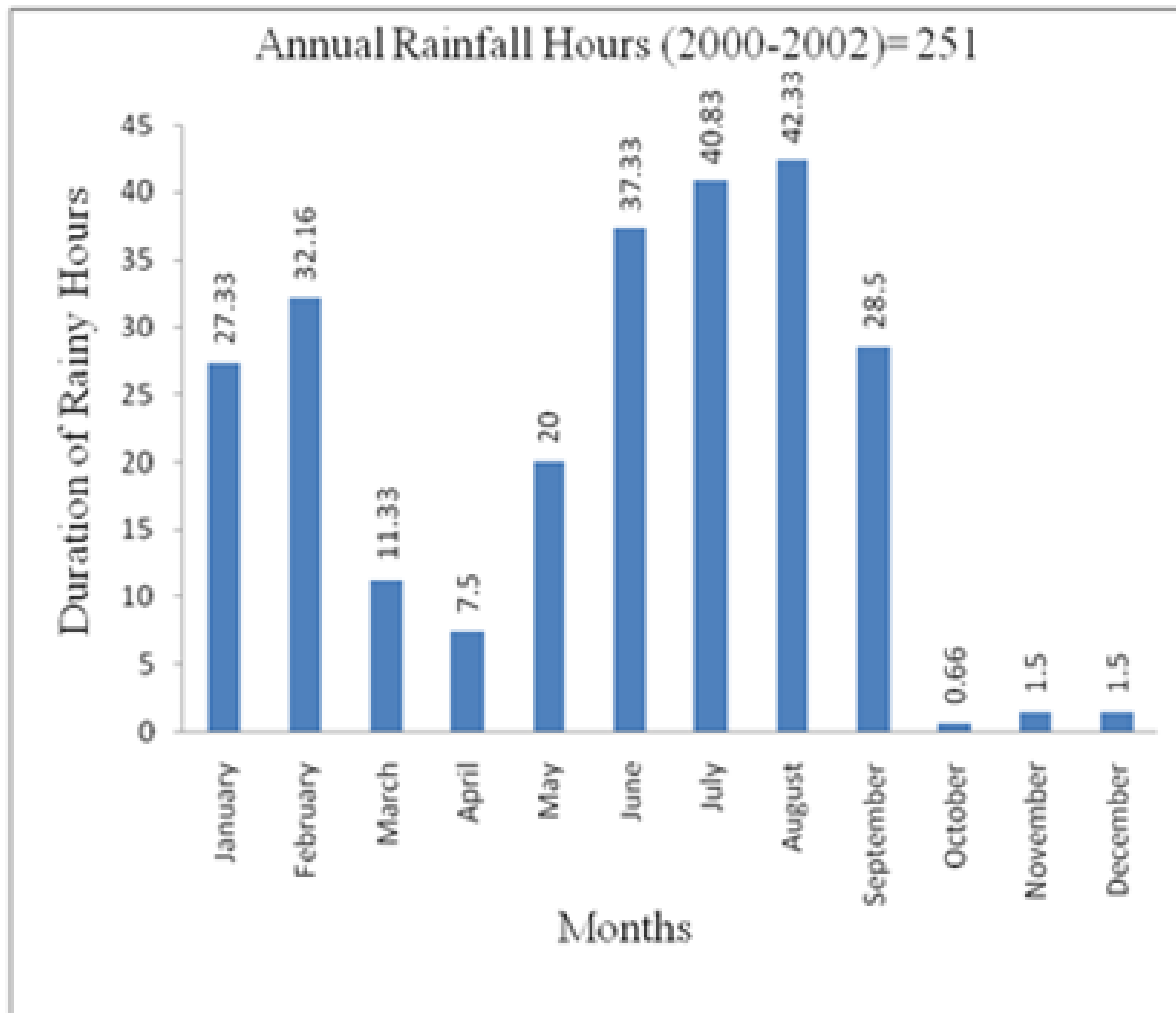


Fig. 5: Average monthly rainfall hours (2000-2002) at Village Salla Rautela, District Almora (after Rawat and Geeta, 2002)

Proper Cleaning of all Natural Drains



Size of Drains not as per Storm Rain ?



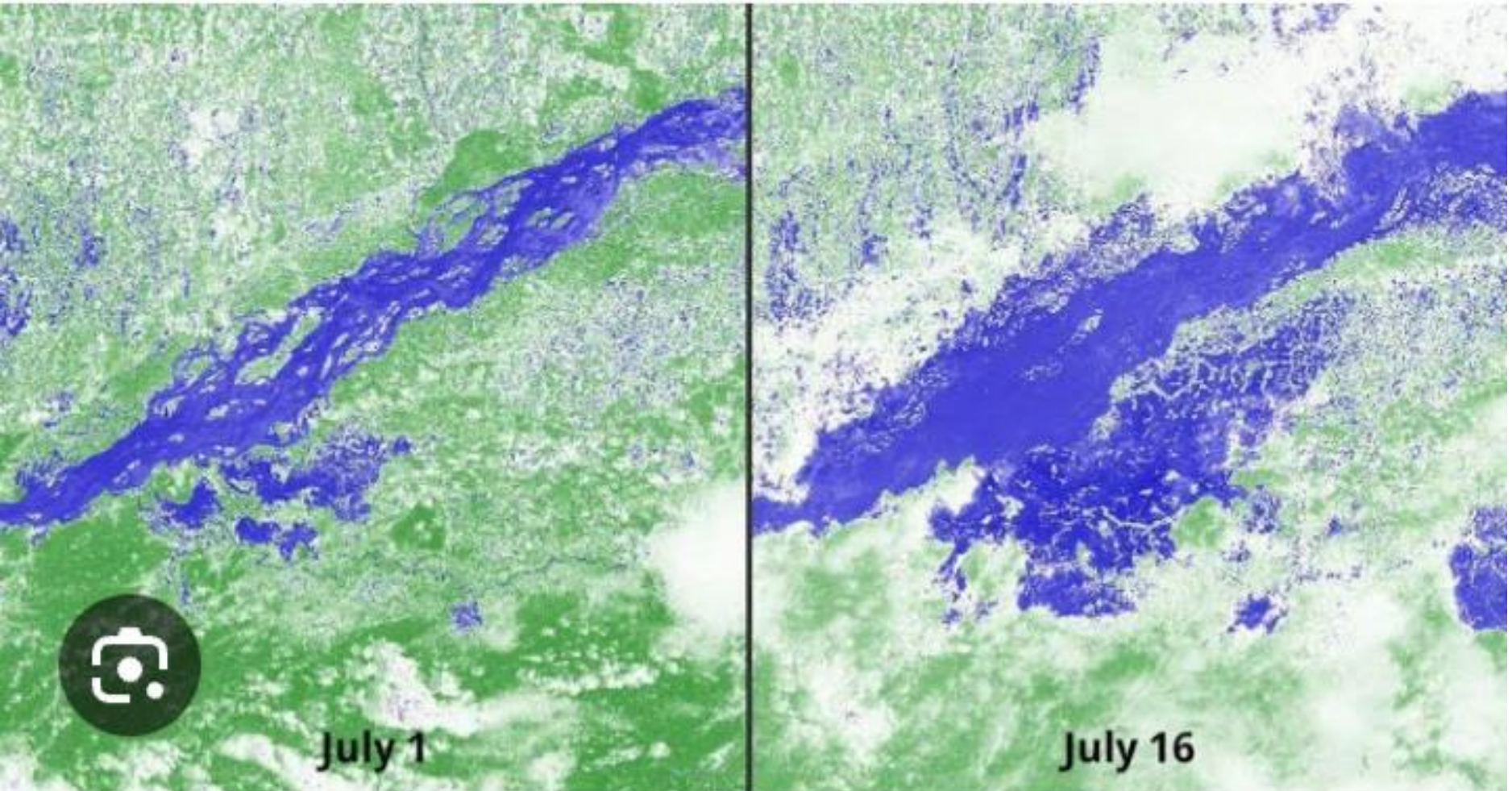


Draining Capacity Bank full Discharge ?



SIZE ?

