National River Conservation Directorate
Ministry of Jal Shakti,
Department of Water Resources,
River Development & Ganga Rejuvenation
Government of India

Floodplain Mapping in Krishna River Basin

August 2025

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National River Conservation Directorate (NRCD)

The National River Conservation Directorate, functioning under the Department of Water Resources, River Development & Ganga Rejuvenation, and Ministry of Jal Shakti providing financial assistance to the State Government for conservation of rivers under the Centrally Sponsored Schemes of 'National River Conservation Plan (NRCP)'. National River Conservation Plan to the State Governments/ local bodies to set up infrastructure for pollution abatement of rivers in identified polluted river stretches based on proposals received from the State Governments/ local bodies.

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Centres for Krishna River Basin Management Studies (cKrishna)

The Centres for Krishna River Basin Management Studies (cKrishna) is a Brain Trust dedicated to River Science and River Basin Management. Established in 2024 by NIT Warangal and NIT Surathkal, under the supervision of cGanga at IIT Kanpur, the center serves as a knowledge wing of the National River Conservation Directorate (NRCD). cKrishna is committed to restoring and conserving the Krishna River and its resources through the collation of information and knowledge, research and development, planning, monitoring, education, advocacy, and stakeholder engagement.

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cGanga is a think tank formed under the aegis of NMCG, and one of its stated objectives is to make India a world leader in river and water science. The Centre is headquartered at IIT Kanpur and has representation from most leading science and technological institutes of the country. cGanga's mandate is to serve as think-tank in implementation and dynamic evolution of Ganga River Basin Management Plan (GRBMP) prepared by the Consortium of 7 IITs. In addition to this, it is also responsible for introducing new technologies, innovations, and solutions into India.

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Acknowledgment

This report is a comprehensive outcome of the project jointly executed by NIT Warangal (Lead Institute) and NIT Surathkal (Fellow Institute) under the supervision of cGanga at IIT Kanpur. It was submitted to the National River Conservation Directorate (NRCD) in 2024. We gratefully acknowledge the individuals who provided information and photographs for this report.

Disclaimer

This report is a preliminary version prepared as part of the ongoing Condition Assessment and Management Plan (CAMP) project. The analyses, interpretations and data presented in the report are subject to further validation and revision. Certain datasets or assessments may contain provisional or incomplete information, which will be updated and refined in the final version of the report after comprehensive review and verification.

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Preface

In an era of unprecedented environmental change, understanding our rivers and their ecosystems has never been more critical. This report aims to provide a comprehensive overview of our rivers, highlighting their importance, current health, and the challenges they face. As we explore the various facets of river systems, we aim to equip readers with the knowledge necessary to appreciate and protect these vital waterways.

Throughout the following pages, you will find an in-depth analysis of the principles and practices that support healthy river ecosystems. Our team of experts has meticulously compiled data, case studies, and testimonials to illustrate the significant impact of rivers on both natural environments and human communities. By sharing these insights, we hope to inspire and empower our readers to engage in river conservation efforts.

This report is not merely a collection of statistics and theories; it is a call to action. We urge all stakeholders to recognize the value of our rivers and to take proactive steps to ensure their preservation. Whether you are an environmental professional, a policy maker, or simply someone who cares about our planet, this guide is designed to support you in your efforts to protect our rivers.

We extend our heartfelt gratitude to the numerous contributors who have generously shared their stories and expertise. Their invaluable input has enriched this report, making it a beacon of knowledge and a practical resource for all who read it. It is our hope that this report will serve as a catalyst for positive environmental action, fostering a culture of stewardship that benefits both current and future generations.

As you delve into this overview of our rivers, we invite you to embrace the opportunities and challenges that lie ahead. Together, we can ensure that our rivers continue to thrive and sustain life for generations to come.

Centres for Krishna River Basin
Management Studies (cKrishna)
NIT Warangal (Lead Institute), NIT Surathkal (Fellow Institute)

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Abbreviations and Acronyms

Abbreviation	Full Form
CWC	Central Water Commission
CHIRPS	Climate Hazards Group InfraRed Precipitation with Stations
DEM	Digital Elevation Model
ESA	European Space Agency
ENSO	El Niño–Southern Oscillation
GEE	Google Earth Engine
GIS	Geographic Information System
IMD	India Meteorological Department
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resources Management
ITCZ	Intertropical Convergence Zone
IW	Interferometric Wide (Sentinel-1 acquisition mode)
KRB	Krishna River Basin
NASA	National Aeronautics and Space Administration
RH	Relative Humidity
SAR	Synthetic Aperture Radar
SRTM	Shuttle Radar Topography Mission
SSP	Shared Socioeconomic Pathway
SWAT	Soil and Water Assessment Tool
Tmax	Maximum Temperature
Tmin	Minimum Temperature
VV / VH	Vertical–Vertical / Vertical–Horizontal Polarization
WEAP	Water Evaluation and Planning System
WD	Wind Direction
WS	Wind Speed

1. Introduction

The Krishna River Basin, one of the largest river basins in peninsular India, plays a crucial role in sustaining agriculture, ecosystems, and socio-economic activities across Maharashtra, Karnataka, Telangana, and Andhra Pradesh. However, its geographical setting, monsoon-dominated climate, and extensive human interventions make it highly vulnerable to flooding. Historical records indicate recurrent flood events, with extreme occurrences in 2005, 2009, and 2019, which caused severe damage to infrastructure, crops, and livelihoods, particularly in downstream districts (CWC, 2020; IMD, 2021).

Floodplains are low-lying lands adjacent to river channels, serve as natural buffers by absorbing excess runoff during heavy rainfall or reservoir releases. While they support fertile agriculture and biodiversity, increasing anthropogenic pressures such as urbanization, floodplain encroachment, and deforestation have reduced their resilience, intensifying the impacts of floods (Mishra & Shah, 2018). Climate change projections further indicate a rise in the frequency of extreme rainfall events across central and southern India (NASA POWER Data, 2022; IMD, 2020), exacerbating flood risks in the Krishna Basin.

Floodplain mapping is therefore a critical tool for sustainable basin management. It involves delineating flood-prone areas using hydrological and hydraulic models, combined with satellite remote sensing and GIS. Modern techniques such as Synthetic Aperture Radar (SAR) and Google Earth Engine (GEE) allow flood monitoring even under cloud cover, enabling near real-time assessment of inundation extents (Mason et al., 2007; Twele et al., 2016). These methods provide insights into flood frequency, spatial extent, and severity, forming the scientific basis for disaster risk reduction, land-use planning, reservoir operation policies, and climate adaptation strategies.

For the Krishna River Basin, floodplain mapping is not only essential for protecting vulnerable communities but also for balancing development with ecological integrity. By identifying active and passive floodplains, policymakers can implement informed zoning regulations, ensure resilient infrastructure planning, and conserve wetlands and riverine habitats. Ultimately, floodplain mapping strengthens integrated water resources management (IWRM) in the Krishna Basin by bridging the gap between flood risk mitigation and sustainable development.

2. Data Sources

Floodplain mapping for the Krishna River Basin was carried out by integrating multi-source datasets to capture both rainfall variability and flood inundation dynamics. Daily precipitation data was obtained from the Climate Hazards Group InfraRed Precipitation with Stations (CHIRPS)**,** which provides quasi-global rainfall estimates at a high spatial resolution (0.05°) by blending satellite imagery with in-situ station data. This dataset ensured continuous and reliable rainfall information across the basin, including regions with sparse ground-based observations. To delineate flood-affected areas, Synthetic Aperture Radar (SAR) data from the Sentinel-1 mission (Copernicus Programme, European Space Agency) was employed. Sentinel-1 provides C-band SAR images at a 10 m spatial resolution, which are highly effective for detecting inundated areas even under cloud cover, a frequent condition during the monsoon season. The combination of CHIRPS rainfall data and Sentinel-1 SAR imagery enabled a robust assessment of flood generation, extent, and spatio-temporal variability within the Krishna River Basin.

3. Methodology

For floodplain mapping in the Krishna River Basin, representative pre-flood and flood periods were selected based on rainfall peaks and river discharge records during the southwest monsoon seasons from 2018 to 2024. The pre-flood periods (generally in June) correspond to baseline hydrological conditions before major flood events, while the flood periods capture the peak inundation phases associated with extreme rainfall and reservoir releases. The identification of these intervals was guided by CHIRPS daily rainfall data and corroborated using Sentinel-1 SAR imagery to ensure accurate delineation of flood extents. By systematically comparing pre- and post-event SAR images across these selected periods, flood-prone zones in the Krishna River Basin were mapped with high spatial detail. Selected pre-flood and flood periods (2018-2024) used for floodplain mapping in the Krishna River Basin were represented in Table 3.1. Figure 3.1 represents the floodplain mapping flowchart.

Table 3. 1 Selected pre-flood and flood periods (2018–2024) used for floodplain mapping in the Krishna River Basin.

Sl. No.	Pre Flood Periods	Flood Periods
1	1-Jun-18 to 30-Jun-18	19-Jul-17 to 16-Aug-17
2	15-Jun-19 to 30-Jun-19	22-Jul-19 to 30-Jul-19
3	1-Jun-20 to 30-Jun-20	7-Aug-20 to 16-Aug-20
4	1-Jun-20 to 30-Jun-20	5-Sep-20 to 15-Sep-20
5	1-Jun-21 to 30-Jun-21	5-Oct-20 to 19-Oct-20
6	1-Jun-22 to 30-Jun-22	1-Jul-22 to 15-Jul-22
7	1-Jun-23 to 30-Jun-23	15-Jul-23 to 25-Jul-23
8	1-Jun-24 to 30-Jun-24	25-Aug-24 to 9-Sep-24

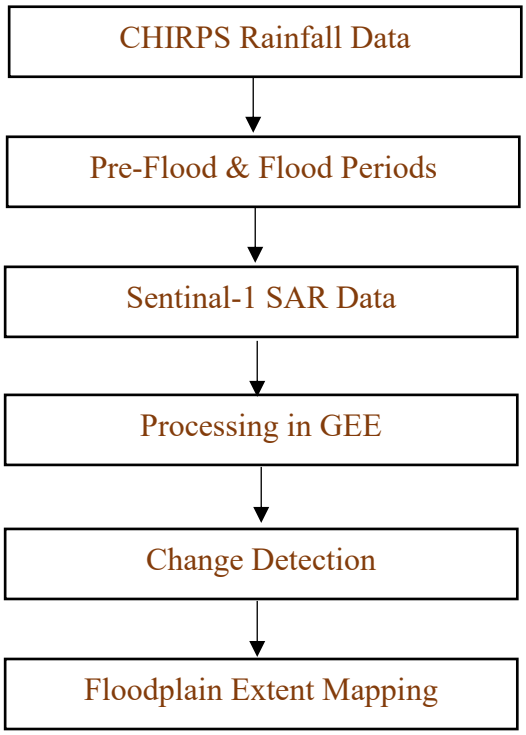

Figure 3. 1 Floodplain Mapping Flowchart

The floodplain mapping for the Krishna River Basin was conducted using a combination of satellite-based precipitation and radar datasets integrated through the Google Earth Engine (GEE) cloud computing platform. Daily rainfall data from CHIRPS (Climate Hazards Group InfraRed Precipitation with Stations), available at a spatial resolution of 0.05°, was used to capture basin-wide precipitation dynamics and to identify high-intensity rainfall episodes responsible for major flood events. This dataset was particularly valuable in regions where ground-based rainfall stations are sparse, providing consistent spatio-temporal coverage across the entire basin. Based on CHIRPS rainfall peaks, representative pre-flood and flood periods were selected for each hydrological year between 2018 and 2024.

To delineate inundated areas, Synthetic Aperture Radar (SAR) data from the Sentinel-1 mission of the Copernicus Programme was employed. Sentinel-1 provides C-band radar imagery in Interferometric Wide (IW) swath mode with 10 m resolution, which is highly effective for flood mapping due to its capability to penetrate cloud cover and operate independent of daylight conditions a critical advantage during the monsoon season. Pre-flood and flood composites were generated for each year using VV and VH polarizations. Change detection was then applied, whereby pixels showing significant reduction in backscatter during the flood period compared to the pre-flood baseline were classified as inundated zones.

The workflow was implemented in GEE, which allowed efficient access, processing, and visualization of multi-temporal datasets without the need for local storage or heavy computational resources. To enhance accuracy, speckle noise in SAR imagery was minimized using adaptive filters, and non-flood water surfaces were masked out using the JRC Global Surface Water dataset. Additionally, topographic corrections were performed using the SRTM Digital Elevation Model (DEM) to exclude steep slopes and high-elevation zones unlikely to experience flooding. The final outputs included event-wise flood inundation layers as well as a cumulative multi-year floodplain map, which highlights the persistent flood-prone regions of the Krishna River Basin.

4. Floodplain Extent in the Krishna River Basin

The floodplain extent of the Krishna River Basin (KRB) was delineated using multi-temporal Sentinel-1 SAR imagery integrated with CHIRPS rainfall data. The resulting map (Figure 4.1) illustrates the spatial distribution of flood-prone areas across the basin. Major tributaries such as the Bhima, Ghataprabha, Malaprabha, Munneru, Musi, and Tungabhadra rivers exhibit significant floodplain zones, reflecting their hydrological contribution to downstream flooding. The upper basin tributaries (e.g., Bhima, Ghataprabha, and Malaprabha) show localized inundation linked to reservoir releases and intense monsoonal precipitation, while the eastern tributaries such as the Musi and Munneru contribute to flood risks in Telangana and Andhra Pradesh. The Tungabhadra, being one of the largest tributaries, demonstrates widespread floodplain coverage due to its large catchment area and regulated flows from major reservoirs. The Krishna delta in Andhra Pradesh shows extensive floodplain activity, highlighting its vulnerability to both riverine flooding and tidal interactions. This spatial depiction of floodplains provides critical insights into the distribution of flood-prone zones and forms the basis for risk management and sustainable land-use planning across the basin.

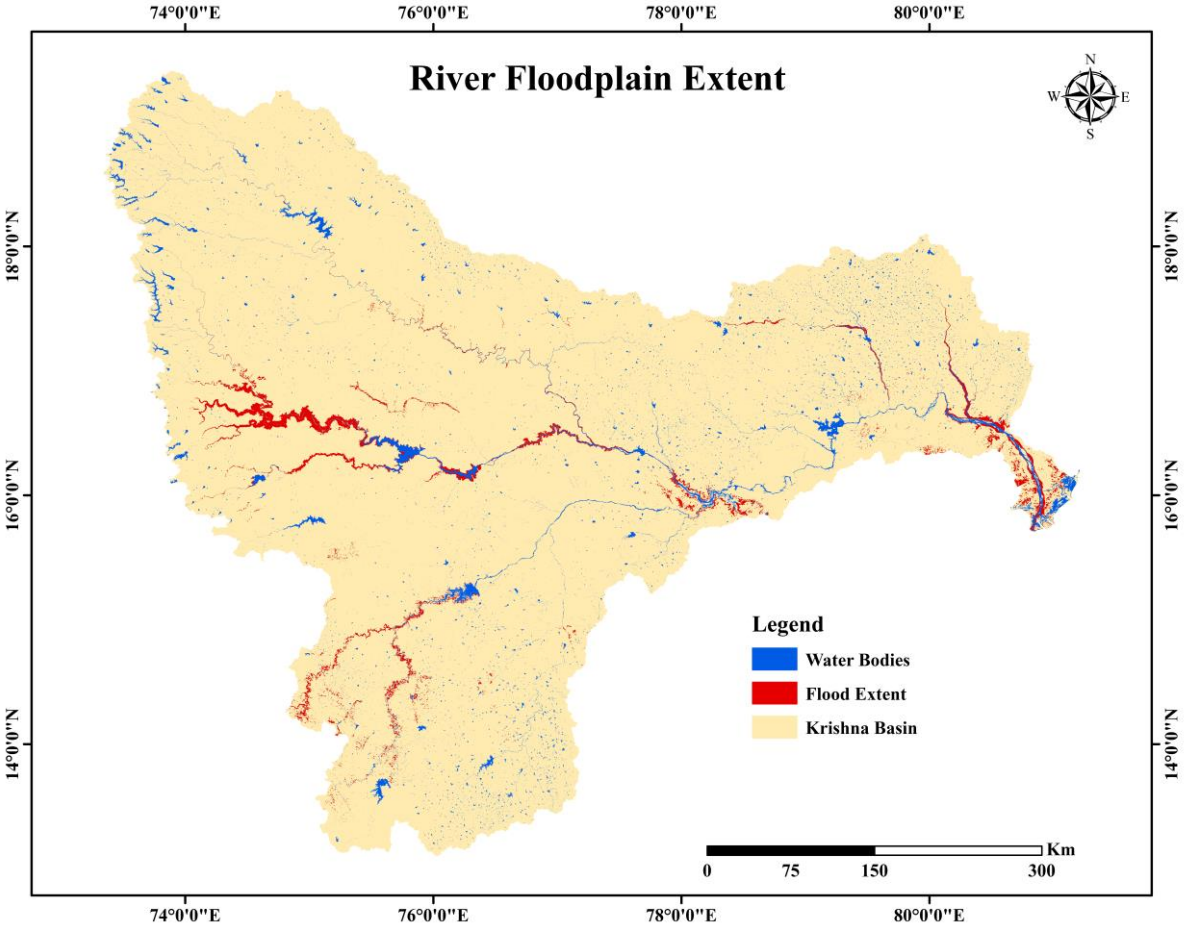

Figure 4. 1 Spatial distribution of flood-prone areas across the Krishna River Basin

4.1 Floodplain Mapping of Bhima River

The floodplain extent of the Bhima River between Reach 33 and Reach 36 highlights the active inundation corridors adjacent to the river margins. This stretch includes several important settlements such as Narube, Hunsihal, Sunatti, Tangadgi, Yadgiri, Kesler, and Jagpri, which are located in close proximity to the river and its floodplain. The mapping clearly shows that the active river channel (blue) is flanked by adjacent floodplain zones (yellow), indicating areas susceptible to seasonal flooding during high-flow events. In Reach 33, the floodplain is narrow and confined but expands downstream in Reach 34, where meandering sections near Sunatti and Tangadgi display wider floodplain coverage. Reach 35 shows extensive lateral floodplains, with inundation potential near Yadgiri, a major town along the Bhima. Further downstream in Reach 36, the floodplain again widens, encompassing villages such as Kesler and Jagpri, reflecting the geomorphic adjustment of the river before entering Reach 37. This spatial analysis demonstrates that the Bhima River floodplain is not uniform but varies significantly across reaches, influenced by local topography, channel morphology, and settlement distribution. Such reach-based floodplain delineation provides critical inputs for flood risk zoning and planning at the sub-basin scale. Figure 4.2 represents floodplain extent of the Bhima River from reach 33 to reach 36.