Application of GIS in Monitoring Flood





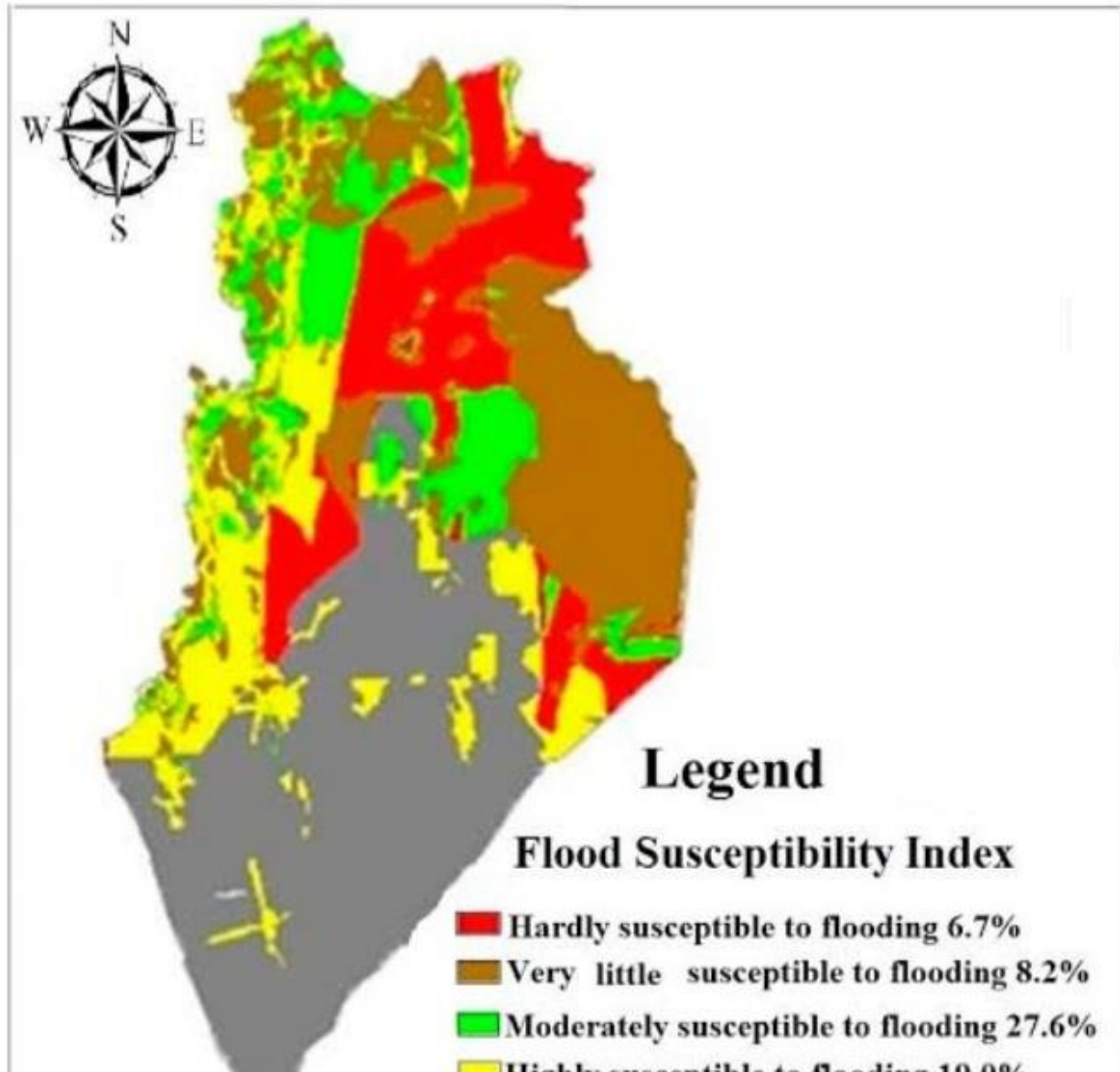
Landsat 5 TM
Image Subset
Path 23, Row 34
Acquired: 14 October 2010

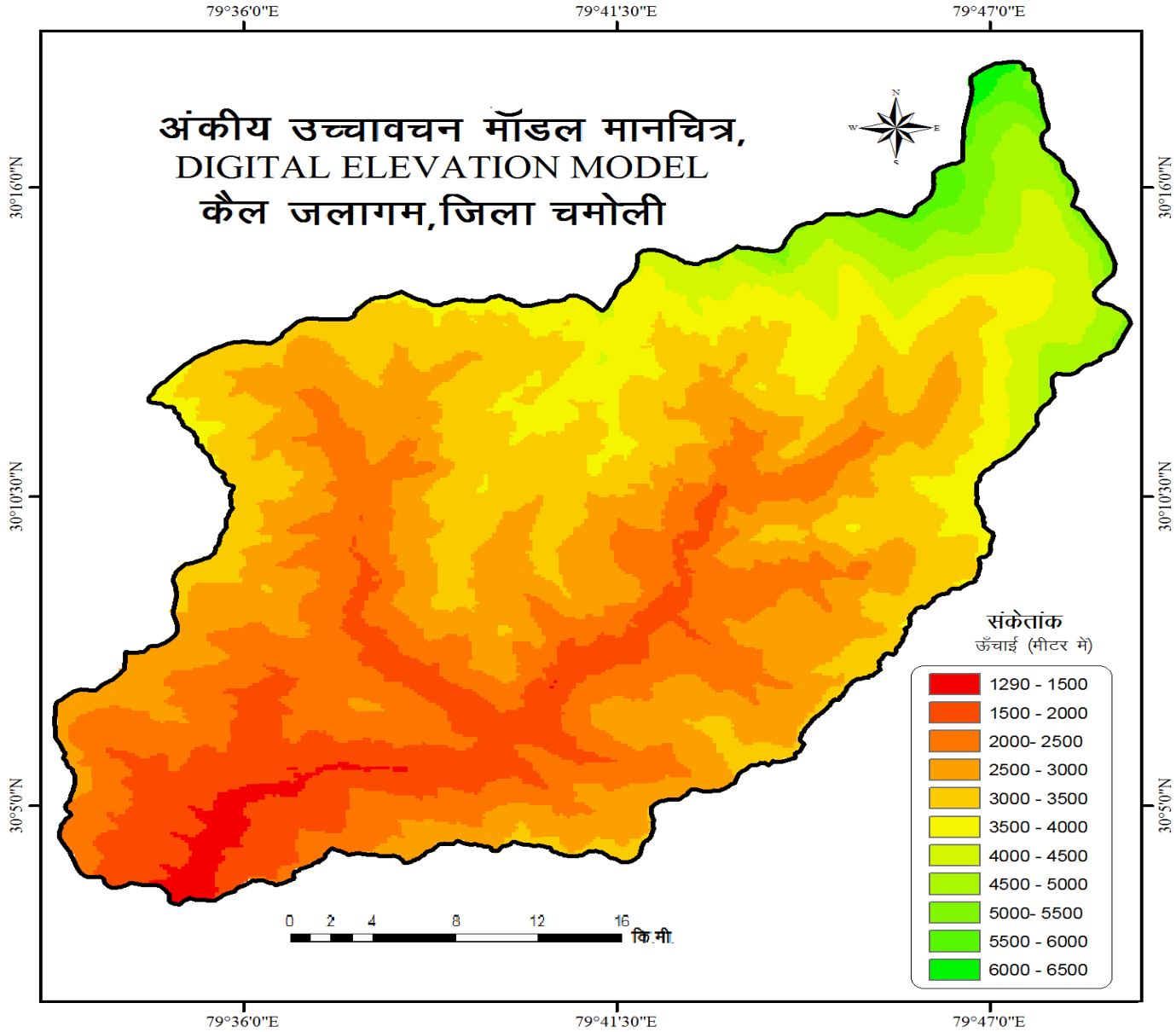


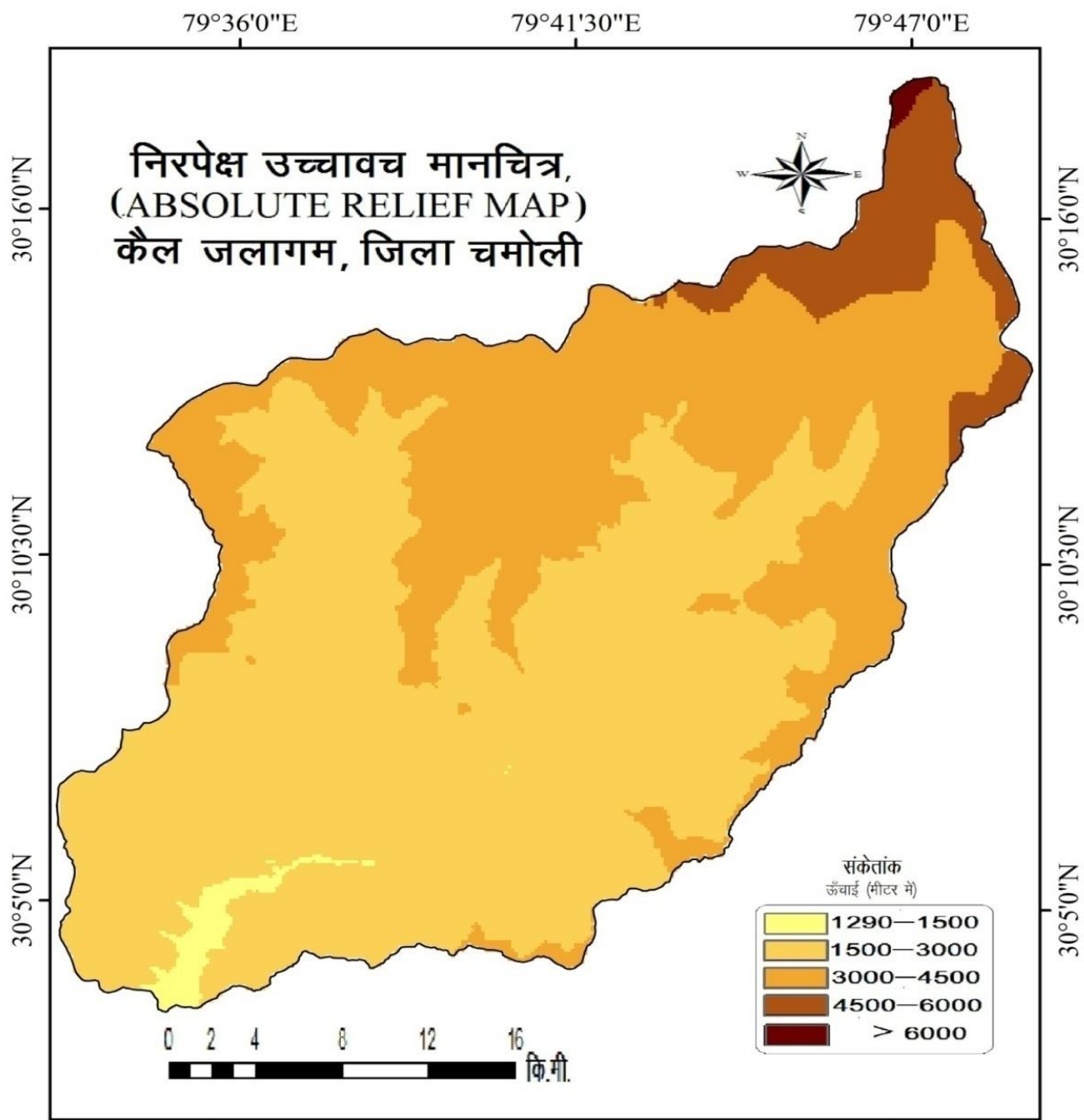
Landsat 5 TM
Image Subset
Path 23, Row 34
Acquired: 10 May 2011