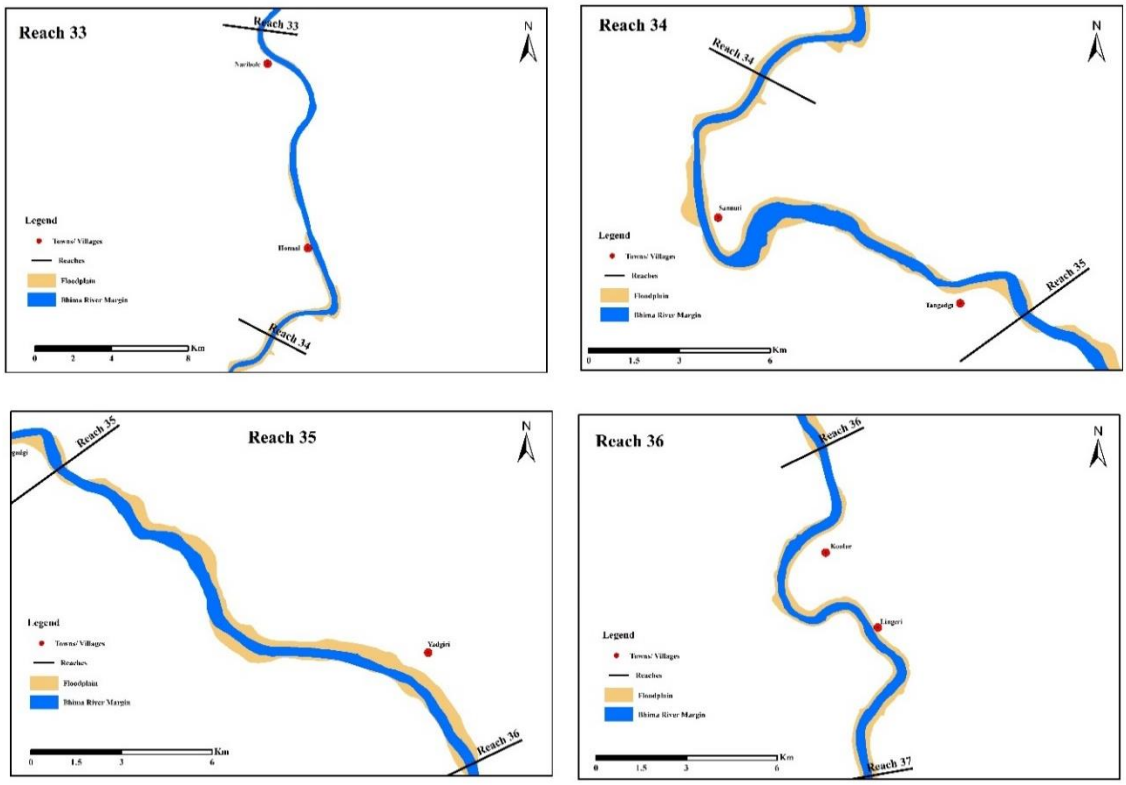

Figure 4. 2 Floodplain extent of the Bhima River from Reach 33 to Reach 36, showing river margins, floodplains and vulnerable settlements.

4.2 Floodplain Mapping of Ghatarprabha River

The floodplain extent of the Ghatarprabha River between Reach 9 and Reach 12 highlights the dynamic inundation corridors flanking the river margins, encompassing key settlements such as Sanganatti, Soragon, Baragi, Machakanur, and Kundargi situated close to the channel and its adjoining floodplain. In Reach 9, the floodplain remains narrow and confined with localized inundation near Sanganatti, while downstream in Reach 10, increased meandering near Soragon results in broader floodplain coverage. In Reach 11, the floodplain expands laterally around Baragi, which lies adjacent to a significant meander loop, indicating heightened flood susceptibility. Further downstream, Reach 12 demonstrates wide floodplain extents near Machakanur, gradually expanding toward Kundargi at the interface with Reach 13. This spatial analysis reveals that the Ghatarprabha River floodplain is highly variable across reaches, influenced by local channel morphology, valley confinement, and settlement distribution, providing valuable insights for flood risk zoning, hazard mitigation, and sustainable land-use planning within the sub-basin. Figure 4.3 represents floodplain extent of the Ghataprabha River from reach 9 to reach 12.

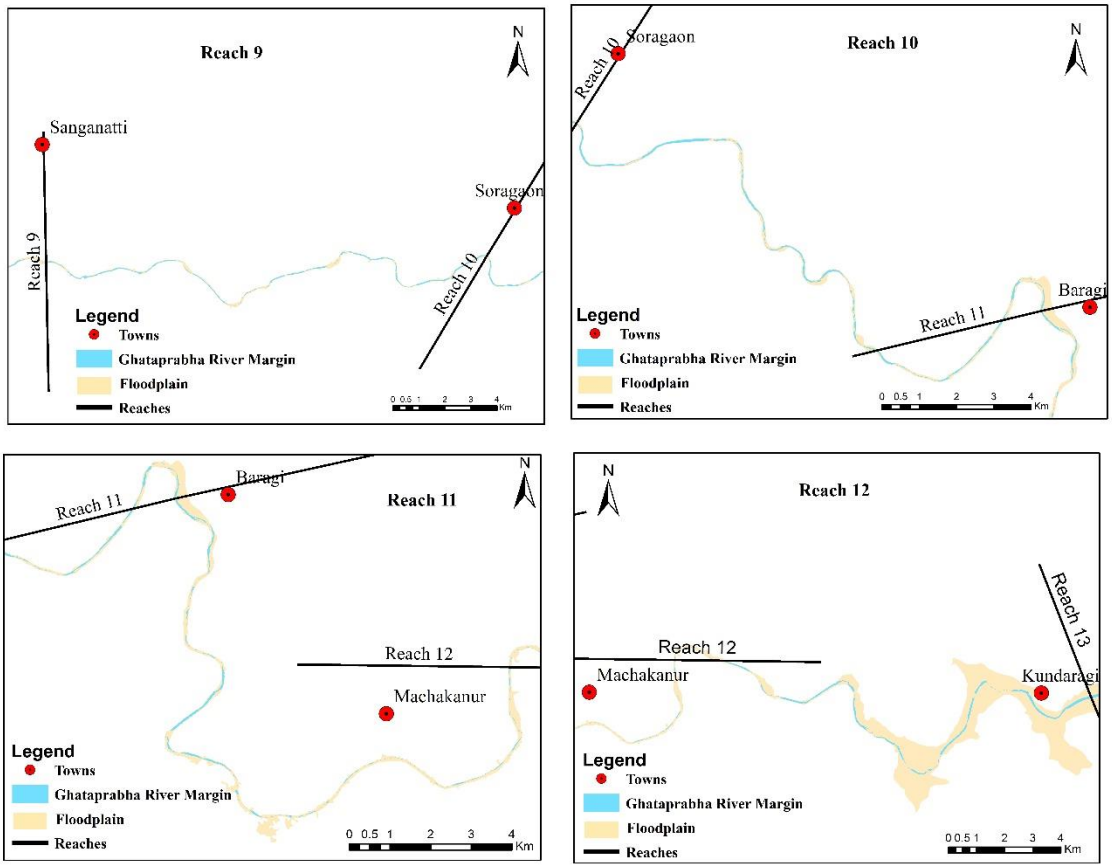

Figure 4. 3 Floodplain extent of the Ghataprabha River from Reach 9 to Reach 12, showing river margins, floodplains and vulnerable settlements.

4.3 Floodplain Mapping of Malaprabha River

The floodplain extent of the Malaprabha River between Reach 9 and Reach 12 shows variable inundation corridors along the river. Settlements such as Gonaganur, Kolachi, Kalas, Hole Alur, and Nelwagi lie close to the floodplain, making them vulnerable to seasonal flooding. In Reach 9, the floodplain is narrow, while in Reach 10, wider meanders near Kolachi increase lateral spread. Reach 11 exhibits continuous floodplain expansion near Kalas and Hole Alur, and in Reach 12, the floodplain widens again toward Nelwagi. Overall, the Malaprabha floodplain is highly variable, shaped by channel morphology and settlement distribution, offering key inputs for flood risk management. This spatial assessment demonstrates that the Malaprabha River floodplain is non-uniform across reaches, shaped by local topography, channel morphology, and settlement proximity. Such reach-wise delineation provides critical insights for flood hazard assessment, zoning, and sustainable land-use planning in the sub-basin. . Figure 4.4 represents floodplain extent of the Malaprabha River from reach 9 to reach 12.

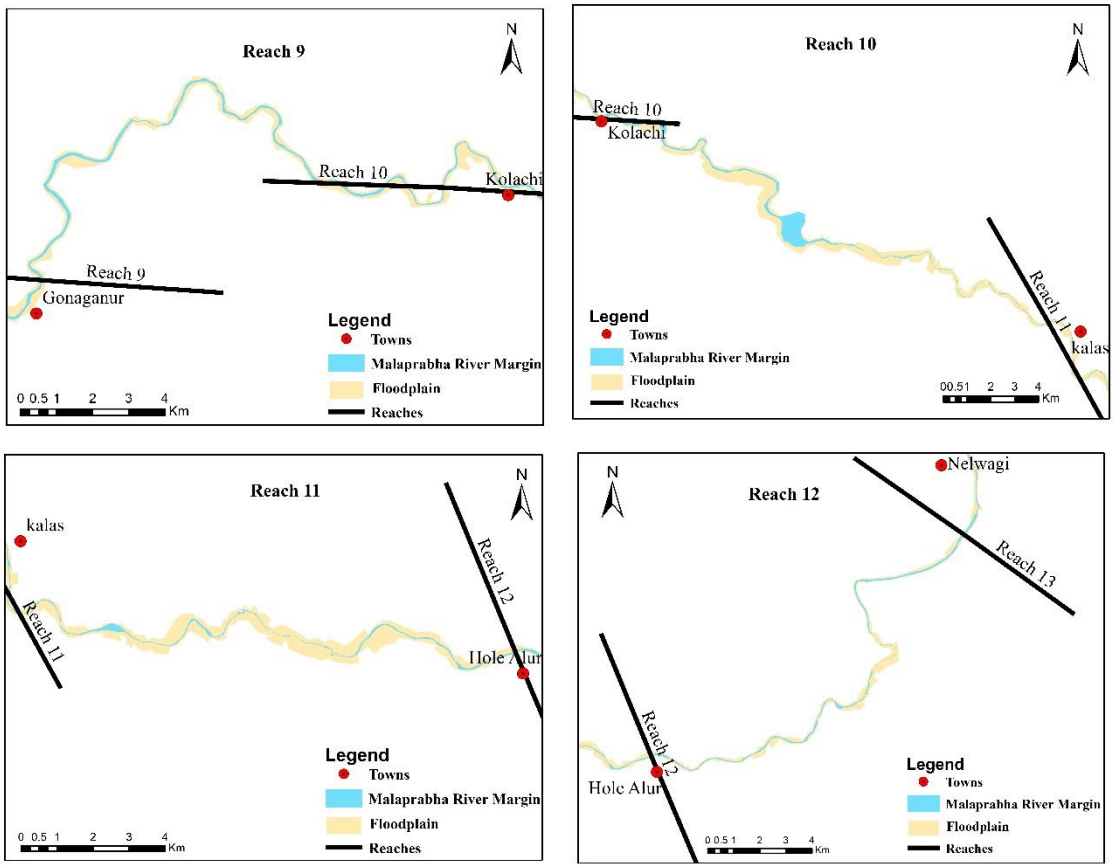

Figure 4. 4 Floodplain extent of the Malaprabha River from Reach 9 to Reach 12, showing river margins, floodplains and vulnerable settlements.

4.4 Floodplain Mapping of Munneru River

The floodplain extent of the Munneru River between Reach 5 and Reach 8 highlights wide inundation zones along the active channel. Settlements such as Dornakal, Khammam, Gandhari, Palampalle, and Penuganchiprolu lie close to the floodplain, making them vulnerable to seasonal floods. In Reach 5, the floodplain is moderately confined near Dornakal, while in Reach 6, it widens considerably around Khammam. Reach 7 shows extensive floodplain spread along both banks near Gandhari and Palampalle, and in Reach 8, broad floodplain coverage is observed near Penuganchiprolu. Overall, the Munneru River exhibits significant floodplain variability across reaches, shaped by channel morphology and settlement proximity, providing critical inputs for flood risk assessment and land-use planning. This spatial assessment demonstrates that the Munneru River floodplain is highly variable, transitioning from moderately confined upstream zones to extensive lateral corridors downstream. Figure 4.5 represents floodplain extent of the Munneeru River from reach5 to reach 8.

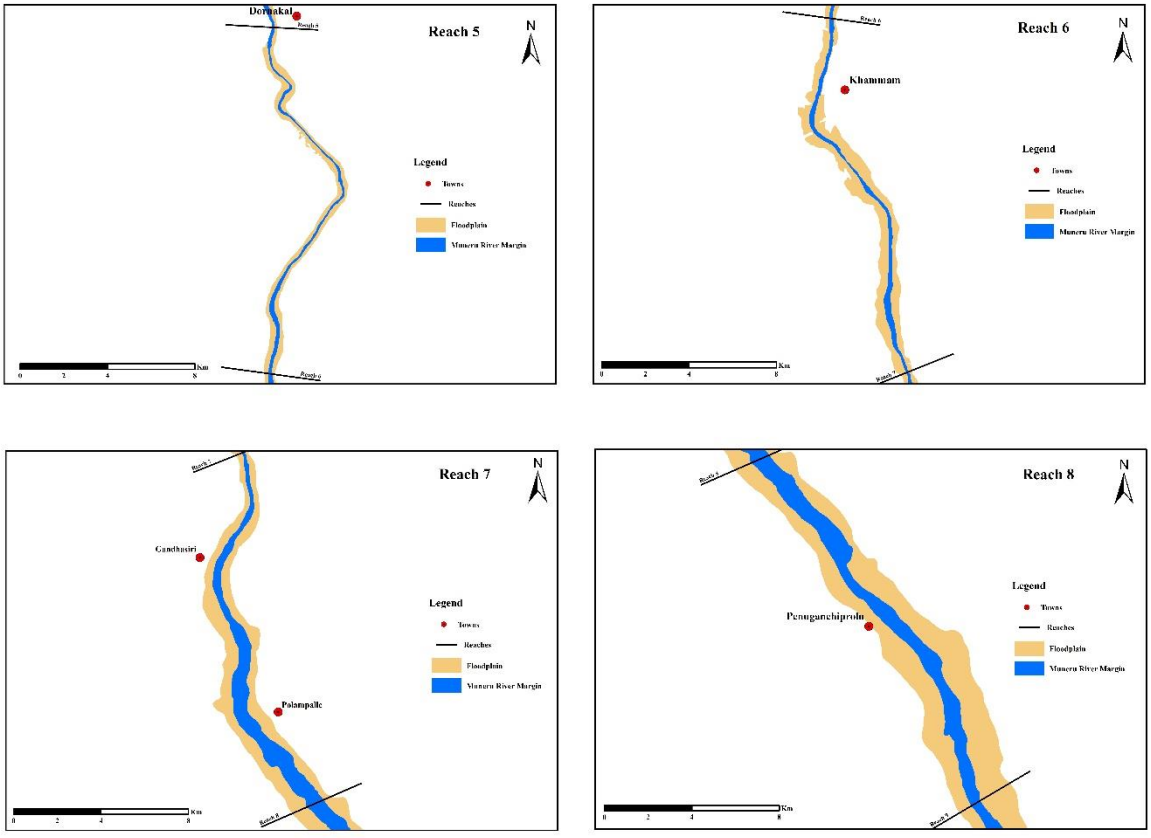

Figure 4. 5 Floodplain extent of the Munneru River from Reach 5 to Reach 8, showing river margins, floodplains and vulnerable settlements.

4.5 Floodplain Mapping of Musi River

The floodplain extent of the Musi River between Reach 9 and Reach 12 highlights variable inundation corridors adjoining the river margins. Settlements such as Suraram, Ammanabole, Manmadde, Chintaloor, Vangamarthy, Kasansapode, Venellapally, Uppalapadu, Rayanagudem, Bonnaram, Dongsabud, Talladugole, Burgalabandha, Chilkapalli, and Vithaparam are located close to the floodplain, making them vulnerable to seasonal flooding. In Reach 9, the floodplain remains narrow near Suraram and Ammanabole, but widens gradually toward Manmadde. In Reach 10, the presence of the Musi Reservoir and adjacent low-lying terrain near Chintaloor, Kasansapode, and Venellapally results in broad floodplain coverage, indicating higher inundation potential. Reach 11 shows lateral floodplain expansion along both banks near Bonnaram and Talladugole, while in Reach 12, the floodplain widens again around Burgalabandha and Chilkapalli, before extending downstream toward Vithaparam. This spatial assessment demonstrates that the Musi River floodplain is highly variable across reaches, influenced by channel morphology, reservoir presence, and settlement distribution. Figure 4.6 represents the floodplain extent of the Musi River from Reach 9 to Reach 12.