Application of GIS in Flood Susceptibility Mapping

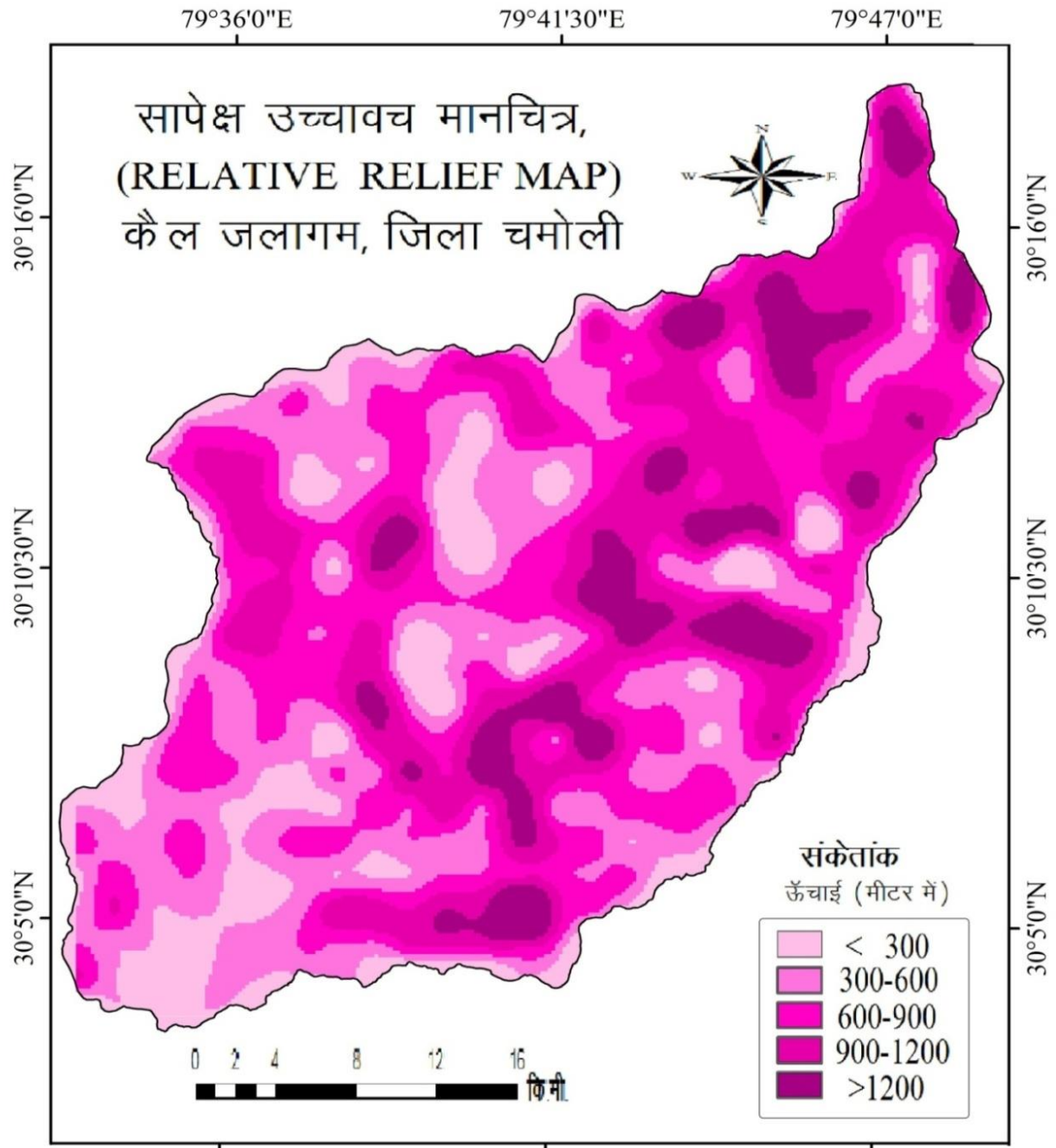




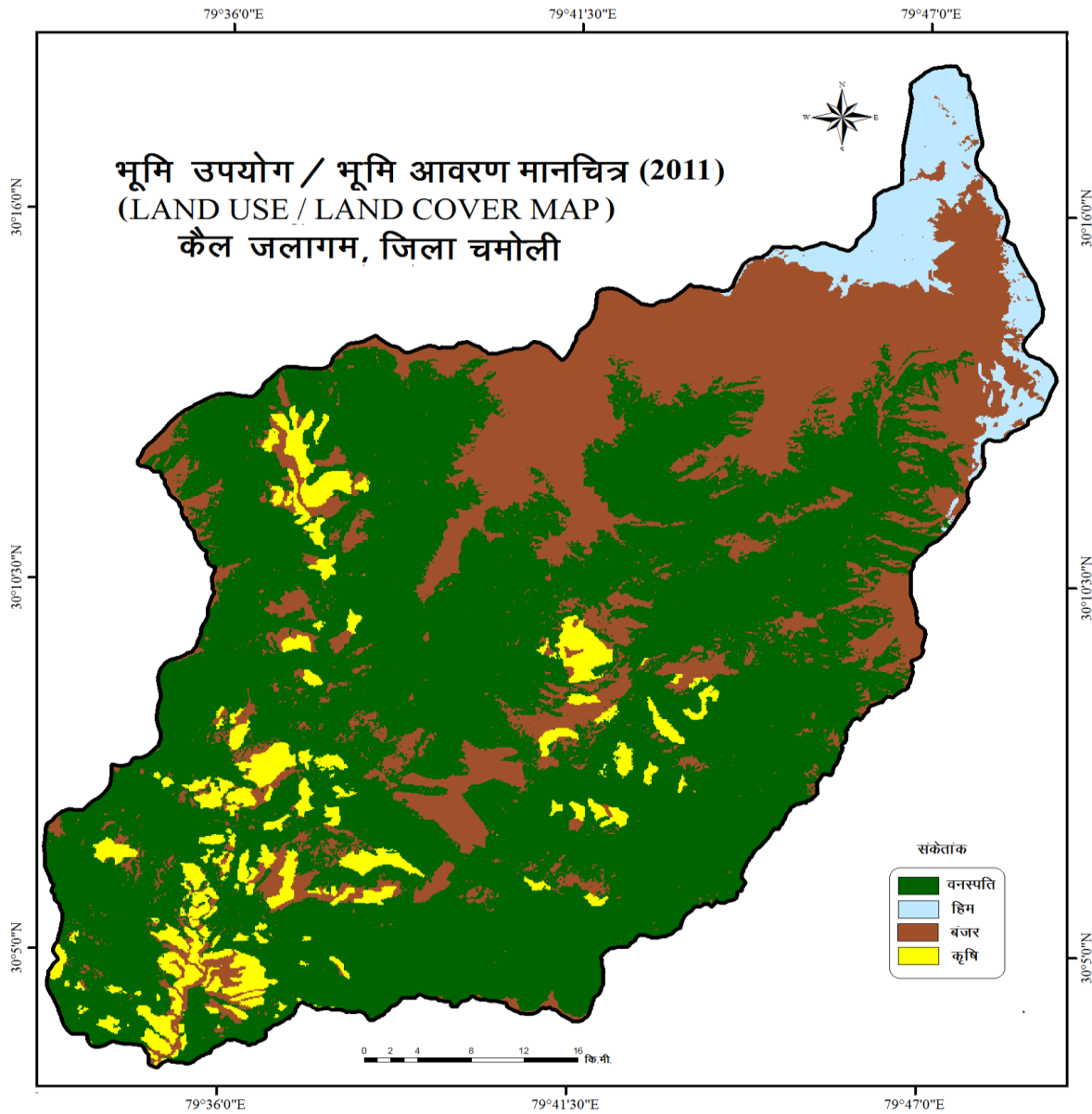


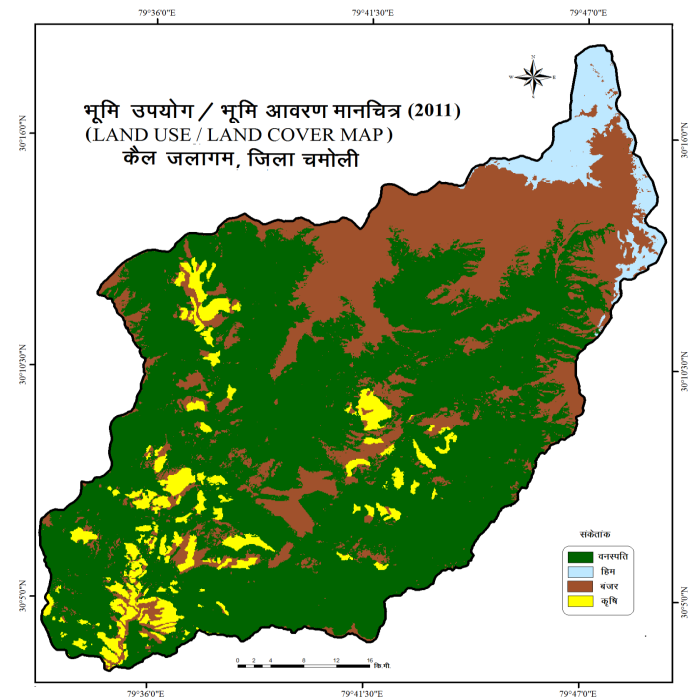
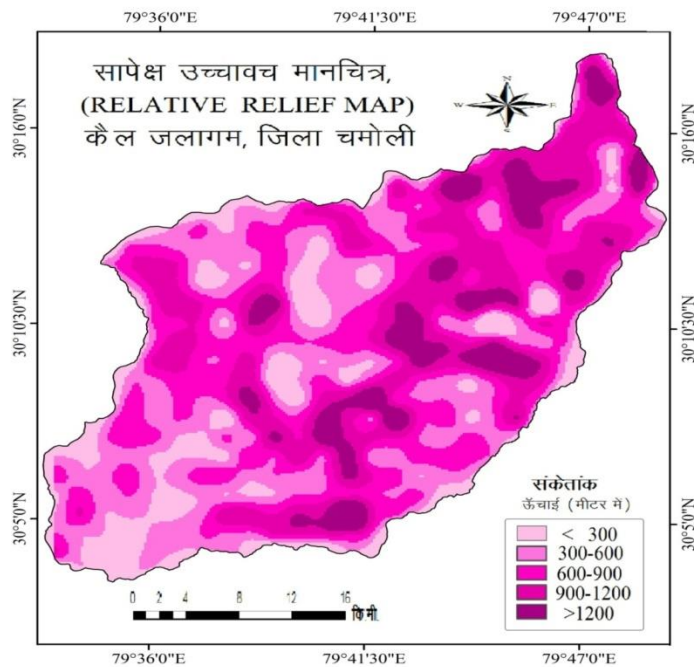
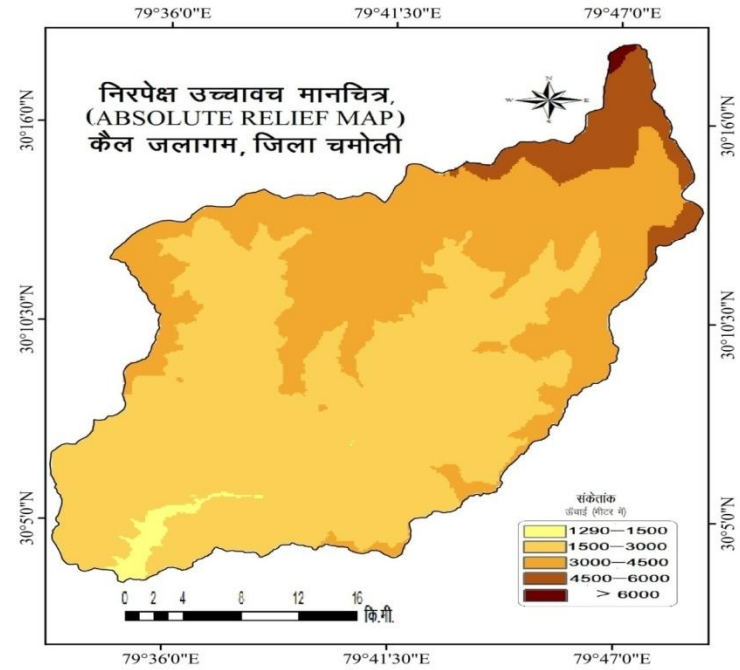
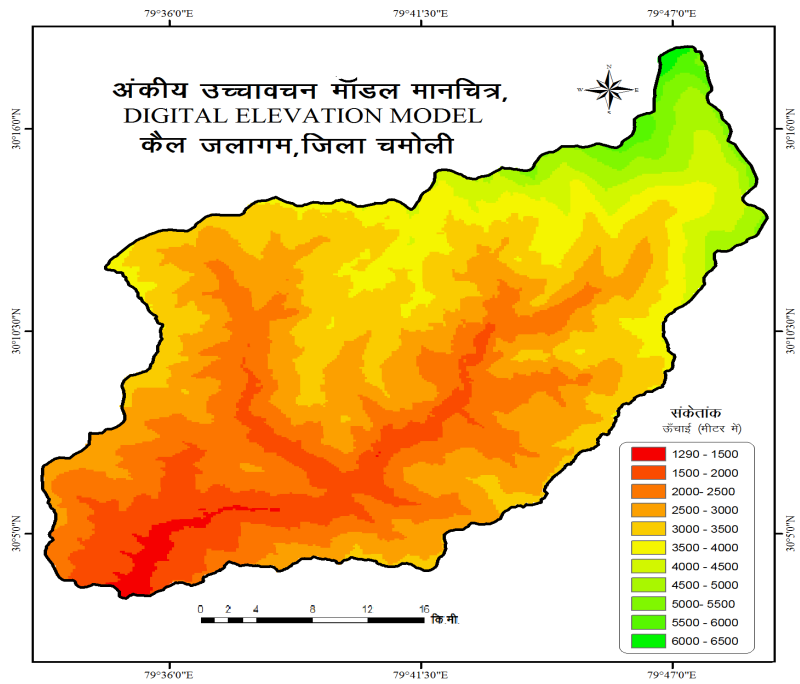
7 चित्र संख्या- 4.4: कैल जलागम (जिला चमोली) का निरपेक्ष उच्चावच मानचित्र.