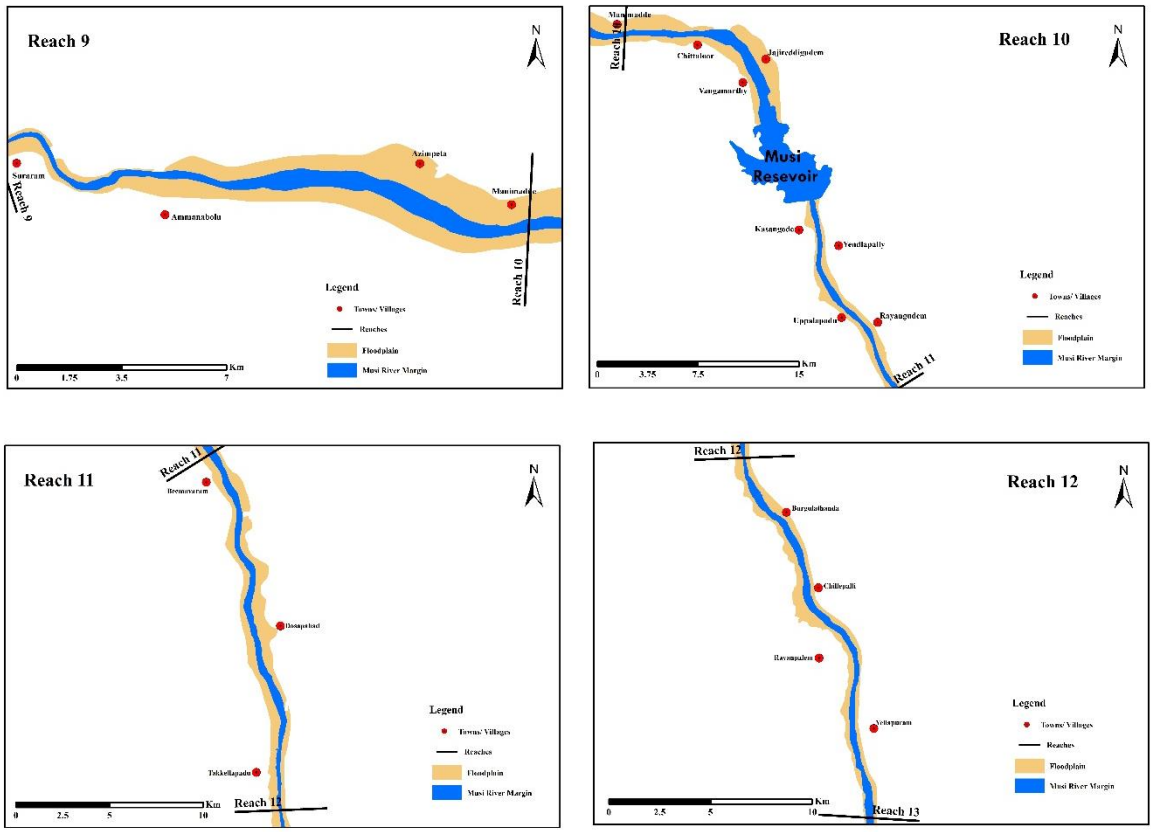

Figure 4. 6 Floodplain extent of the Musi River from Reach 9 to Reach 12, showing river margins, floodplains and vulnerable settlements.

4.6 Floodplain Mapping of Tungabhadra River

The floodplain extent of the Tungabhadra River between Reach 5 and Reach 8 highlights wide and variable inundation corridors along the channel. Settlements such as Johrapuram, Bichhal Camp, Kapudukur, Ayanur, and Dhadesugur Camp are situated near the river margins and floodplain, making them vulnerable to seasonal flooding. In Reach 5, the floodplain is moderately wide near Johrapuram, showing lateral spread across both banks. Moving into Reach 6, the floodplain broadens further near Bichhal Camp and Kapudukur, where meandering sections enhance flood susceptibility. In Reach 7, the corridor becomes more expansive, reflecting active channel migration and extensive inundation potential, particularly downstream of Kapudukur. Finally, Reach 8 shows continuous and wider floodplain coverage near Ayanur and Dhadesugur Camp, marking significant flood-prone areas. This spatial assessment demonstrates that the Tungabhadra River floodplain is highly variable across reaches, with settlement proximity and channel morphology strongly influencing inundation risk. Reach-based delineation thus provides critical insights for flood hazard assessment, zoning, and sustainable land-use planning in the basin.

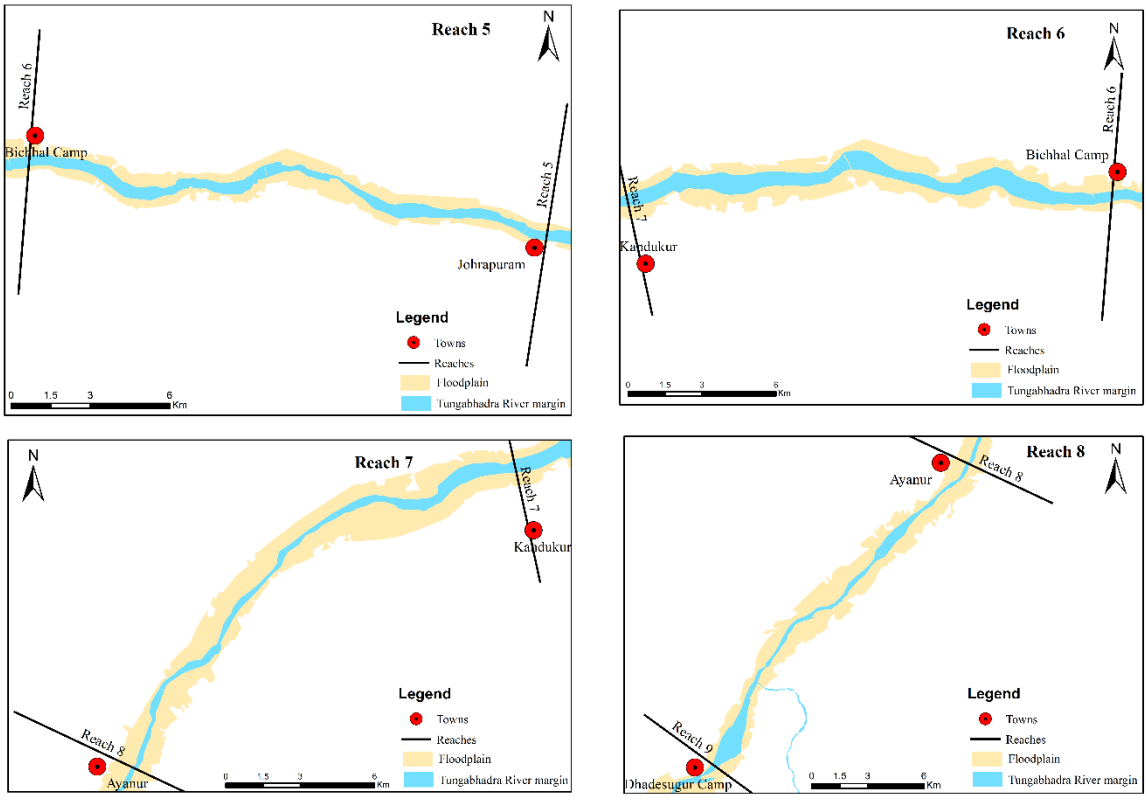

Figure 4. 7 Floodplain extent of the Tungabhadra River from Reach 5 to Reach 8, showing river margins, floodplains and vulnerable settlements

5. CONCLUSIONS

Floodplain mapping of the Krishna River Basin using multi-temporal Sentinel-1 SAR imagery and CHIRPS rainfall data has provided a scientifically robust and spatially explicit understanding of flood-prone areas across one of India's most critical river systems. The integration of satellite-based precipitation estimates with radar-derived inundation extents through the Google Earth Engine platform enabled consistent, cloud-independent, and repeatable floodplain delineation for the period 2018–2024. The results clearly demonstrate that floodplain extents within the Krishna River Basin are highly heterogeneous, varying significantly across main stem reaches and major tributaries such as the Bhima, Ghataprabha, Malaprabha, Munneru, Musi, and Tungabhadra rivers. Tributaries with large catchment areas, extensive reservoirs, and low-lying alluvial reaches exhibit wider and more persistent floodplains, while confined upstream reaches show relatively limited inundation. The Krishna delta emerges as one of the most vulnerable regions due to the combined influence of upstream flows, monsoonal rainfall, and low-gradient terrain. Reach-wise floodplain mapping highlights the close spatial association between inundation zones and human settlements, underscoring the increasing exposure of communities, infrastructure, and agricultural lands to flood hazards. Anthropogenic pressures such as floodplain encroachment, urban expansion, and altered flow regimes have further amplified flood risks, particularly in downstream and peri-urban areas. The generated floodplain maps serve as a critical decision-support tool for basin-scale flood risk zoning, land-use regulation, disaster preparedness, and climate-resilient infrastructure planning. By distinguishing active and recurrent flood-prone areas, the study provides a scientific basis for implementing informed floodplain management policies in line with Integrated Water Resources Management (IWRM) principles. Overall, this work reinforces the importance of satellite-based floodplain mapping as an essential component of sustainable river basin management. The methodology adopted for the Krishna River Basin is scalable and transferable to other river systems in India, supporting national efforts toward flood risk reduction, river conservation, and long-term socio-environmental resilience.

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Appendix

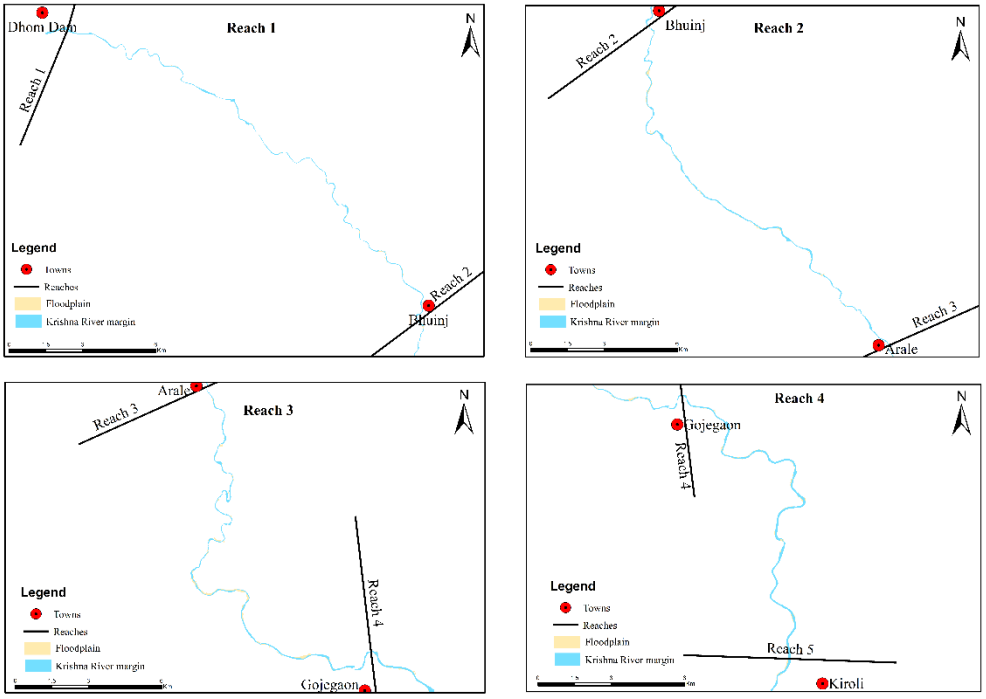

Figure A1. Floodplain extent of the Krishna River from Reach 1 to Reach 4, showing river margins, floodplains and vulnerable settlements

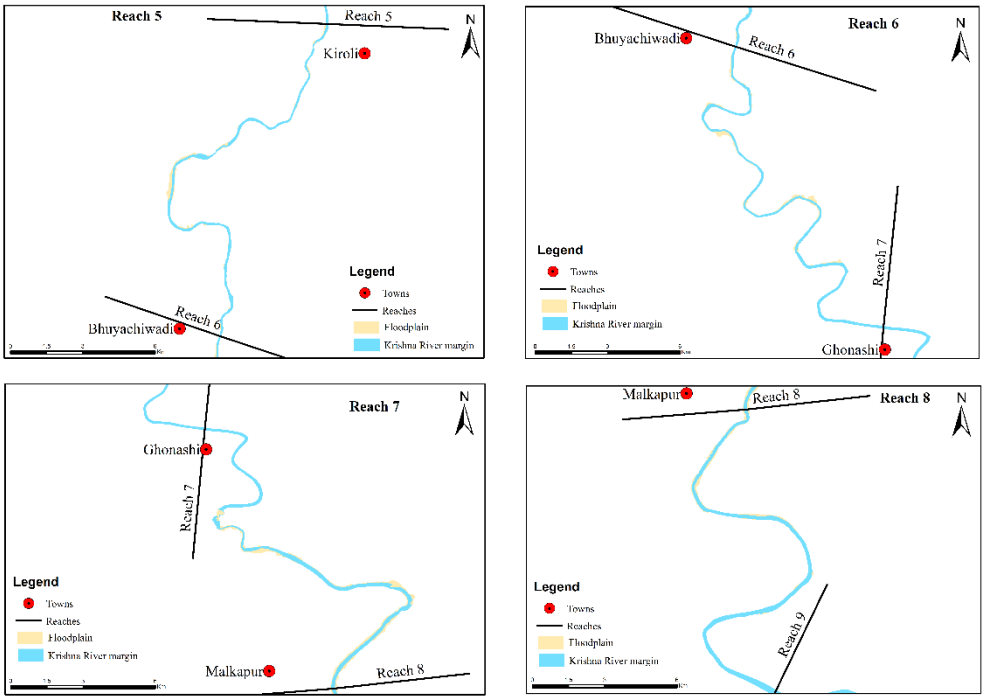

Figure A2. Floodplain extent of the Krishna River from Reach 5 to Reach 8, showing river margins, floodplains and vulnerable settlements

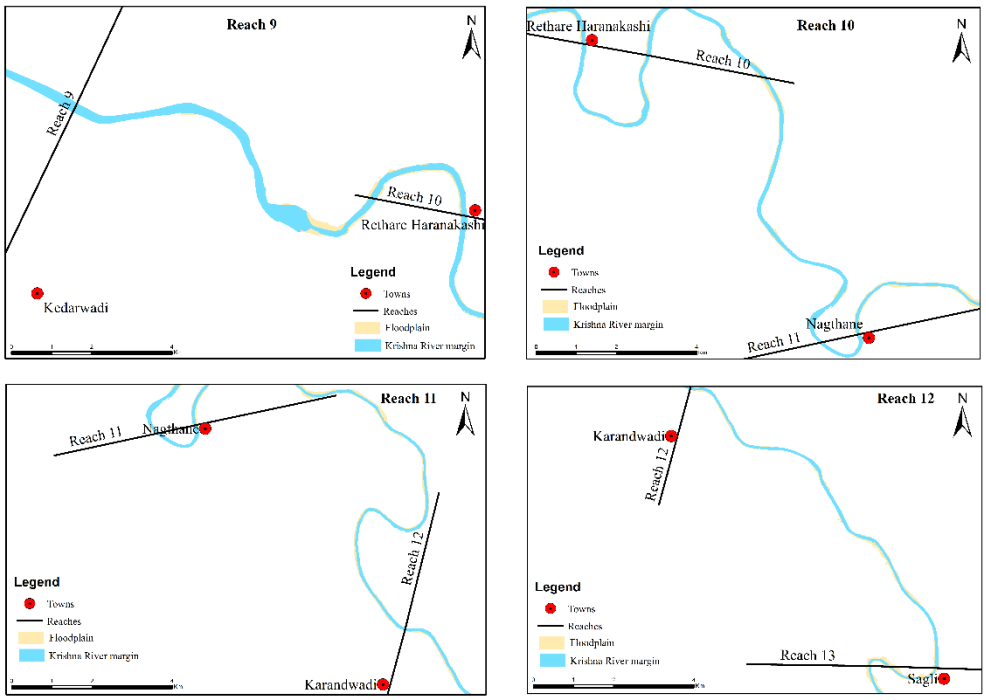

Figure A3. Floodplain extent of the Krishna River from Reach 9 to Reach 12, showing river margins, floodplains and vulnerable settlements

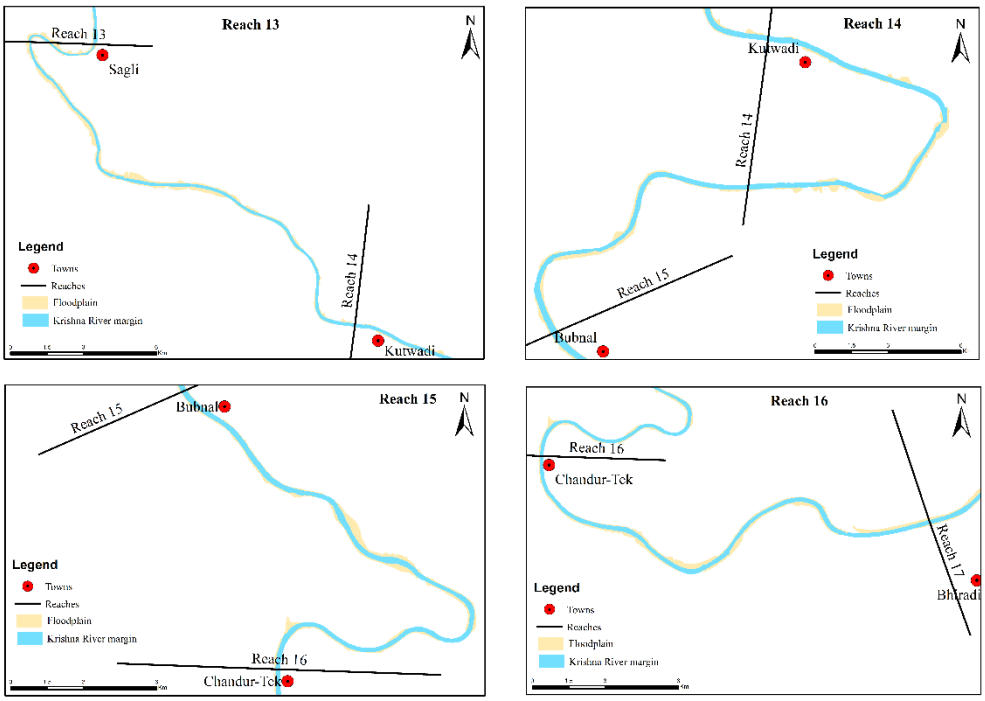

Figure A4. Floodplain extent of the Krishna River from Reach 13 to Reach 16, showing river margins, floodplains and vulnerable settlements