(उपग्रह कार्टोसेट-I के आँकड़ों पर आधारित)।

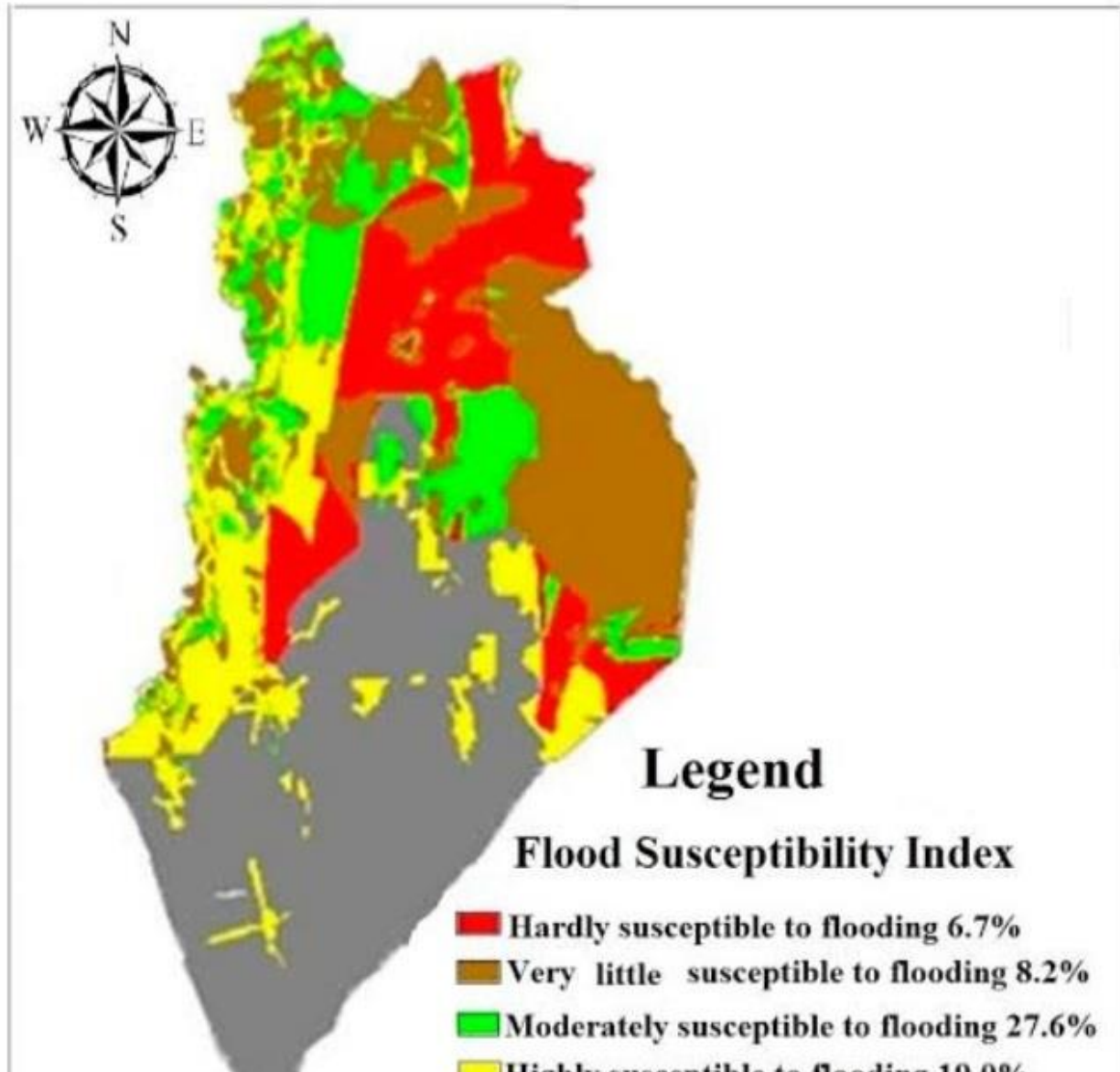


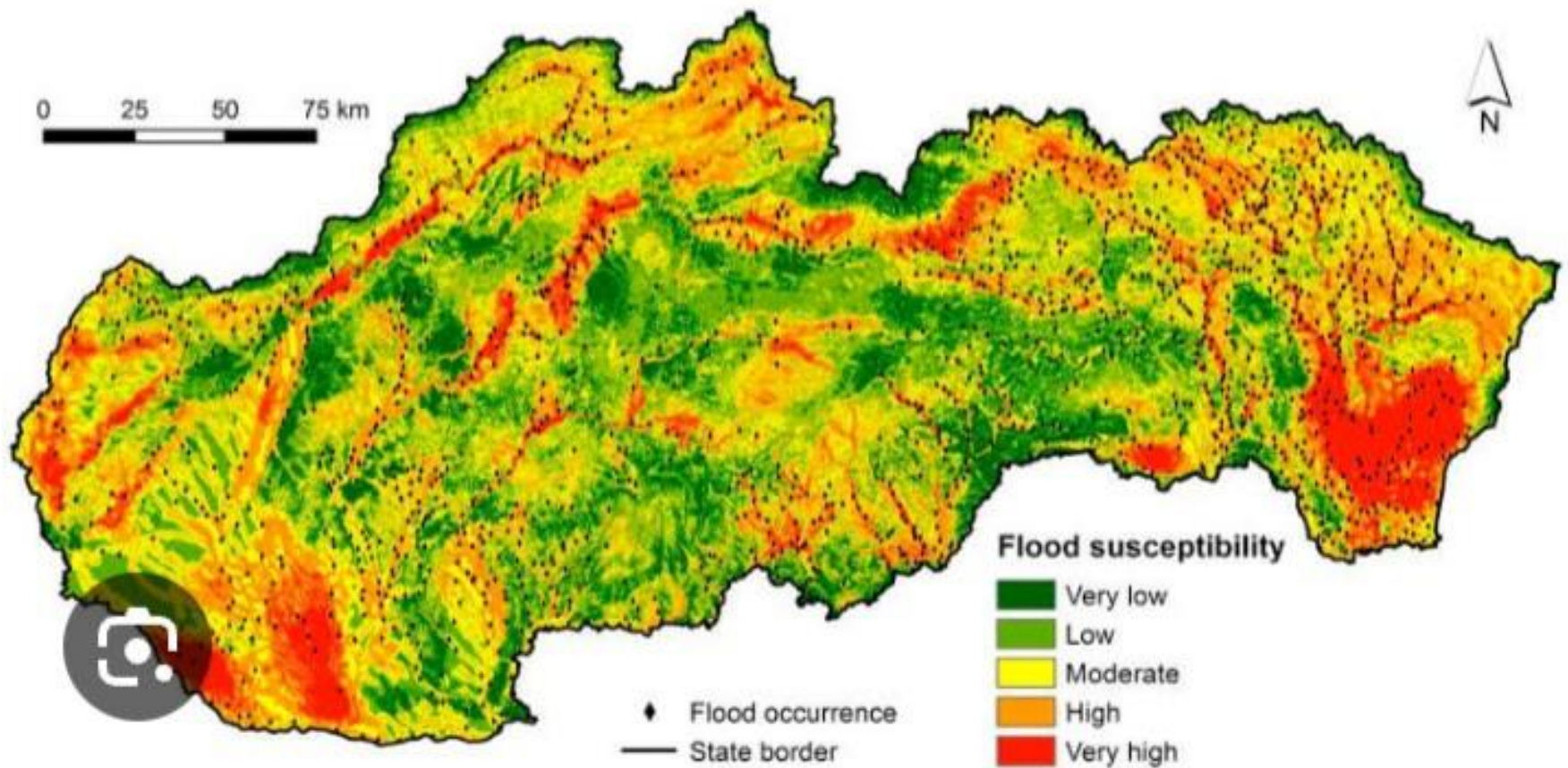
चित्र संख्या-4.6: कैल जलागम (जिला चमोली) का सापेक्ष उच्चावच मानचित्र,
(उपग्रह कार्टोसेट-1 के आँकड़ों पर आधारित)।