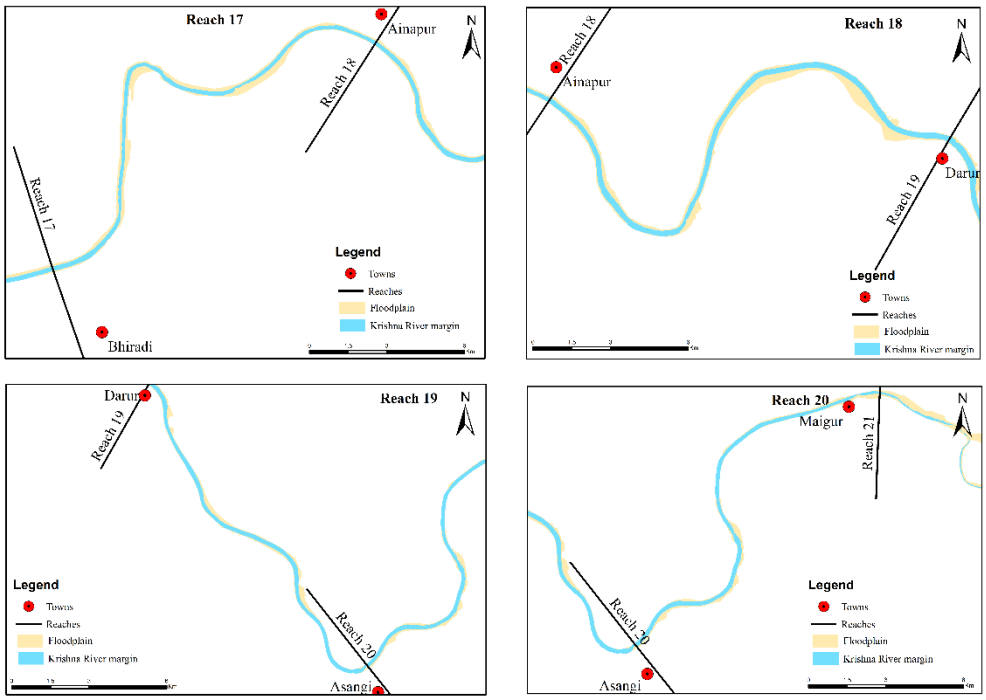

Figure A5. Floodplain extent of the Krishna River from Reach 17 to Reach 20, showing river margins, floodplains and vulnerable settlements

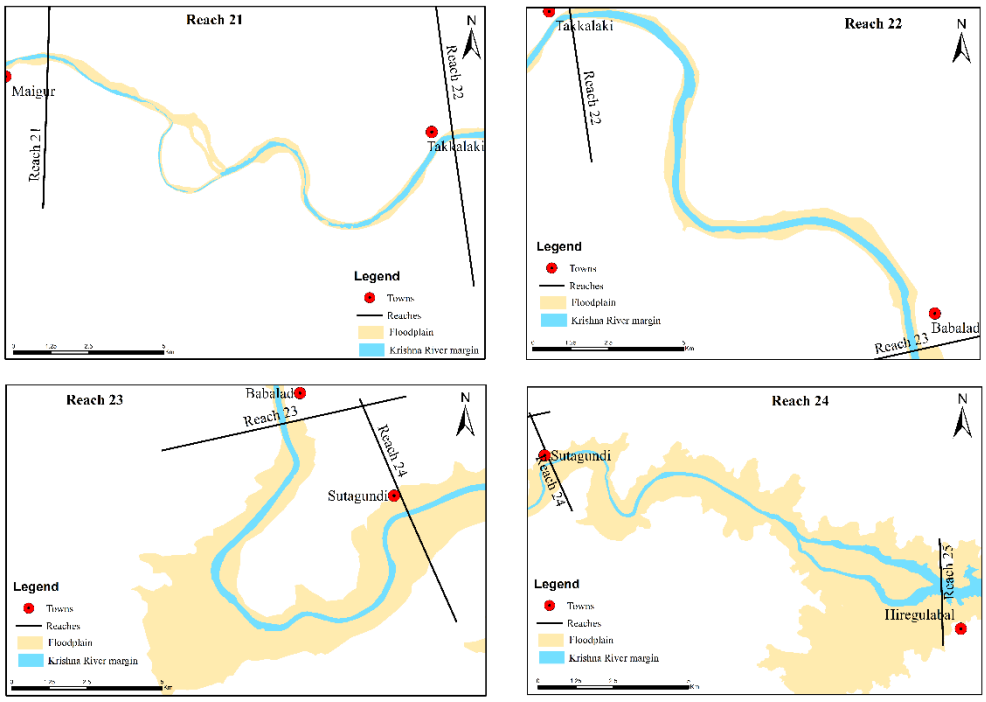

Figure A6. Floodplain extent of the Krishna River from Reach 21 to Reach 24, showing river margins, floodplains and vulnerable settlements

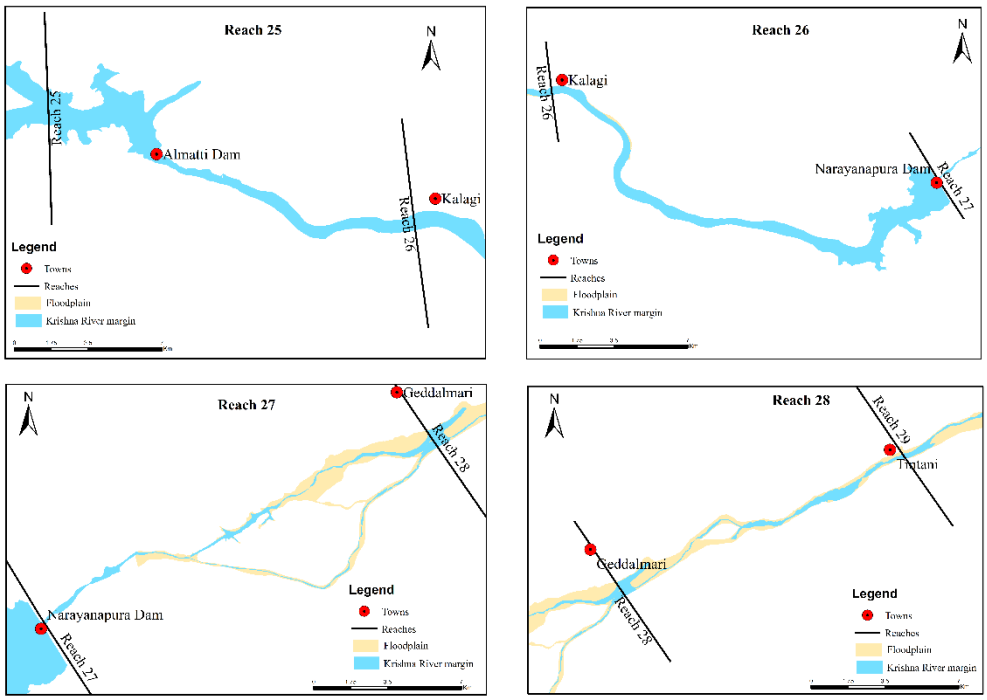

Figure A7. Floodplain extent of the Krishna River from Reach 25 to Reach 28, showing river margins, floodplains and vulnerable settlements

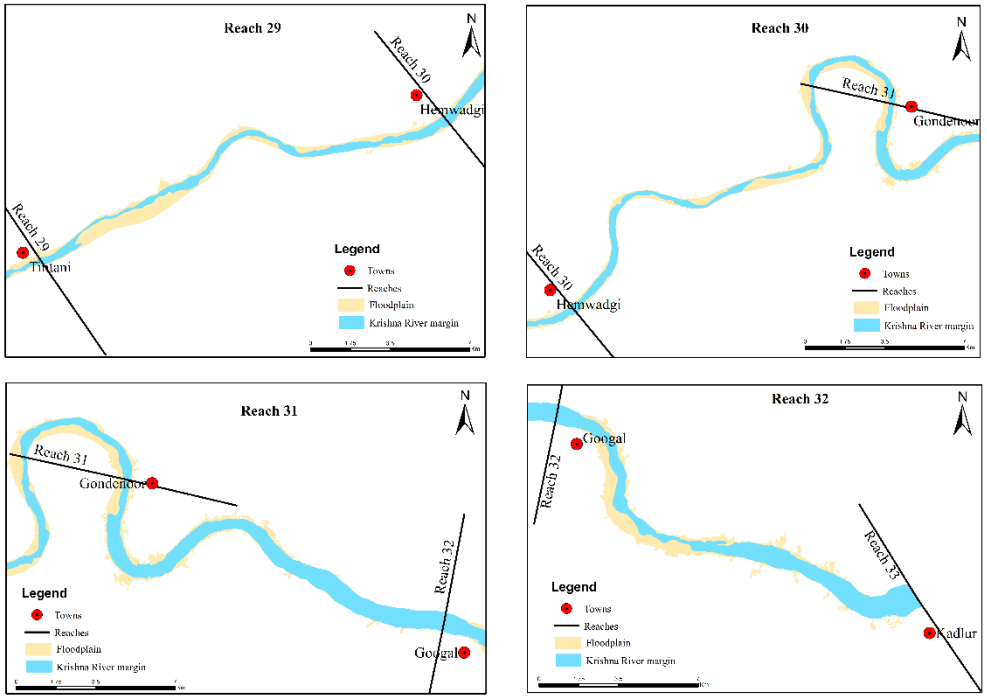

Figure A8. Floodplain extent of the Krishna River from Reach 29 to Reach 32, showing river margins, floodplains and vulnerable settlements

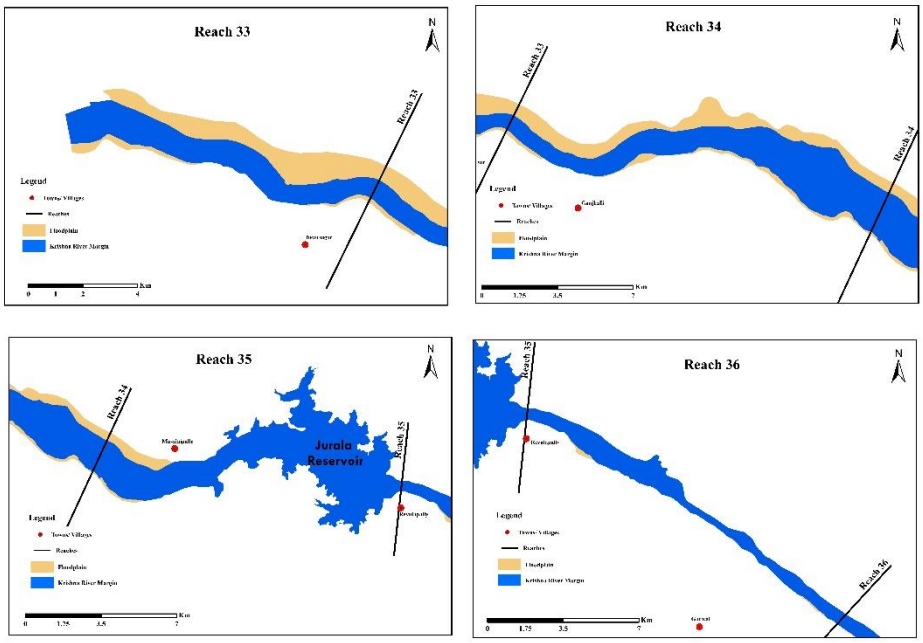

Figure A9. Floodplain extent of the Krishna River from Reach 33 to Reach 36, showing river margins, floodplains and vulnerable settlements

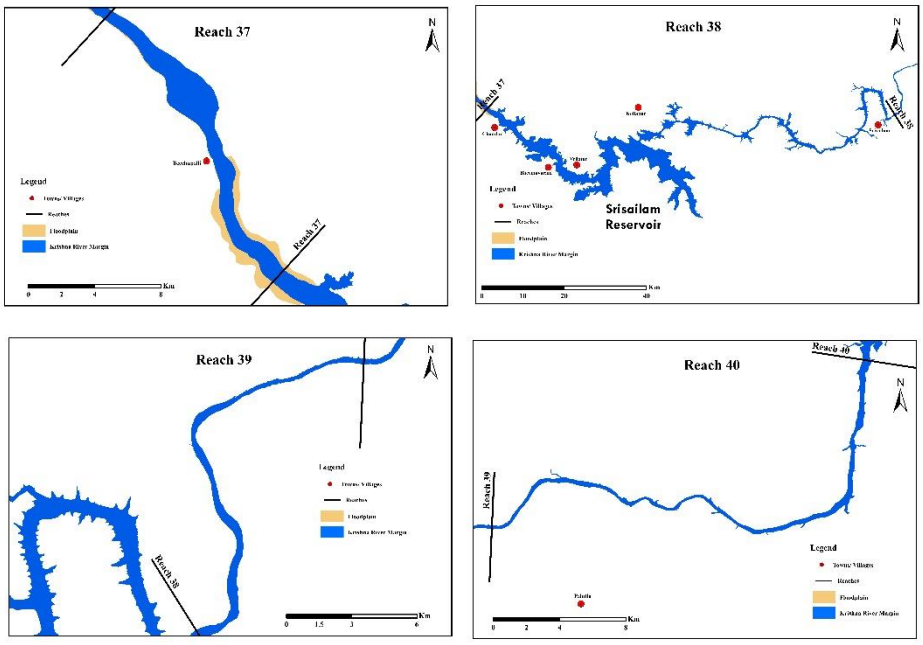

Figure A10. Floodplain extent of the Krishna River from Reach 37 to Reach 40, showing river margins, floodplains and vulnerable settlements

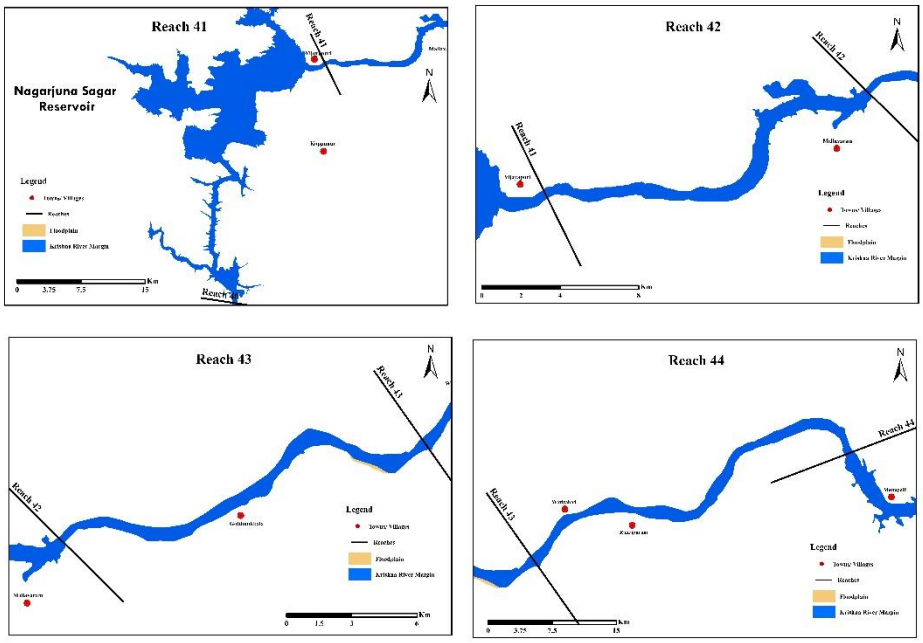

Figure A11. Floodplain extent of the Krishna River from Reach 41 to Reach 44, showing river margins, floodplains and vulnerable settlements

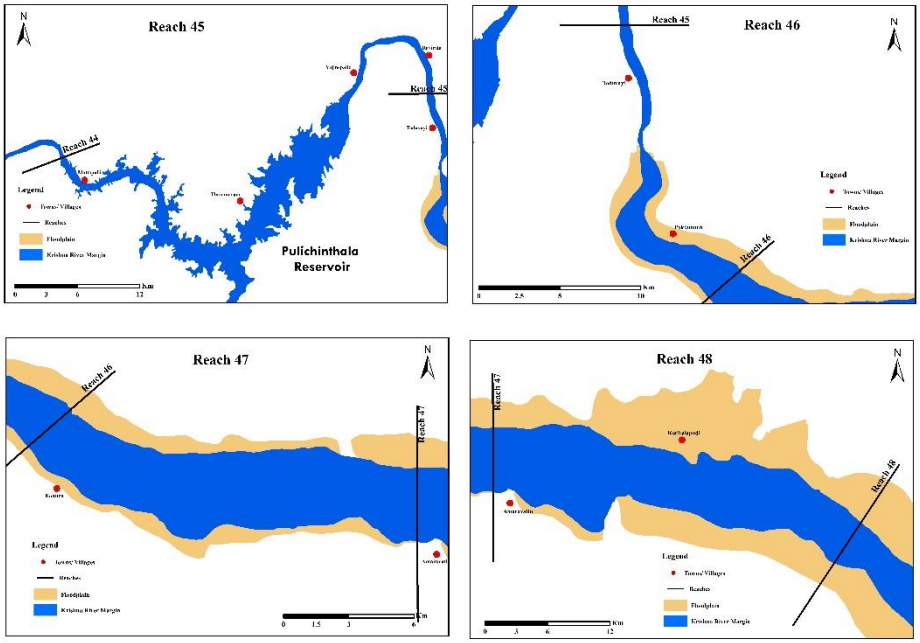

Figure A12. Floodplain extent of the Krishna River from Reach 45 to Reach 48, showing river margins, floodplains and vulnerable settlements