Application of GIS in Flood Susceptibility Mapping








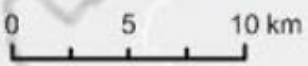
Stream system

-  Nabão river
-  Nabão tributaries

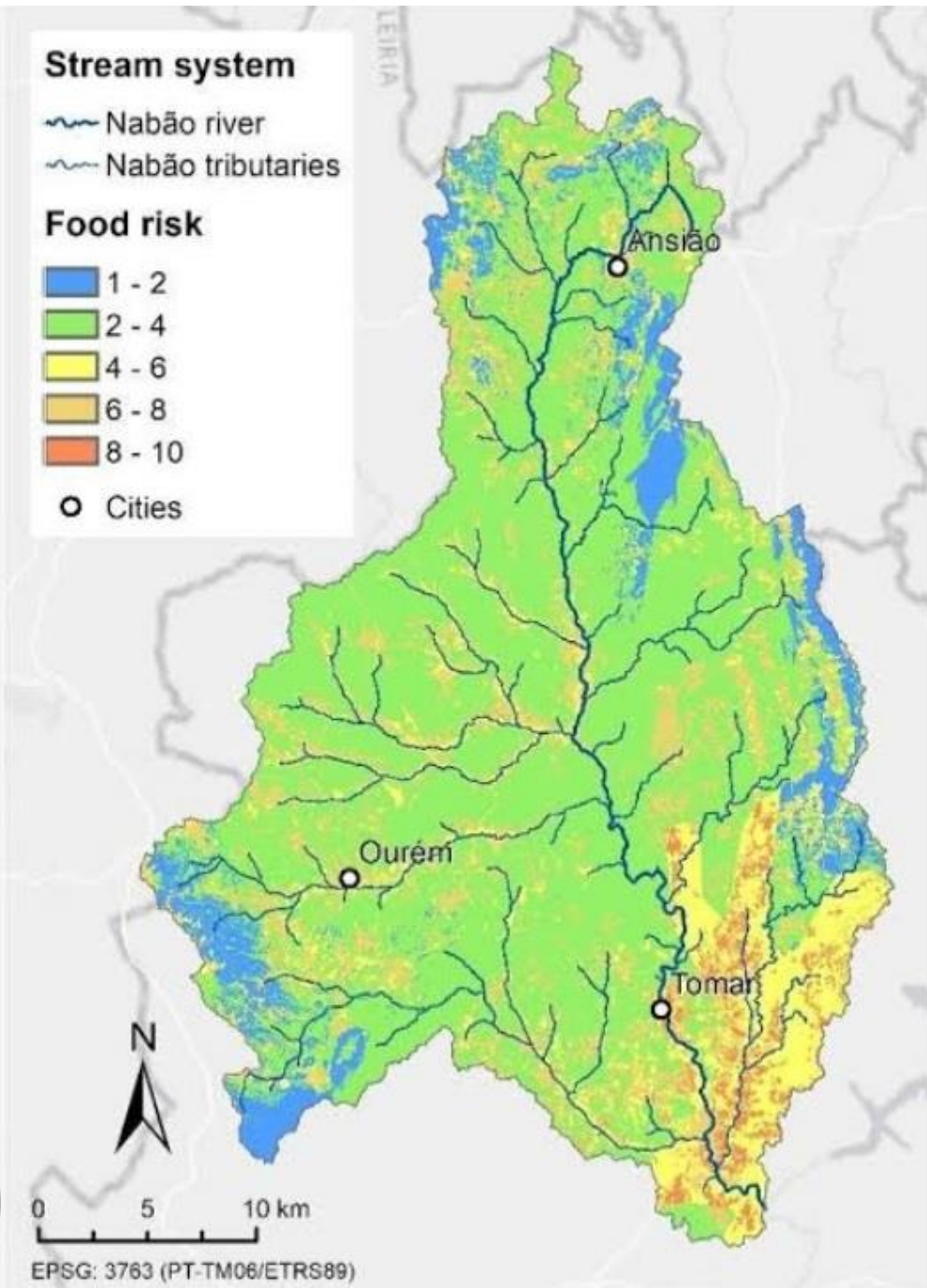
Food risk

-  1 - 2
-  2 - 4
-  4 - 6
-  6 - 8
-  8 - 10

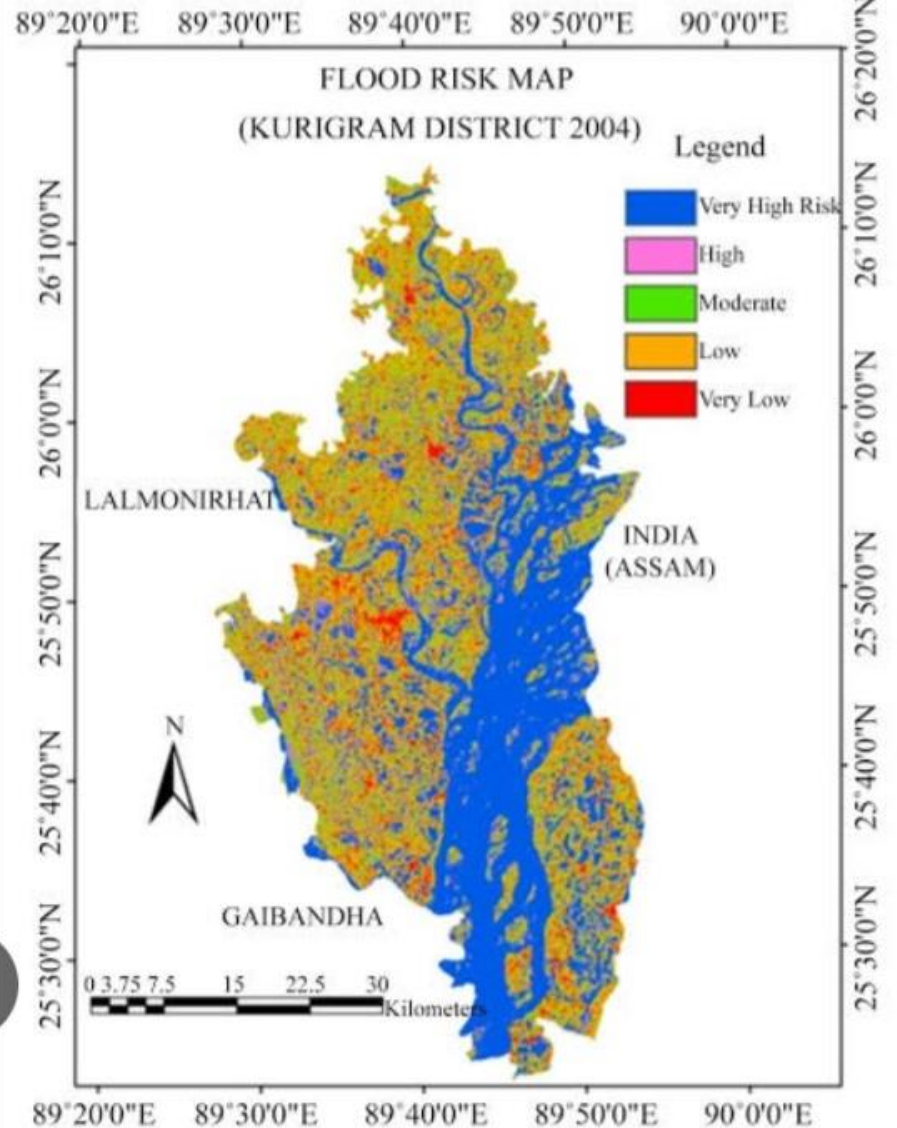
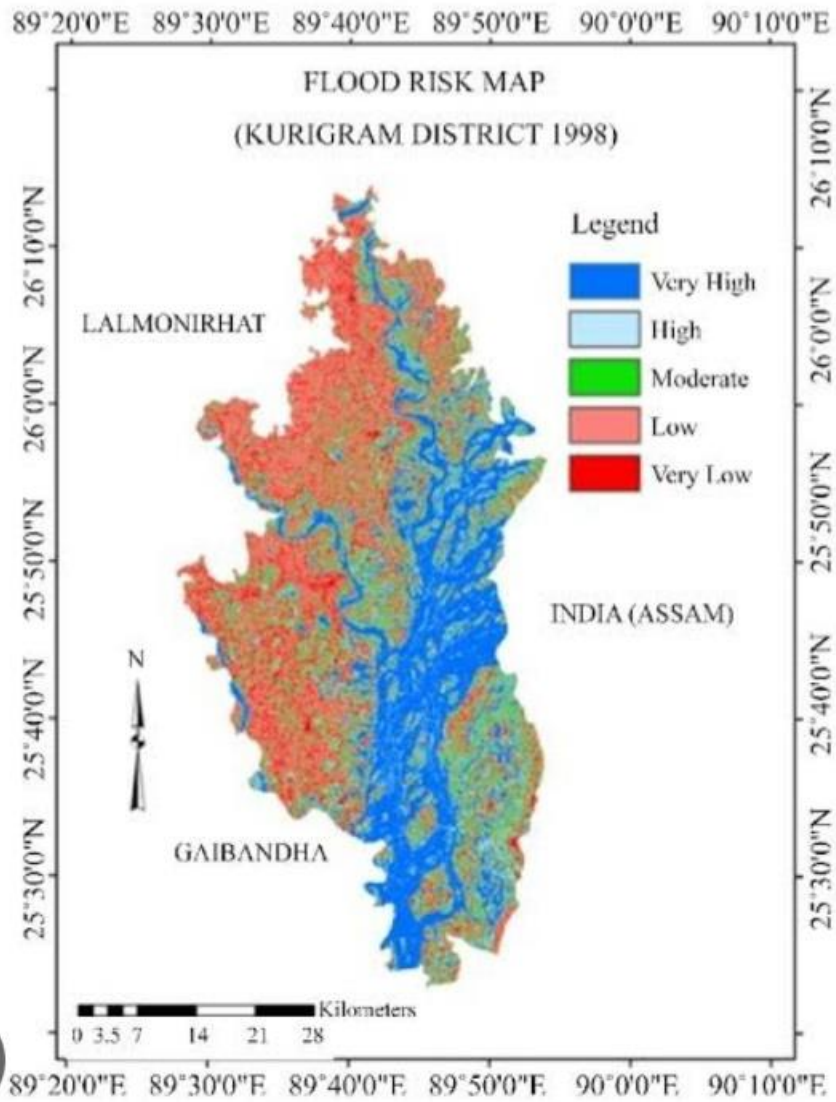
-  Cities



EPSG: 3763 (PT-TM06/ETRS89)