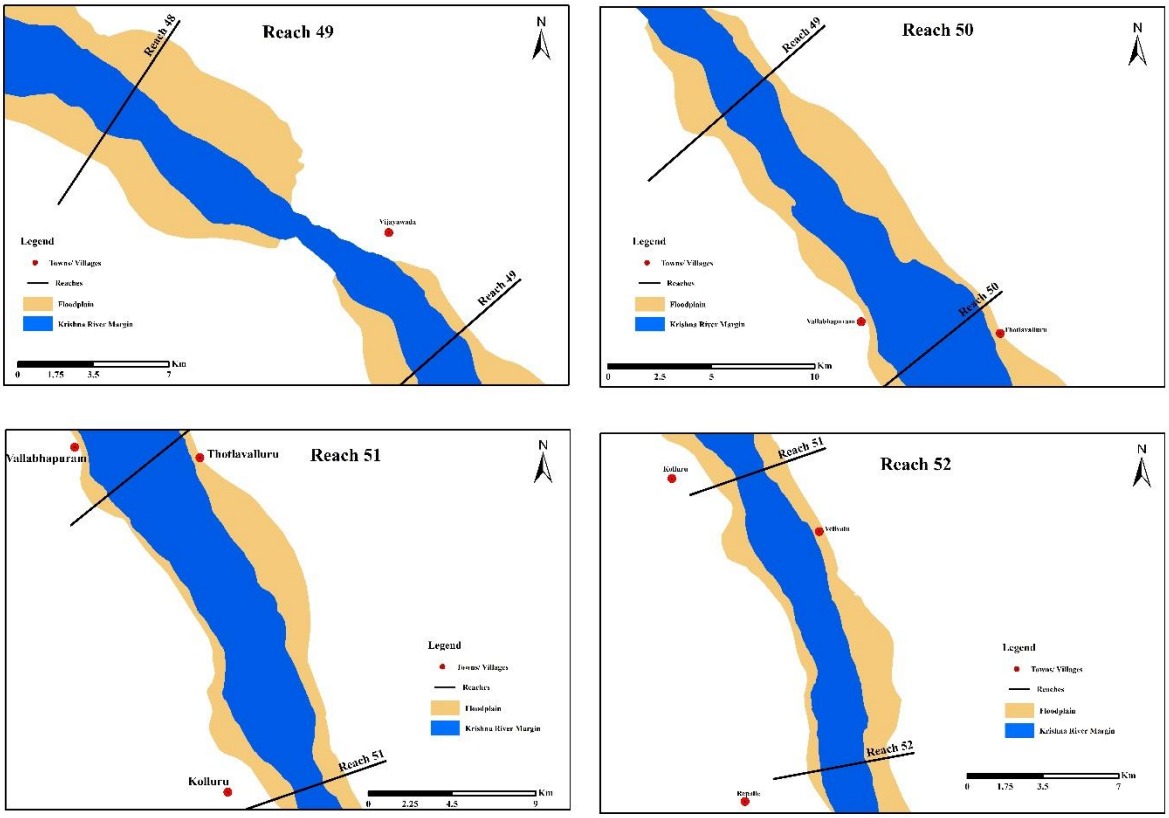

Figure A13. Floodplain extent of the Krishna River from Reach 49 to Reach 52, showing river margins, floodplains and vulnerable settlements

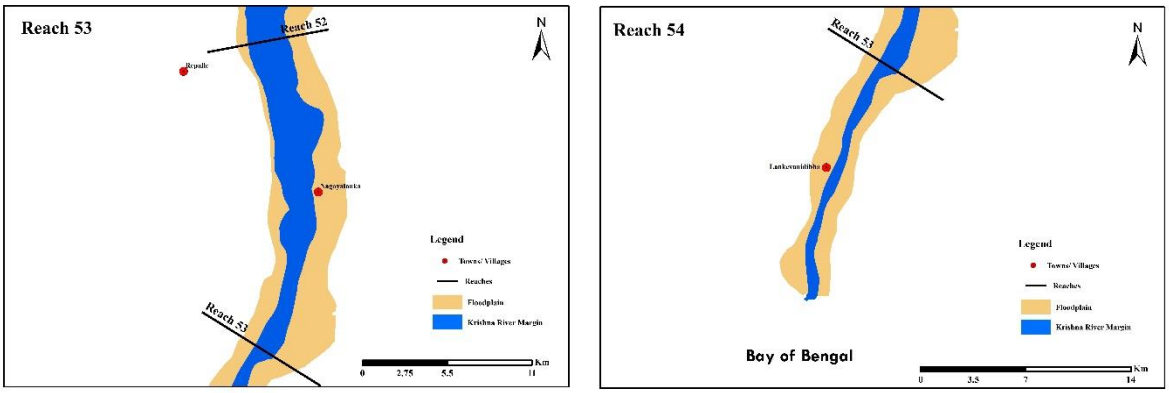

Figure A14. Floodplain extent of the Krishna River from Reach 53 to Reach 54, showing river margins, floodplains and vulnerable settlements

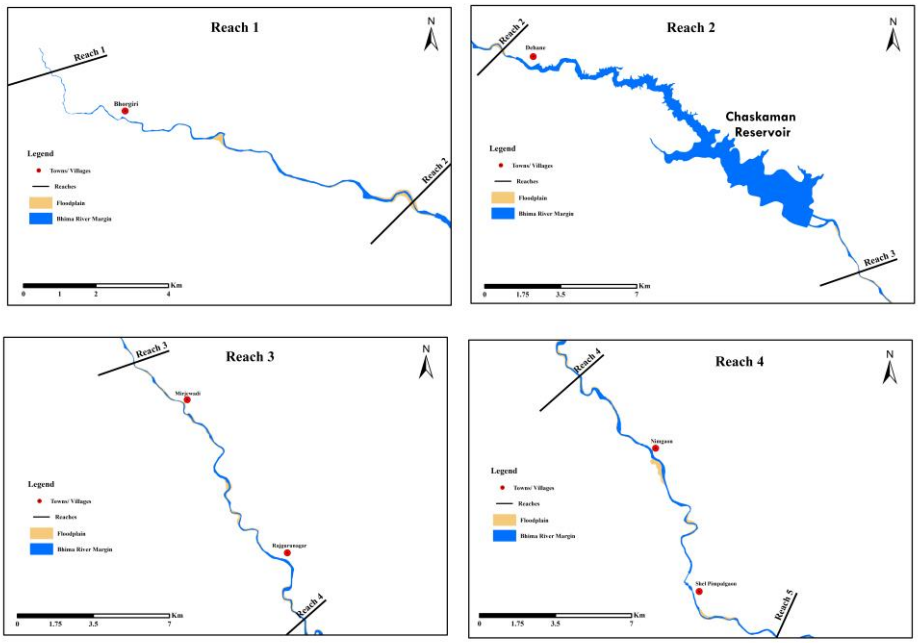

Figure A15. Floodplain extent of the Bhima River from Reach 1 to Reach 4, showing river margins, floodplains and vulnerable settlements

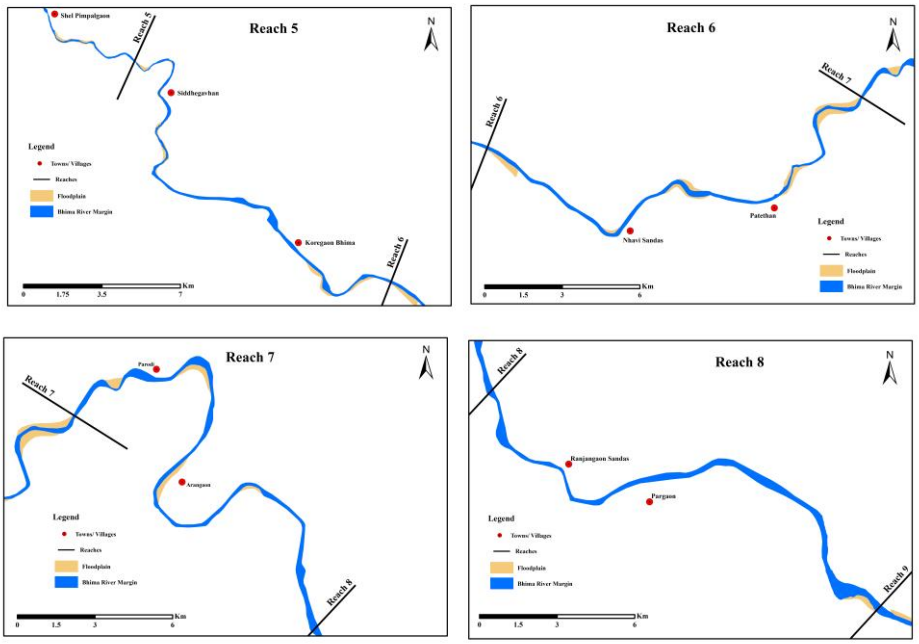

Figure A16. Floodplain extent of the Bhima River from Reach 5 to Reach 8, showing river margins, floodplains and vulnerable settlements

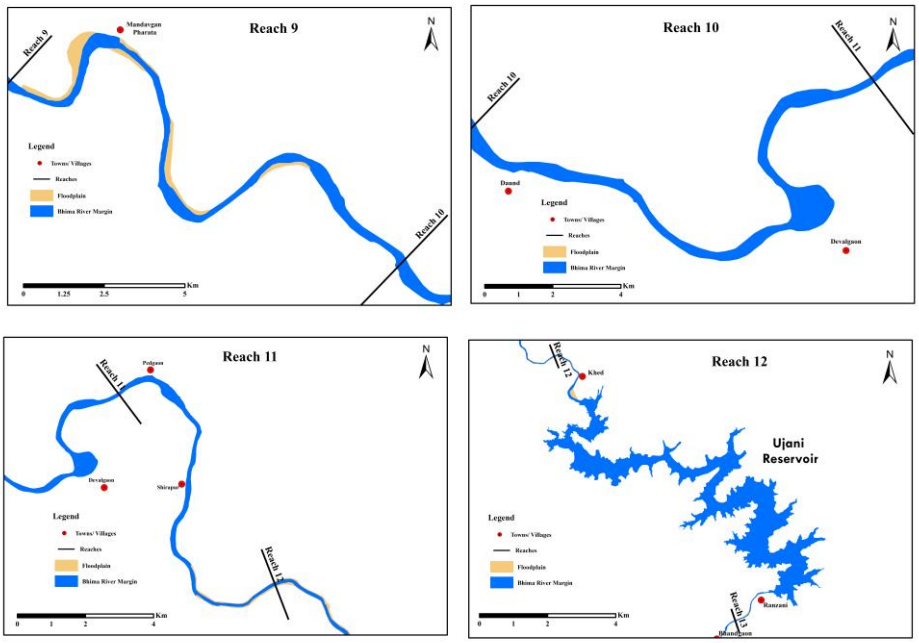

Figure A17. Floodplain extent of the Bhima River from Reach 9 to Reach 12, showing river margins, floodplains and vulnerable settlements

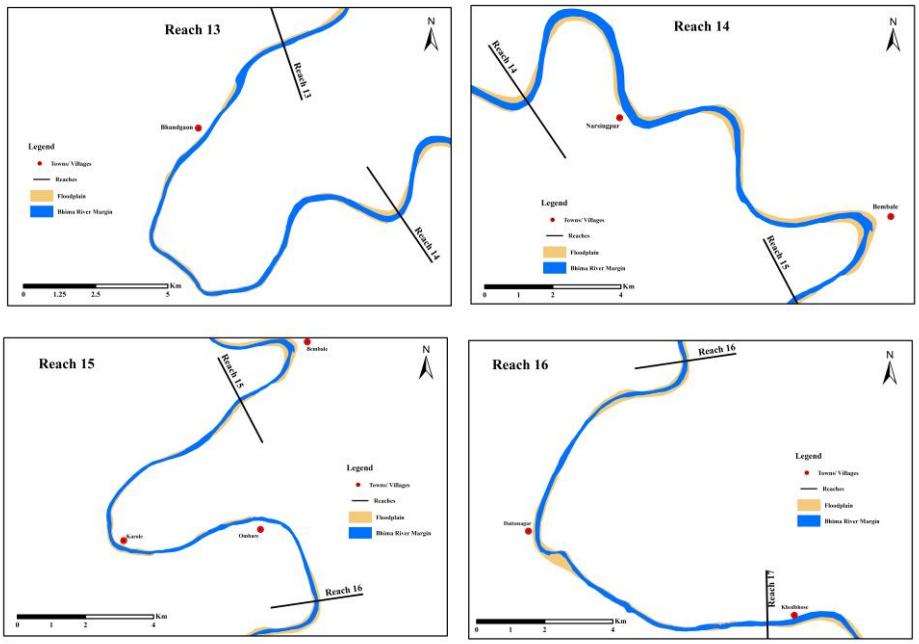

Figure A18. Floodplain extent of the Bhima River from Reach 13 to Reach 16, showing river margins, floodplains and vulnerable settlements

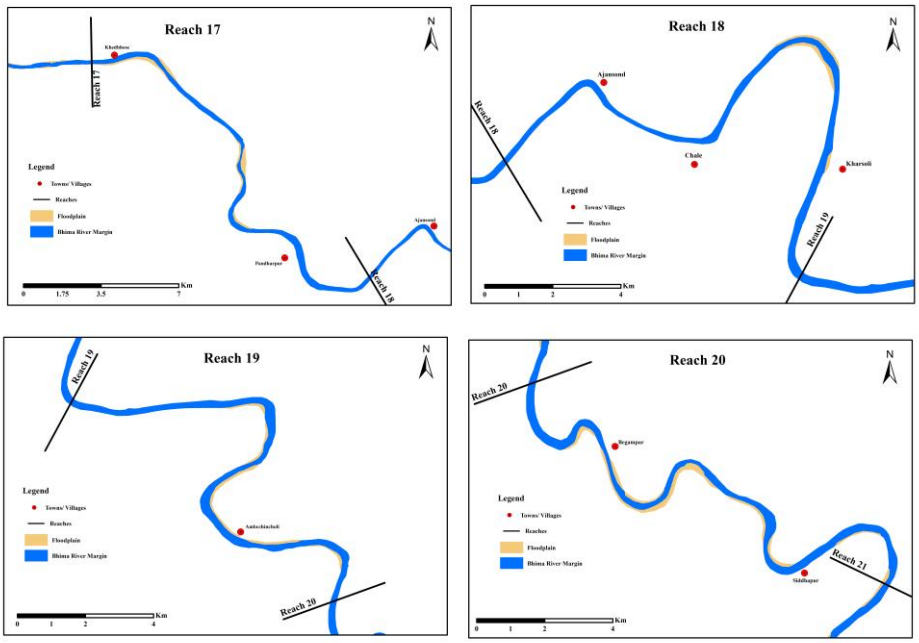

Figure A19. Floodplain extent of the Bhima River from Reach 17 to Reach 20, showing river margins, floodplains and vulnerable settlements

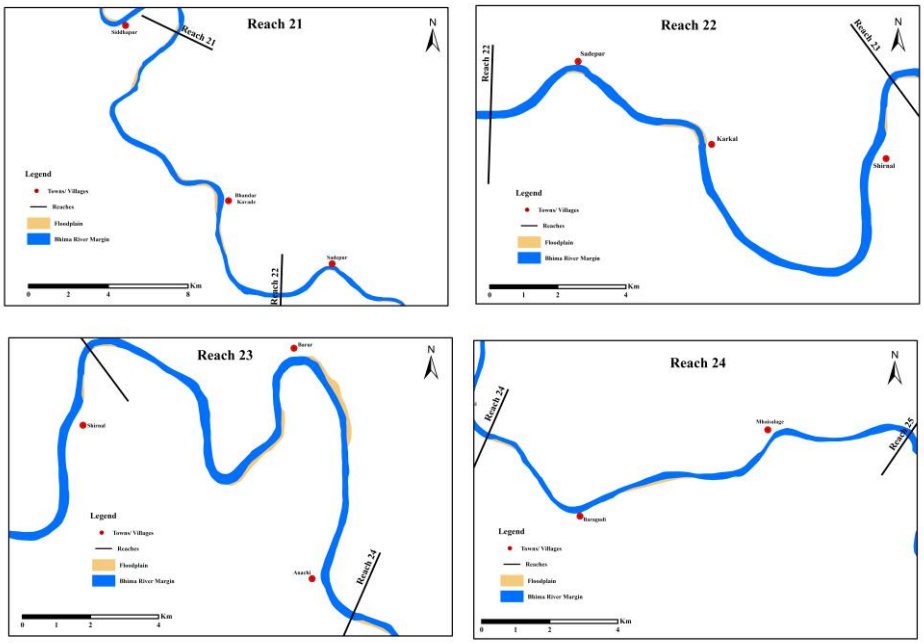

Figure A20. Floodplain extent of the Bhima River from Reach 21 to Reach 24, showing river margins, floodplains and vulnerable settlements

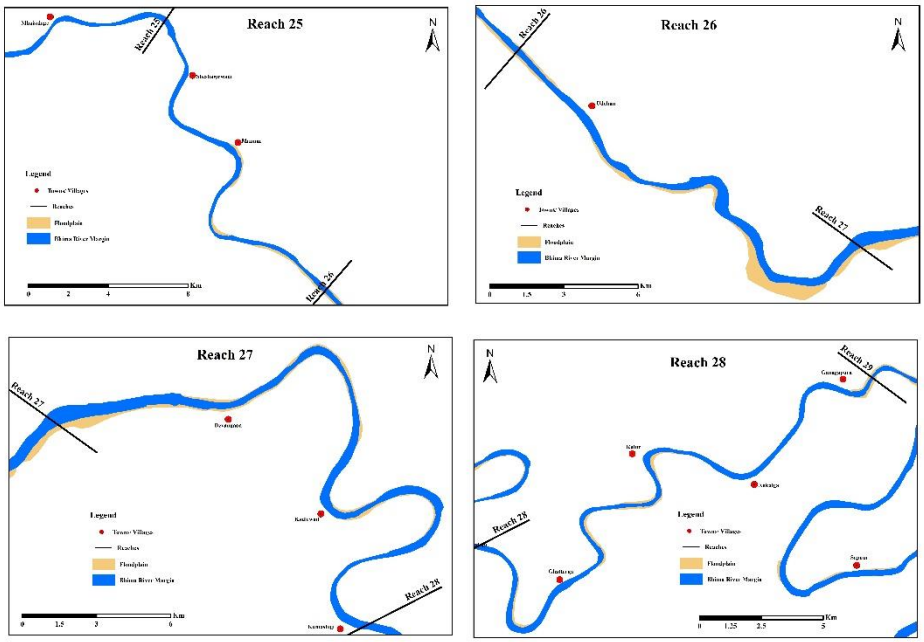

Figure A21. Floodplain extent of the Bhima River from Reach 25 to Reach 28, showing river margins, floodplains and vulnerable settlements