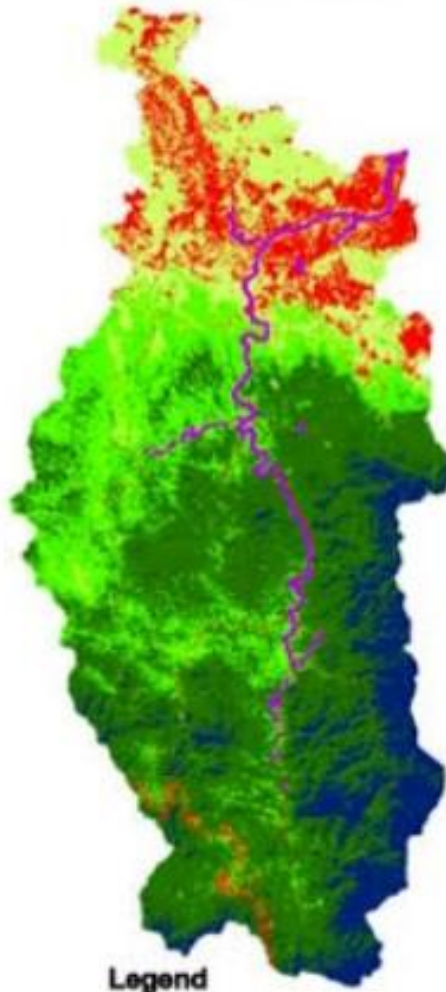
FLOOD RISK MAP UPDATING



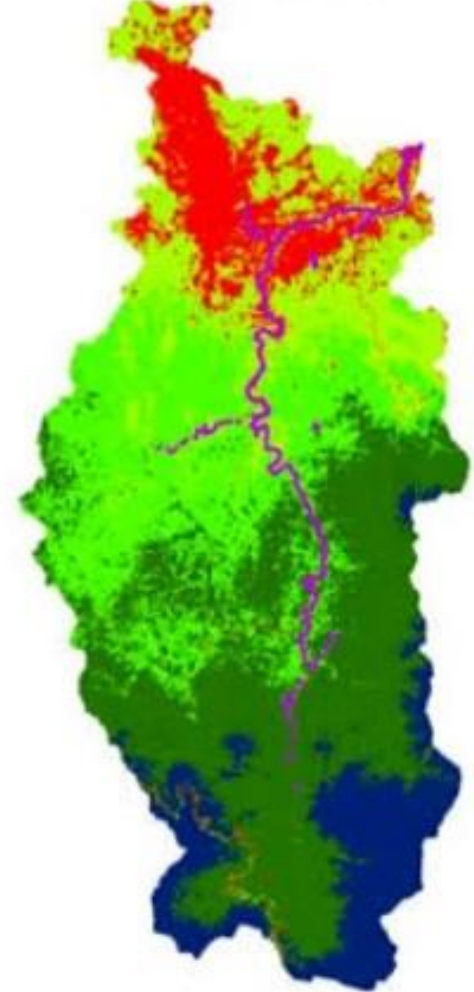
1989 Land Cover



2005 Land Cover



2008 Land Cover

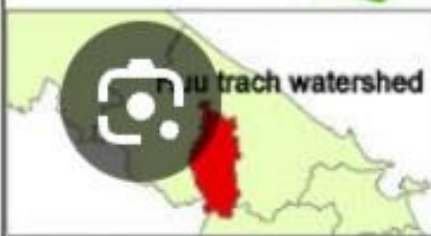


Legend

- Rich forest
- Medium forest
- Poor forest
- Regeneration/Plantation forest
- Non forest
- Huu Trach tributary



0 1.5 3 6 9 12 Kilometers





Article

GIS-Based Urban Flood Risk Assessment and Management—A Case Study of Delhi National Capital Territory (NCT), India

Pallavi Tomar ¹, Suraj Kumar Singh ², Shruti Kanga ¹, Gowhar Meraj ³, Nikola Kranjčić ^{4,*}, Bojan Đurin ⁵ and Amitanshu Pattanaik ⁶

¹ Centre for Climate Change and Water Research, Suresh Gyan Vihar University, Jaipur 302017, India; pallavi.49382@mygyanvihar.com (P.T.); shruti.kanga@mygyanvihar.com (S.K.)

² Centre for Sustainable Development, Suresh Gyan Vihar, Jaipur 302017, India; suraj.kumar@mygyanvihar.com

³ Department of Ecology, Environment and Remote Sensing, Government of Jammu and Kashmir, Srinagar 190018, India; gowharmeraj@gmail.com

⁴ Faculty of Geotechnical Engineering, University of Zagreb, Hallerova Aleja 7, 42000 Varaždin, Croatia

⁵ Department of Civil Engineering, University North, 42000 Varaždin, Croatia; bojan.durin@unin.hr

⁶ Defence Geoinformatics Research Establishment, Defence Research & Development Organisation, Ministry of Defence, Chandigarh 160036, India; amitansu@yahoo.com

* Correspondence: nikola.kranjic@gfv.unizg.hr

2nd International Conference on Recent Research and Innovations in Social Science & Education

(IETE) Institution of Electronics and Telecommunication Engineers, Chandigarh

RISE-18  Conference World

24th June 2018

www.conferenceworld.in

ISBN: 978-93-87793-32-3

REMOTE SENSING AND GIS: A TOOL FOR FLOOD MANAGEMENT IN URBAN INDIA

Anil Malik (Urban Planner-Architect)

Master of Planning (Urban Planning) – MNIT, Jaipur; Bachelor of Architecture – CRSCE, Murthal

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/343006934>

The contribution of GIS in urban flood management

Article · July 2017

CITATIONS

2

READS

1,594

1 author:



Denis Arinabo

The University of Manchester

4 PUBLICATIONS 4 CITATIONS

SEE PROFILE

2nd International Conference on Recent Research and Innovations in Social Science & Education

(IETE) Institution of Electronics and Telecommunication Engineers, Chandigarh

RISE-18  Conference World

24th June 2018

www.conferenceworld.in

ISBN: 978-93-87793-32-3

REMOTE SENSING AND GIS: A TOOL FOR FLOOD MANAGEMENT IN URBAN INDIA

Anil Malik (Urban Planner-Architect)

Master of Planning (Urban Planning) – MNIT, Jaipur; Bachelor of Architecture – CRSCE, Murthal



Article

Urban Flood-Related Remote Sensing: Research Trends, Gaps and Opportunities

Wei Zhu ^{1,2,3}, Zhe Cao ^{1,2,3}, Pingping Luo ^{1,2,3,*}, Zeming Tang ^{1,2,3,4}, Yuzhu Zhang ⁵, Maochuan Hu ⁶ and Bin He ⁷