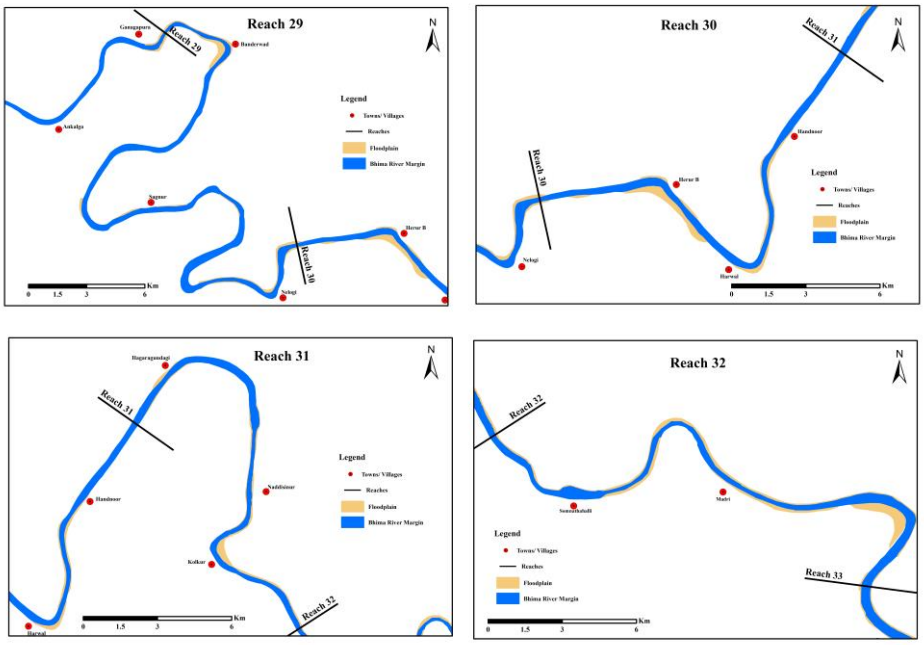

Figure A22. Floodplain extent of the Bhima River from Reach 29 to Reach 32, showing river margins, floodplains and vulnerable settlements

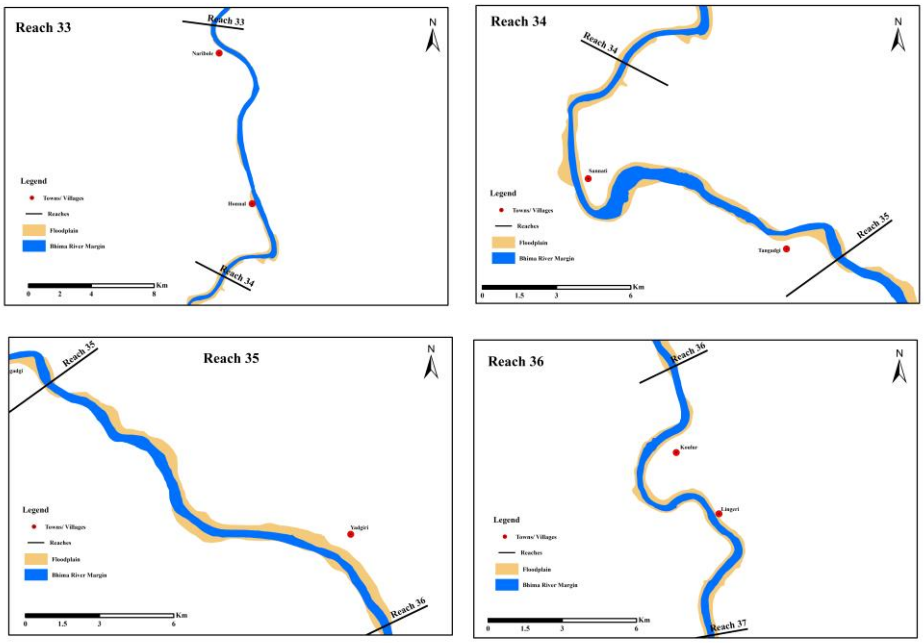

Figure A23. Floodplain extent of the Bhima River from Reach 33 to Reach 36, showing river margins, floodplains and vulnerable settlements

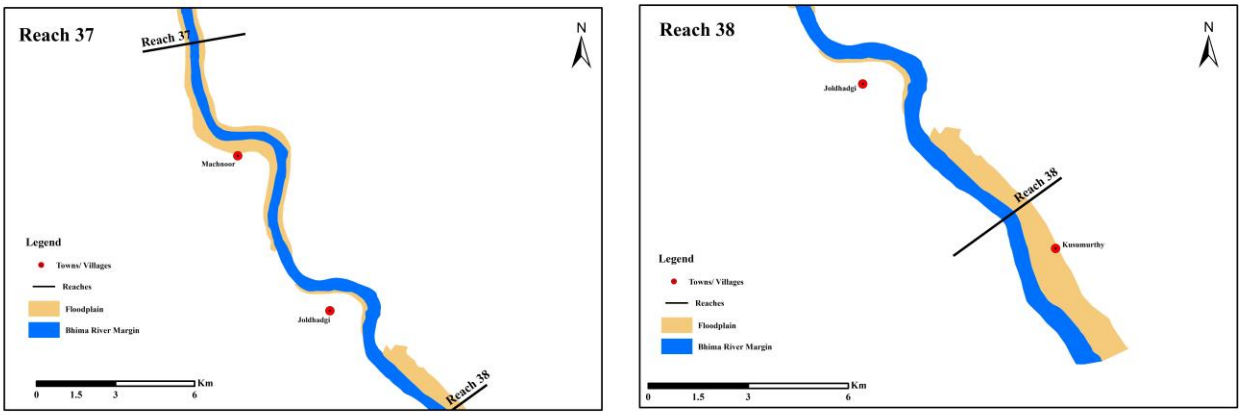

Figure A24. Floodplain extent of the Bhima River from Reach 37 to Reach 38, showing river margins, floodplains and vulnerable settlements

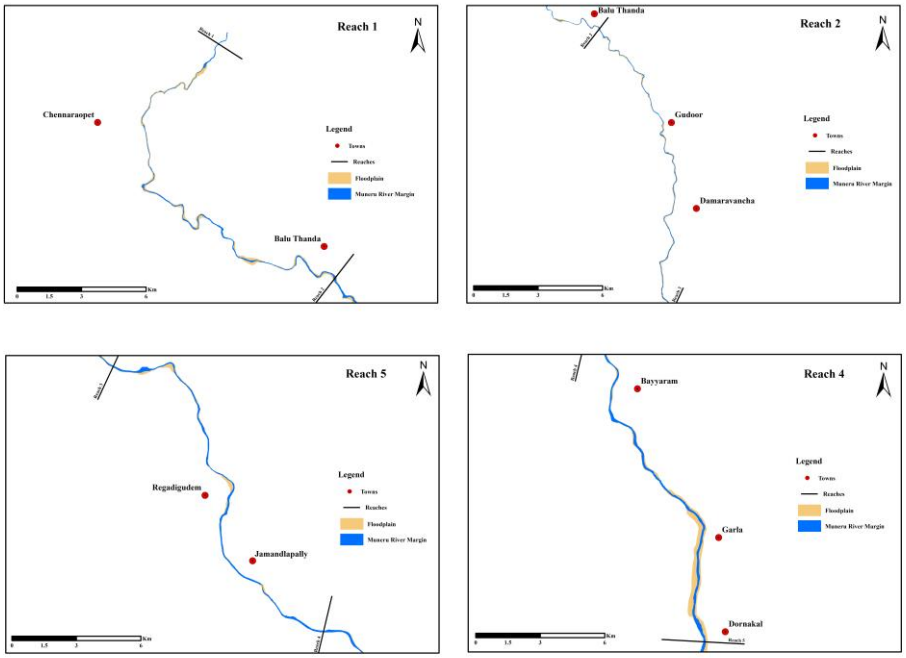

Figure A25. Floodplain extent of the Munneru River from Reach 1 to Reach 4, showing river margins, floodplains and vulnerable settlements

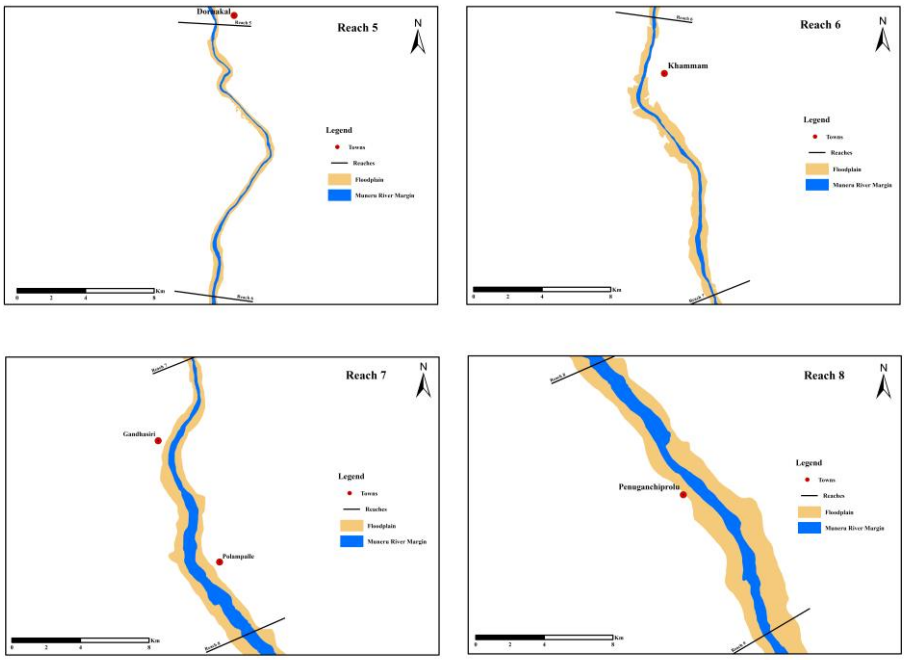

Figure A26. Floodplain extent of the Munneru River from Reach 5 to Reach 8, showing river margins, floodplains and vulnerable settlements

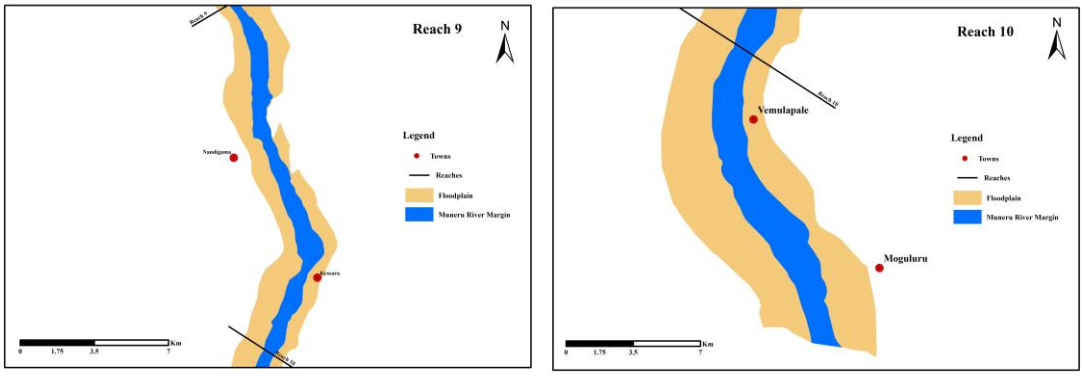

Figure A27. Floodplain extent of the Munneru River from Reach 9 to Reach 10, showing river margins, floodplains and vulnerable settlements

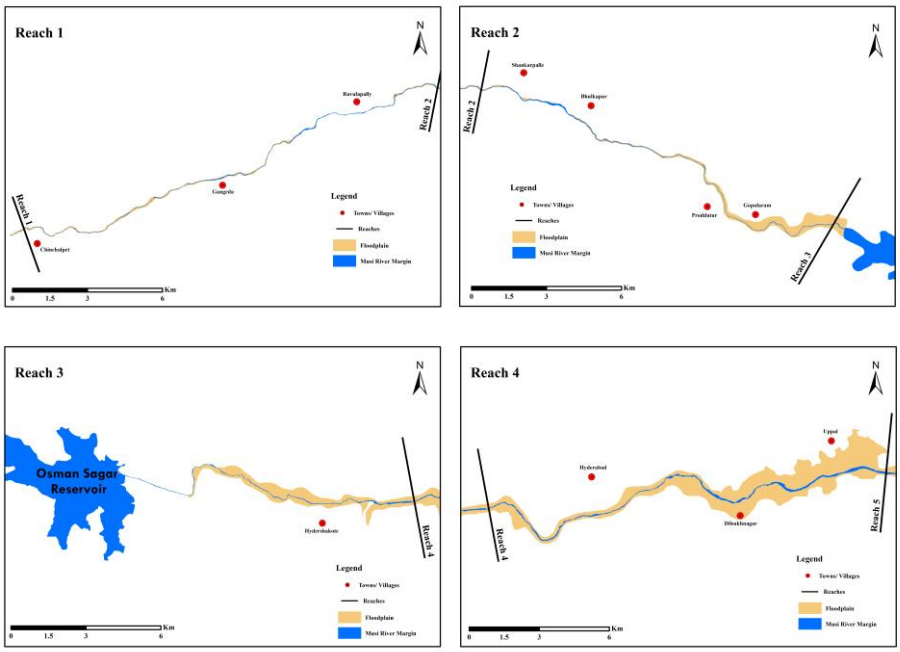

Figure A28. Floodplain extent of the Musi River from Reach 1 to Reach 4, showing river margins, floodplains and vulnerable settlements

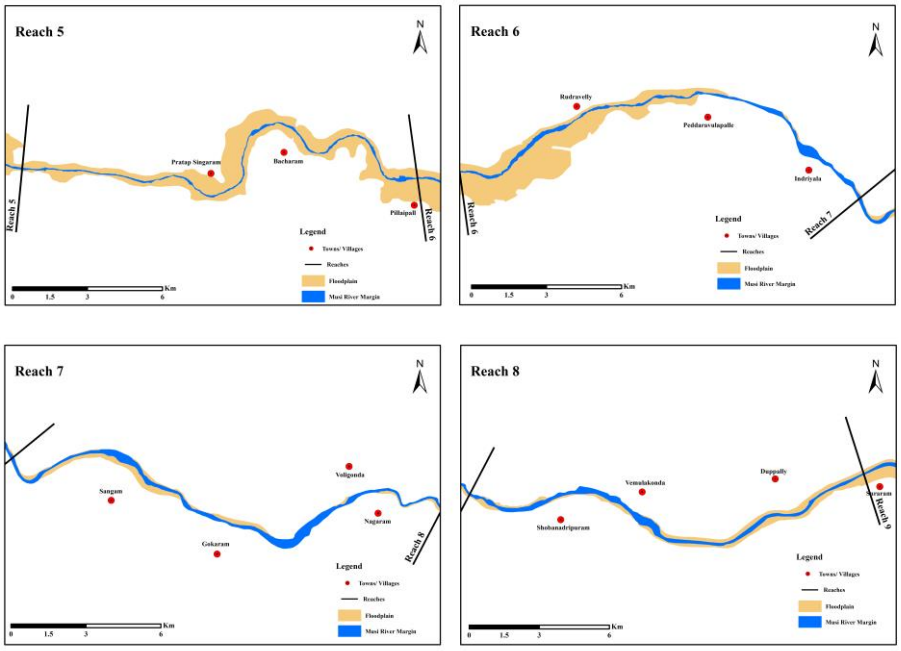

Figure A29. Floodplain extent of the Musi River from Reach 5 to Reach 8, showing river margins, floodplains and vulnerable settlements

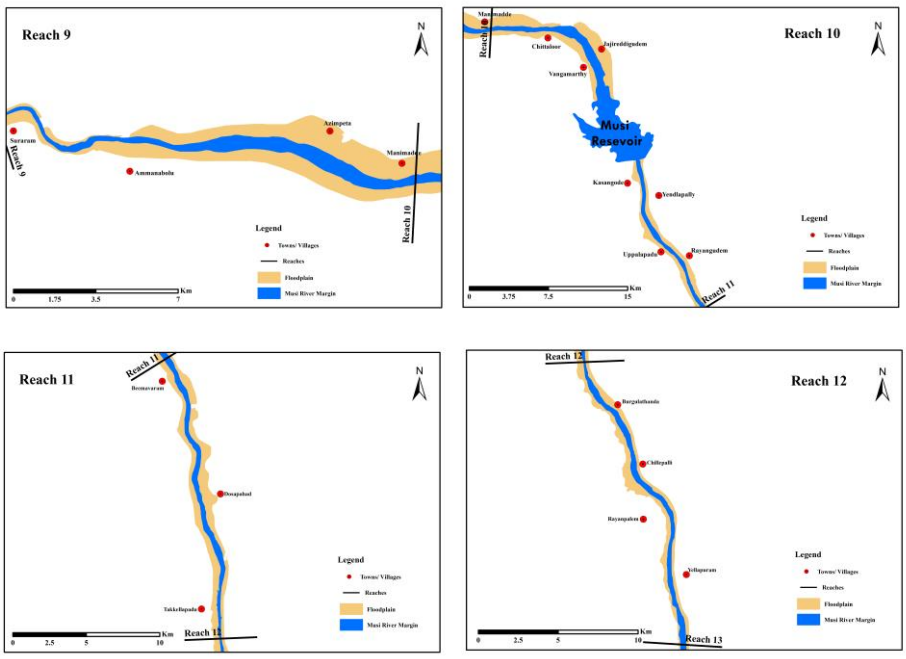

Figure A30. Floodplain extent of the Musi River from Reach 9 to Reach 12, showing river margins, floodplains and vulnerable settlements

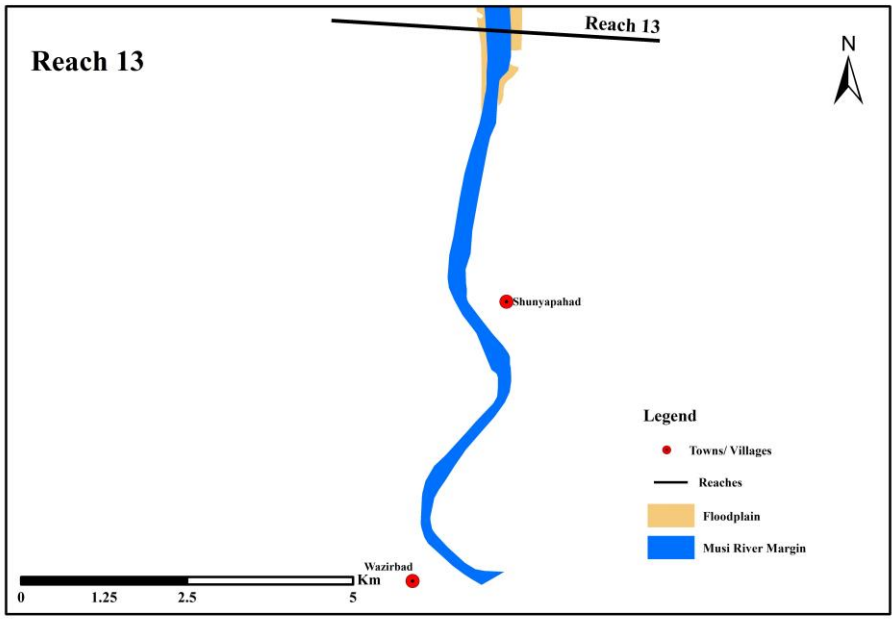

Figure A31. Floodplain extent of the Musi River from Reach 1 to Reach 1, showing river margins, floodplains and vulnerable settlements

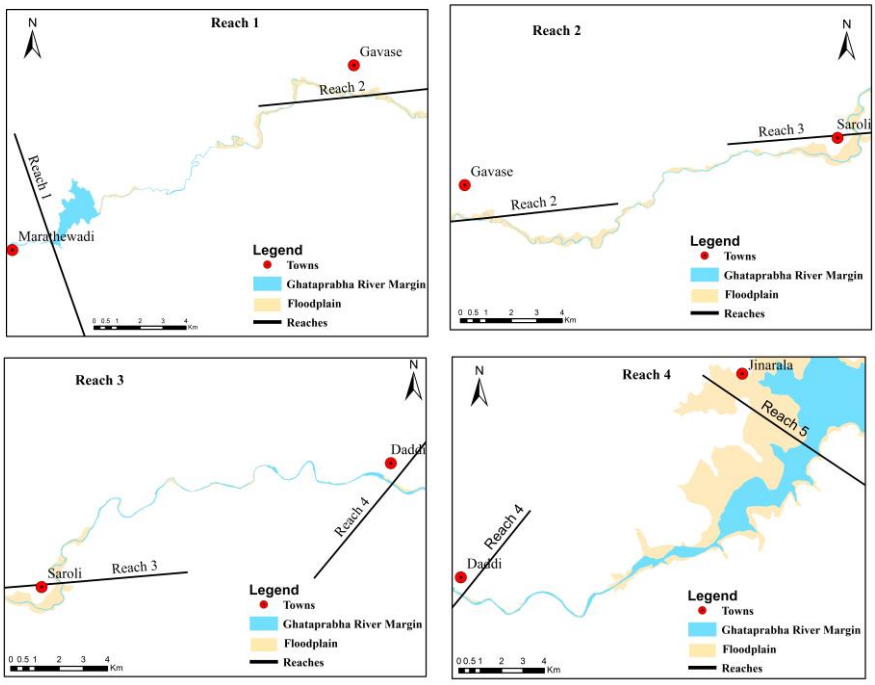

Figure A32. Floodplain extent of the Ghataprabha River from Reach 1 to Reach 4, showing river margins, floodplains and vulnerable settlements

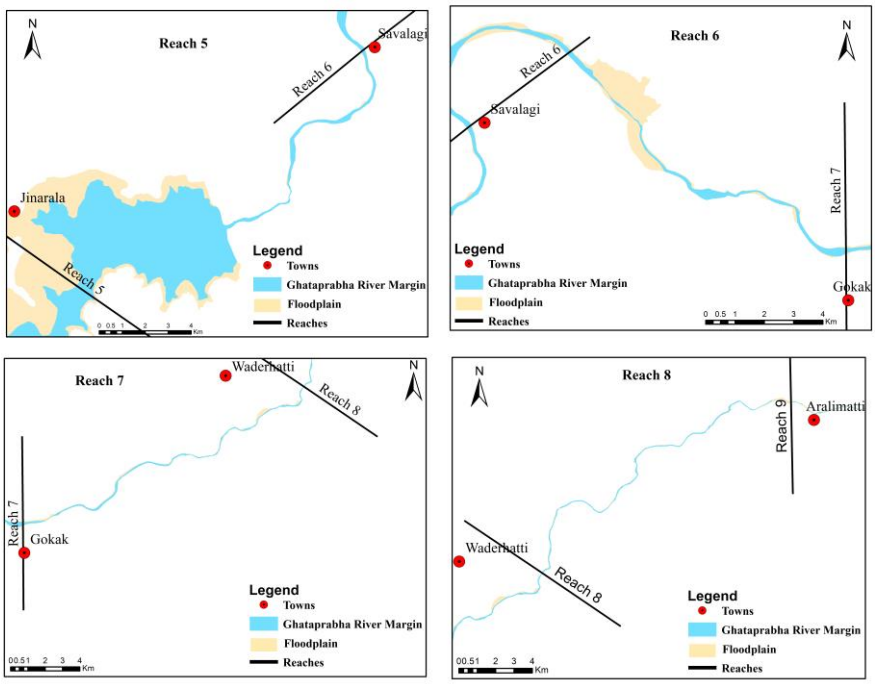

Figure A33. Floodplain extent of the Ghataprabha River from Reach 5 to Reach 8, showing river margins, floodplains and vulnerable settlements

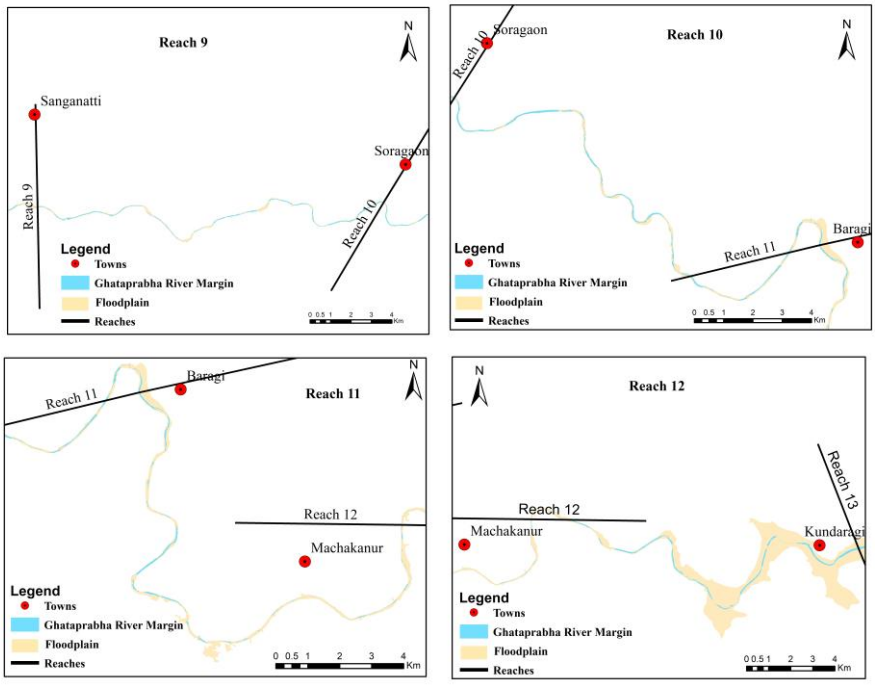

Figure A34. Floodplain extent of the Ghataprabha River from Reach 9 to Reach 12, showing river margins, floodplains and vulnerable settlements

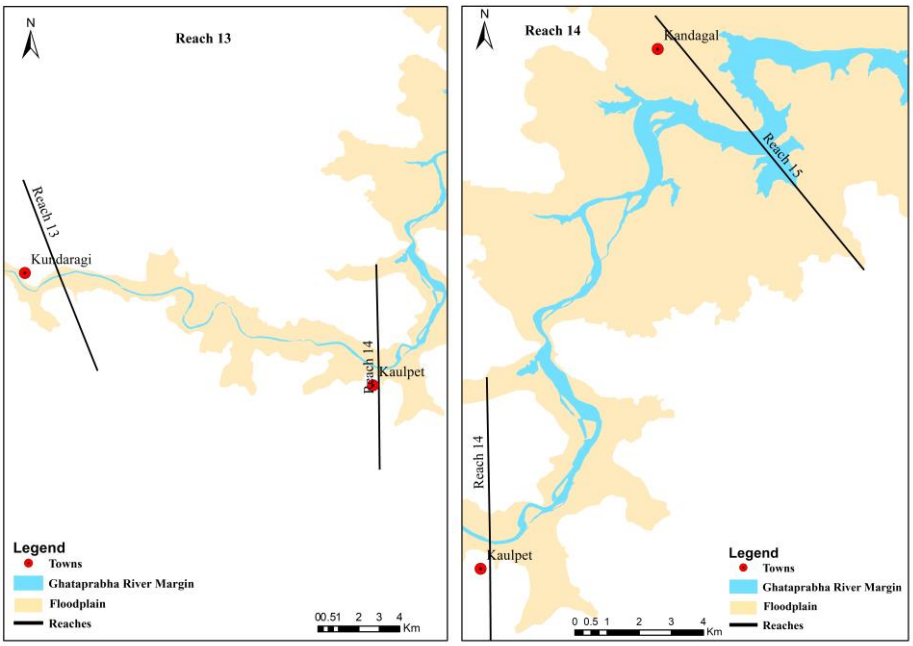

Figure A35. Floodplain extent of the Ghataprabha River from Reach 13 to Reach 14, showing river margins, floodplains and vulnerable settlements

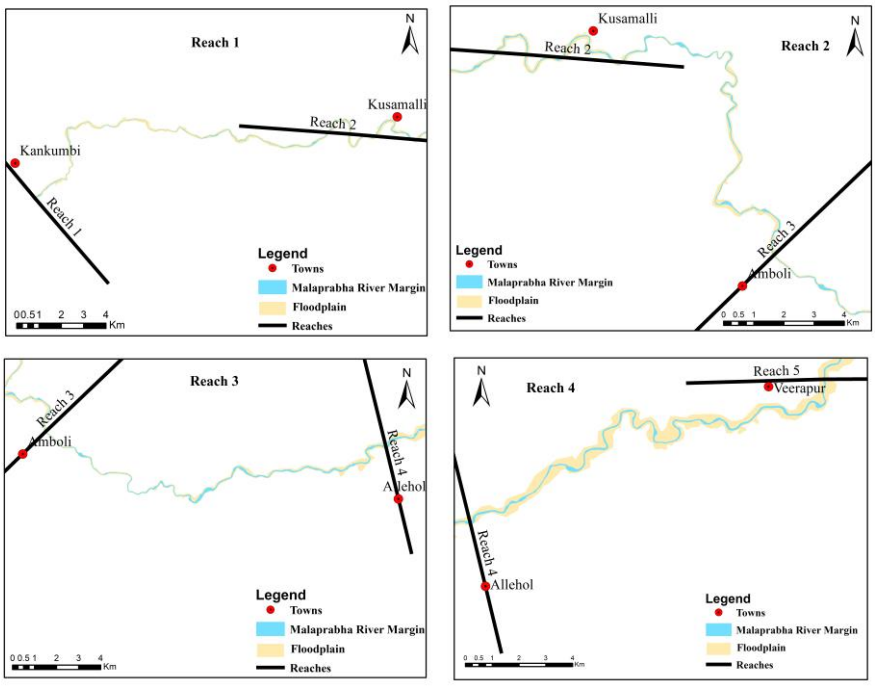

Figure A36. Floodplain extent of the Malaprabha River from Reach 1 to Reach 4, showing river margins, floodplains and vulnerable settlements

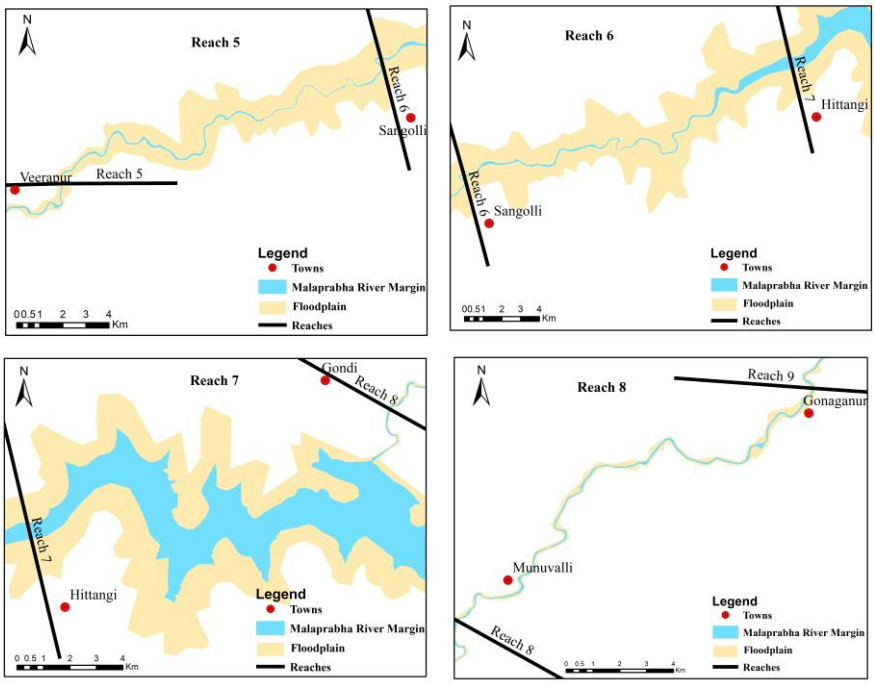

Figure A37. Floodplain extent of the Malaprabha River from Reach 5 to Reach 8, showing river margins, floodplains and vulnerable settlements

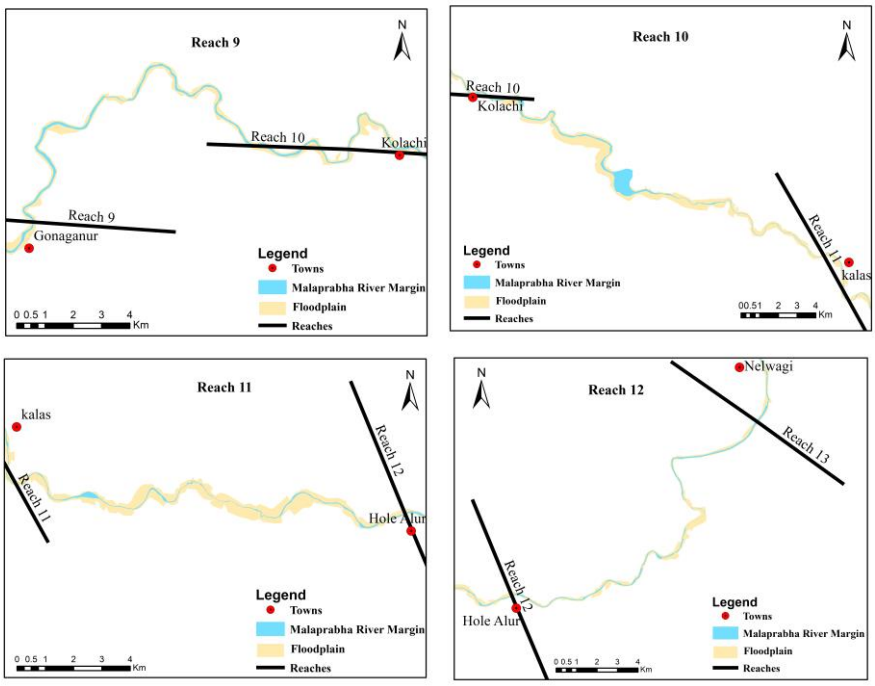

Figure A38. Floodplain extent of the Malaprabha River from Reach 9 to Reach 12, showing river margins, floodplains and vulnerable settlements

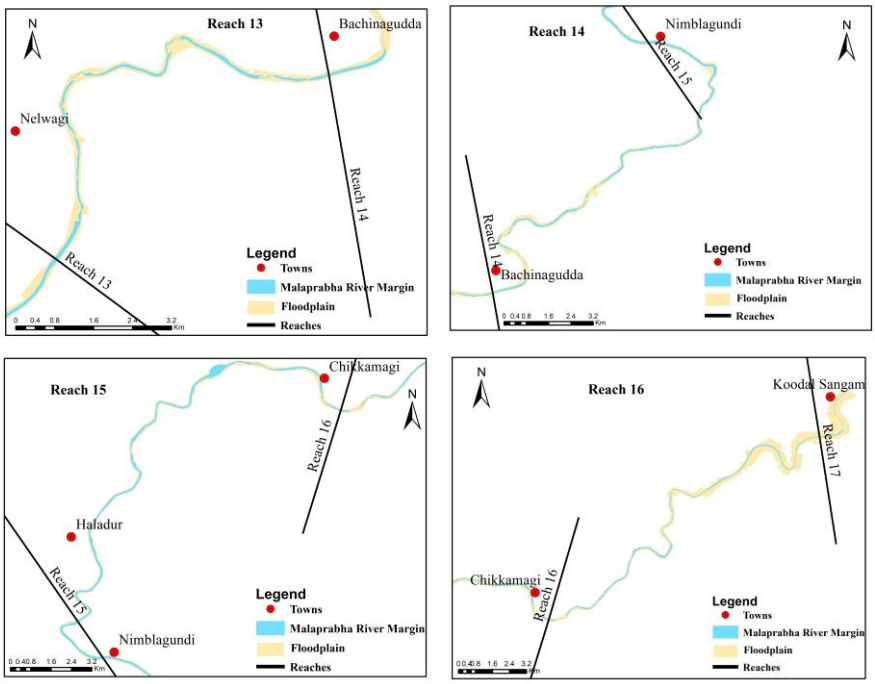

Figure A39. Floodplain extent of the Malaprabha River from Reach 13 to Reach 16, showing river margins, floodplains and vulnerable settlements