Remote Sens. **2022**, *14*, 5505. <https://doi.org/10.3390/rs14215505>

REMOTE SENSING AND GIS APPLICATIONS IN FLOOD MANAGEMENT

S. P. Aggarwal, Praveen K. Thakur and V.K. Dadhwal

Corresponding author(s): spa@iirs.gov.in and praveen@iirs.gov.in

GIS Application in Flood Monitoring

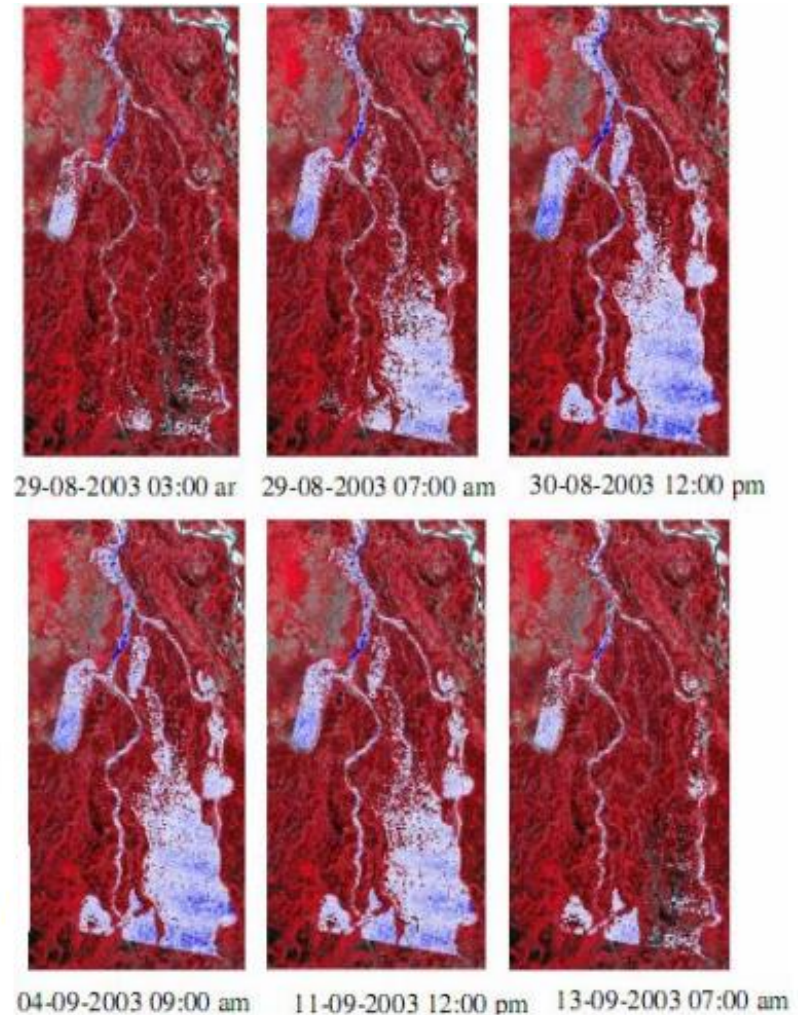
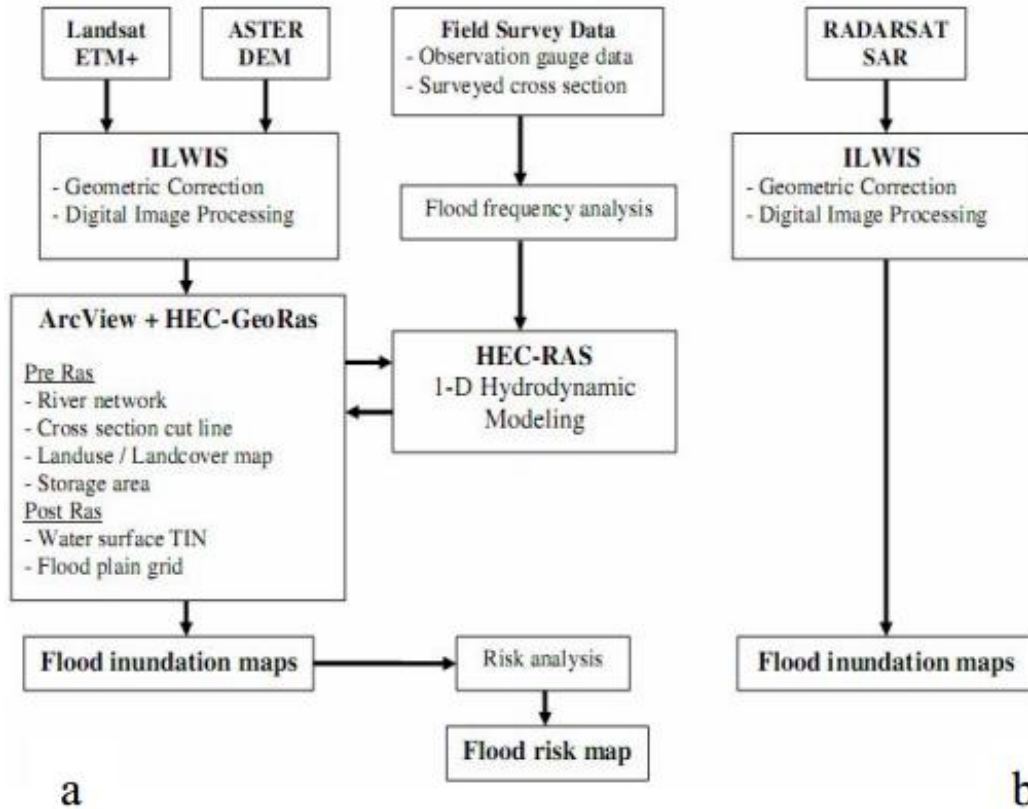


Fig.4a: Methodology flow chart; **4b:** Flood inundation maps derived from simulation

SGVU J CLIM CHANGE WATER
VOL. 7, 2020 pp 115-123
ISSN: 2347-7741

Tomar, P.

SGVU J CLIM CHANGE WATER
VOL 7, 115-123

URBAN FLOOD MANAGEMENT USING GEO-SPATIAL TECHNIQUES – A LITERATURE REVIEW

Pallavi Tomar*

*Centre for Climate Change and Water Research, Suresh Gyan Vihar University, Jaipur

Email id- pallavi.49382@mygyanvihar.com



Natural Hazards **33**: 283–301, 2004.
© 2004 Kluwer Academic Publishers. Printed in the Netherlands.

283

Application of Remote Sensing in Flood Management with Special Reference to Monsoon Asia: A Review

JOY SANYAL* and X. X. LU

*Department of Geography, Faculty of Arts and Social Science, National University of Singapore, 1
Arts Link, Singapore 117570*

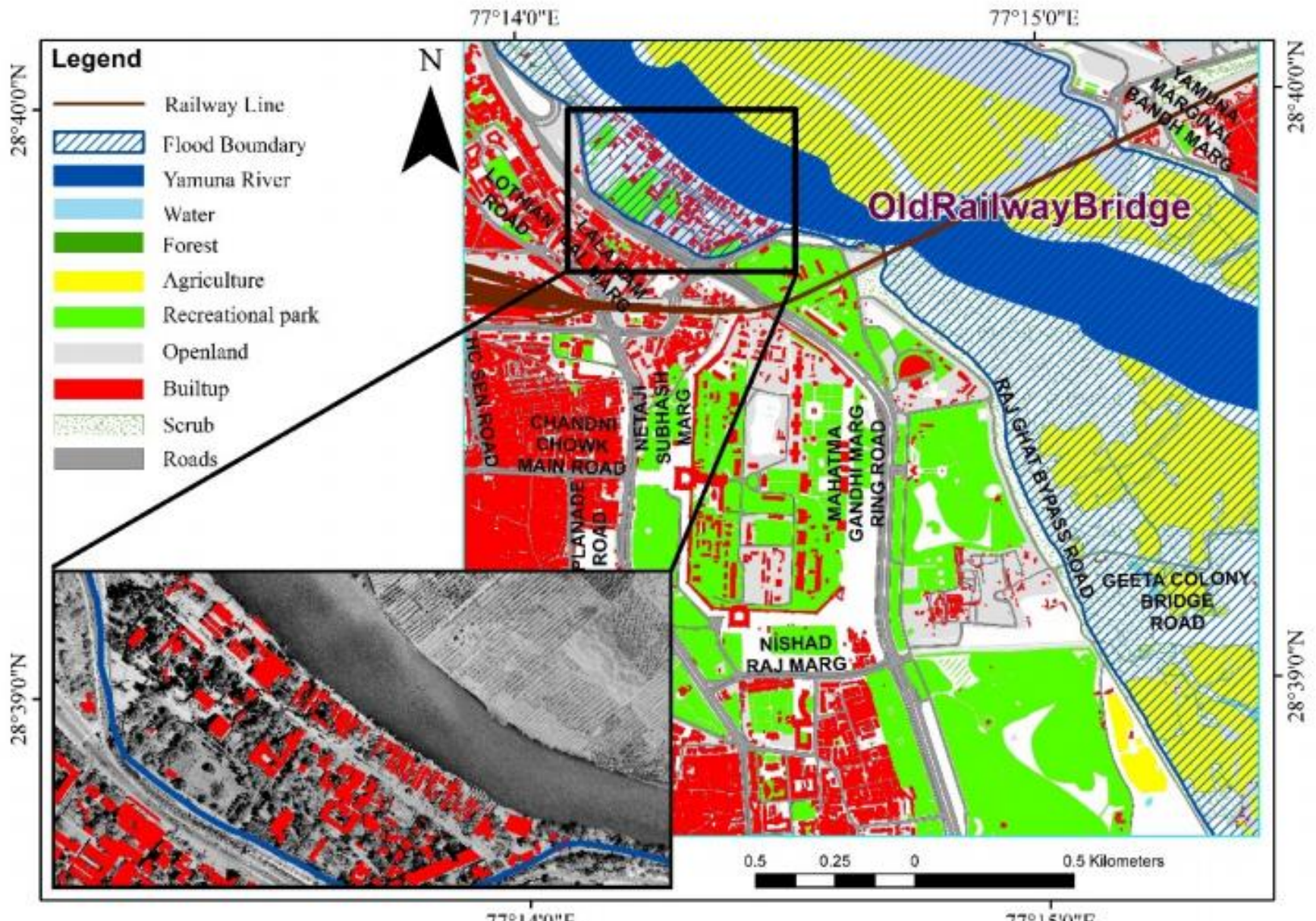
(Received: 20 June 2003; accepted: 4 November 2003)

**Application of GIS:
Buildings that are Susceptible to Flood
Damage and where there is greater risk of flooding**



Application of GIS:

Delineation of Flood Affected Area & Property Damage Assessment



GIS Applications in Urban Flooding:

Quick Mapping

Quick Visualization

Quick Management

Quick Monitoring

Quick Measurement

Quick Surveying

Quick Analysis

Quick Property Damage Assessment

Quick Planning (Rehabilitation)

Quick Governance

(g-Urban Governance)

THANKS

jsrawat1955@gmail.com

7533983533