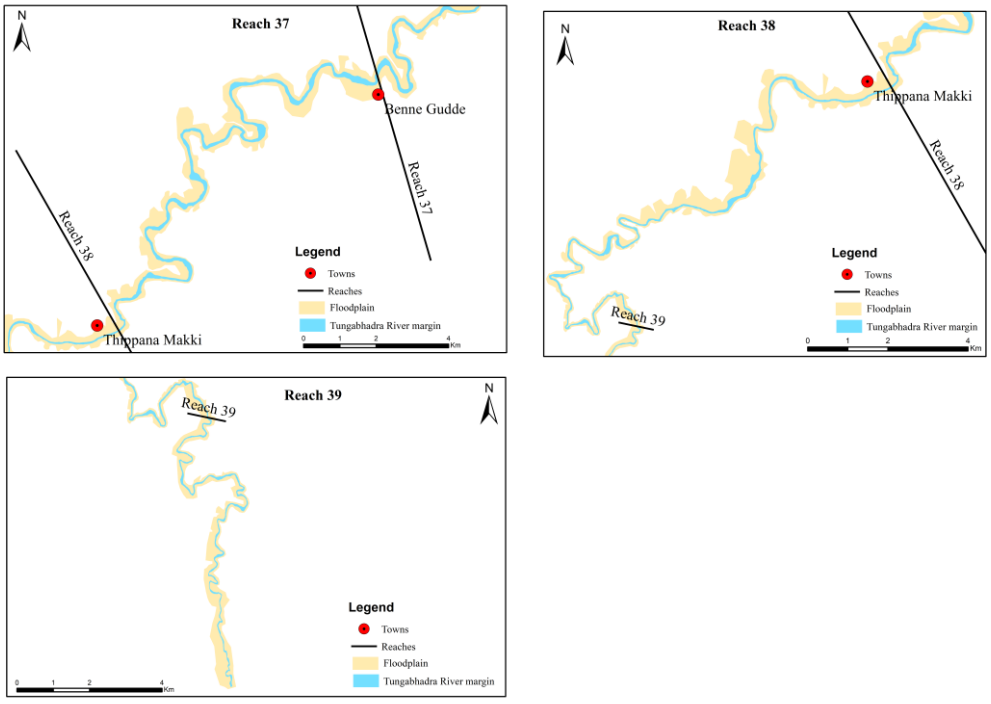

Figure A40. Floodplain extent of the Tungabhadra River from Reach 37 to Reach 39, showing river margins, floodplains and vulnerable settlements

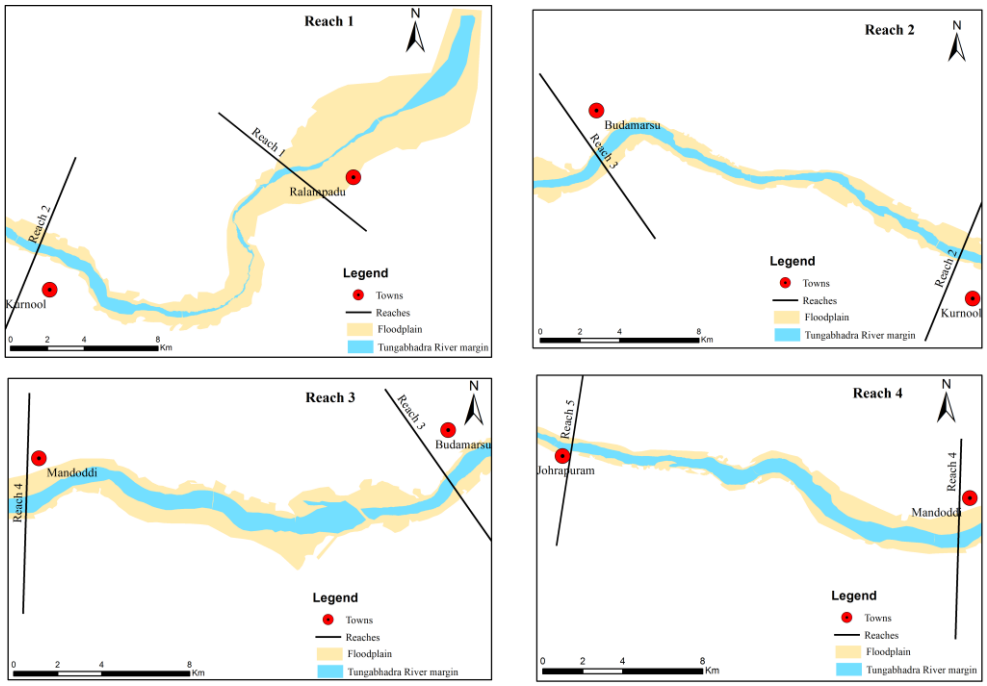

Figure A41. Floodplain extent of the Tungabhadra River from Reach 1 to Reach 4, showing river margins, floodplains and vulnerable settlements

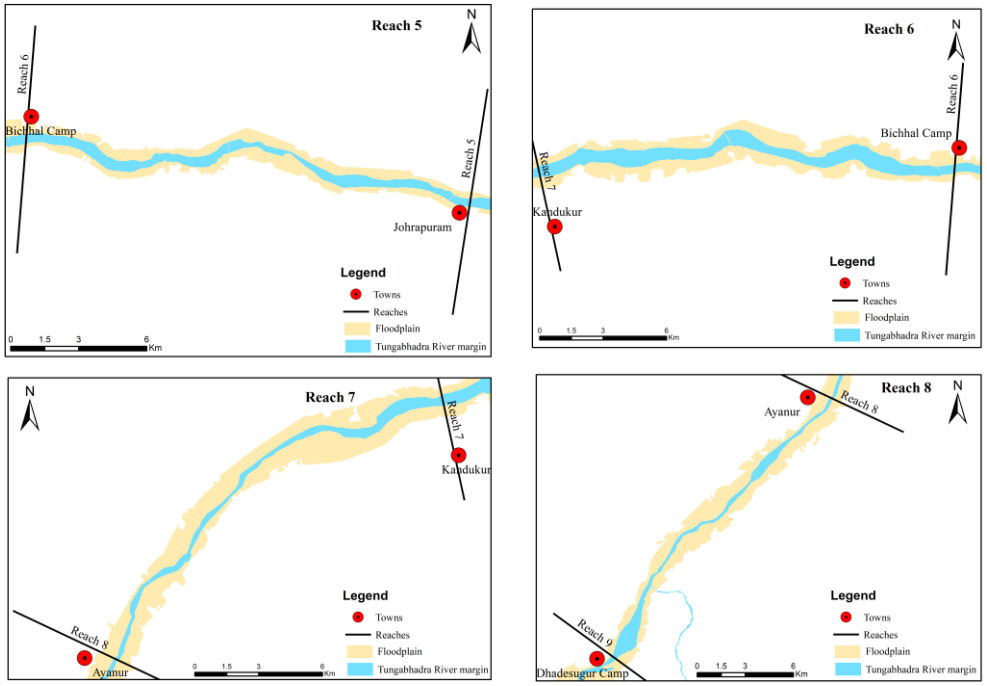

Figure A42. Floodplain extent of the Tungabhadra River from Reach 5 to Reach 8, showing river margins, floodplains and vulnerable settlements

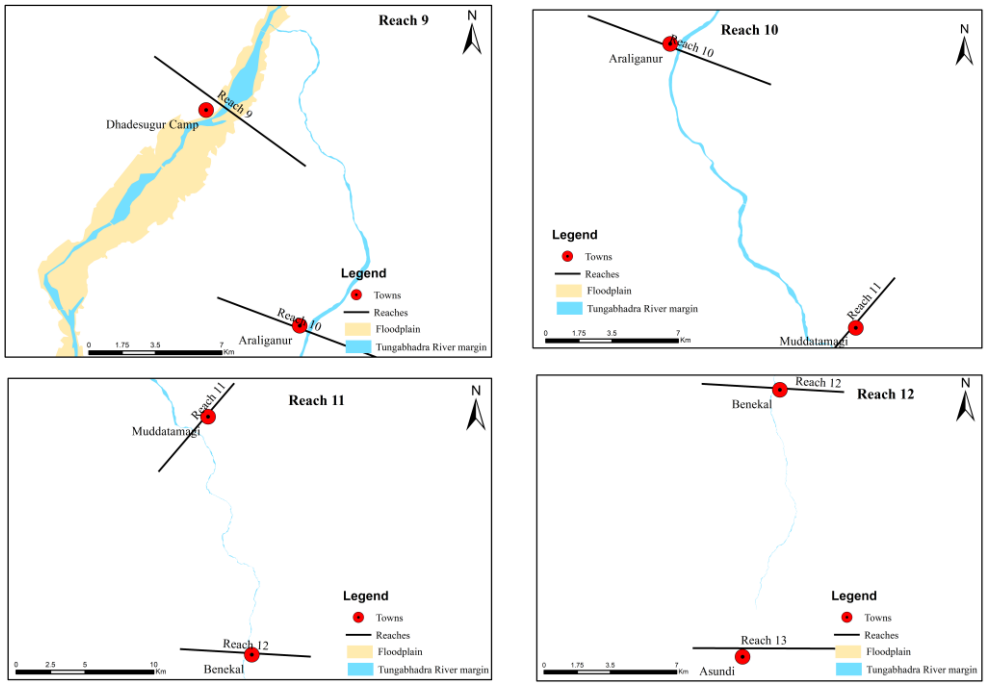

Figure A43. Floodplain extent of the Tungabhadra River from Reach 9 to Reach 12, showing river margins, floodplains and vulnerable settlements

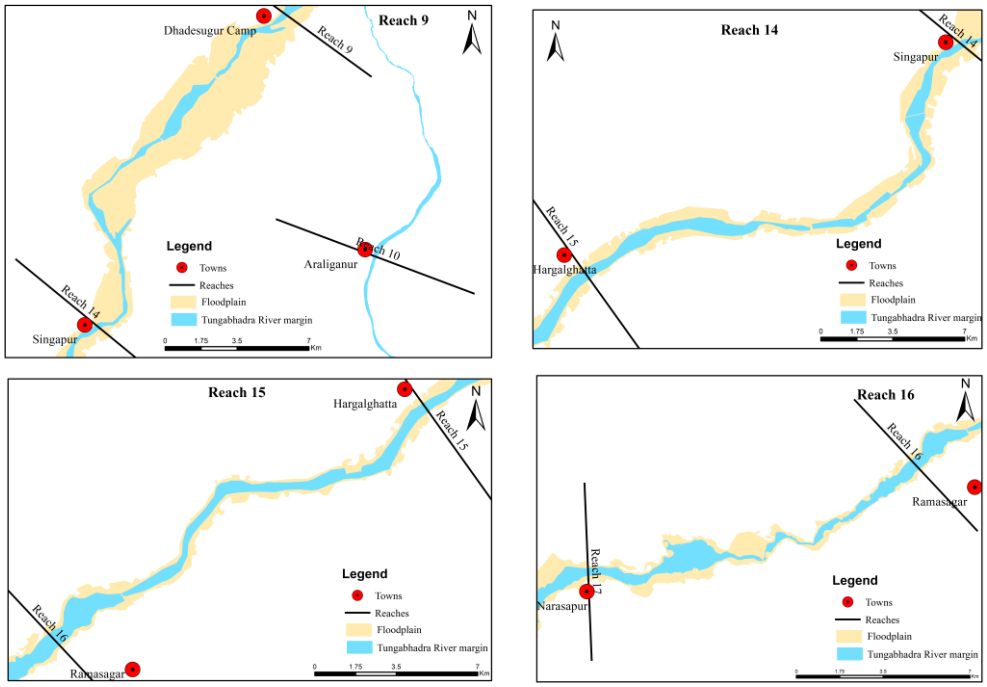

Figure A44. Floodplain extent of the Tungabhadra River from Reach 9 to Reach 16, showing river margins, floodplains and vulnerable settlements

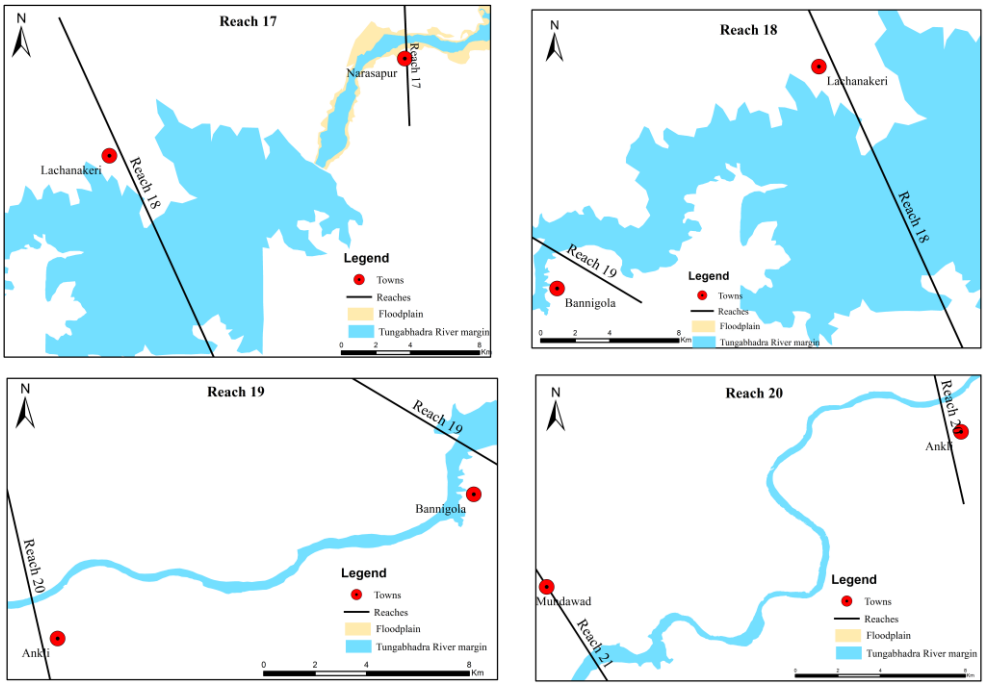

Figure A45. Floodplain extent of the Tungabhadra River from Reach 17 to Reach 20, showing river margins, floodplains and vulnerable settlements

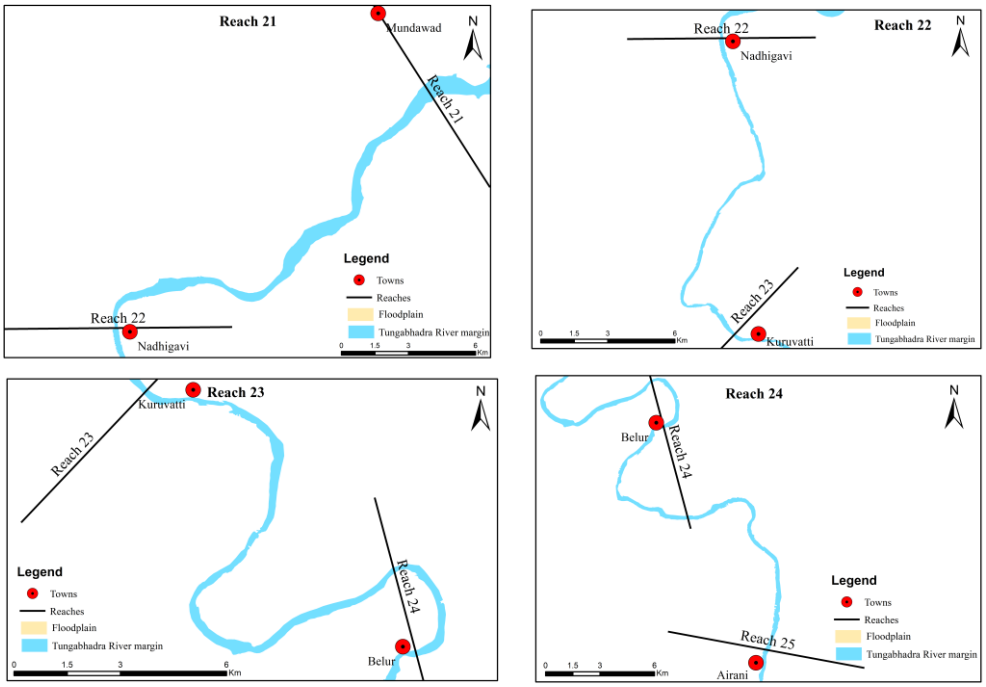

Figure A46. Floodplain extent of the Tungabhadra River from Reach 21 to Reach 24, showing river margins, floodplains and vulnerable settlements

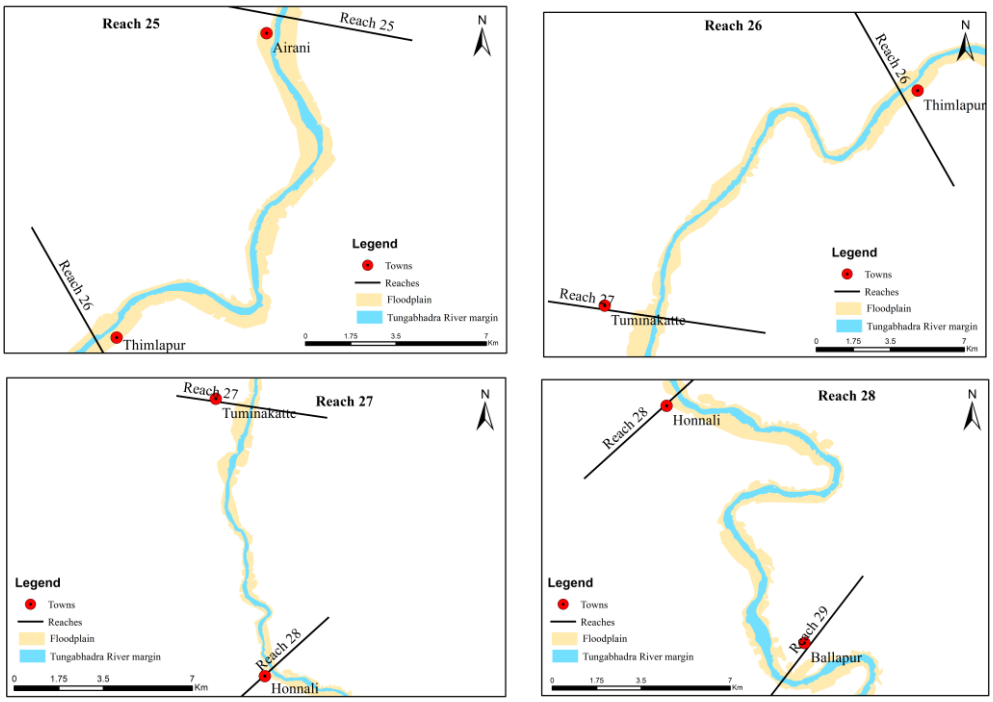

Figure A47. Floodplain extent of the Tungabhadra River from Reach 25 to Reach 28, showing river margins, floodplains and vulnerable settlements

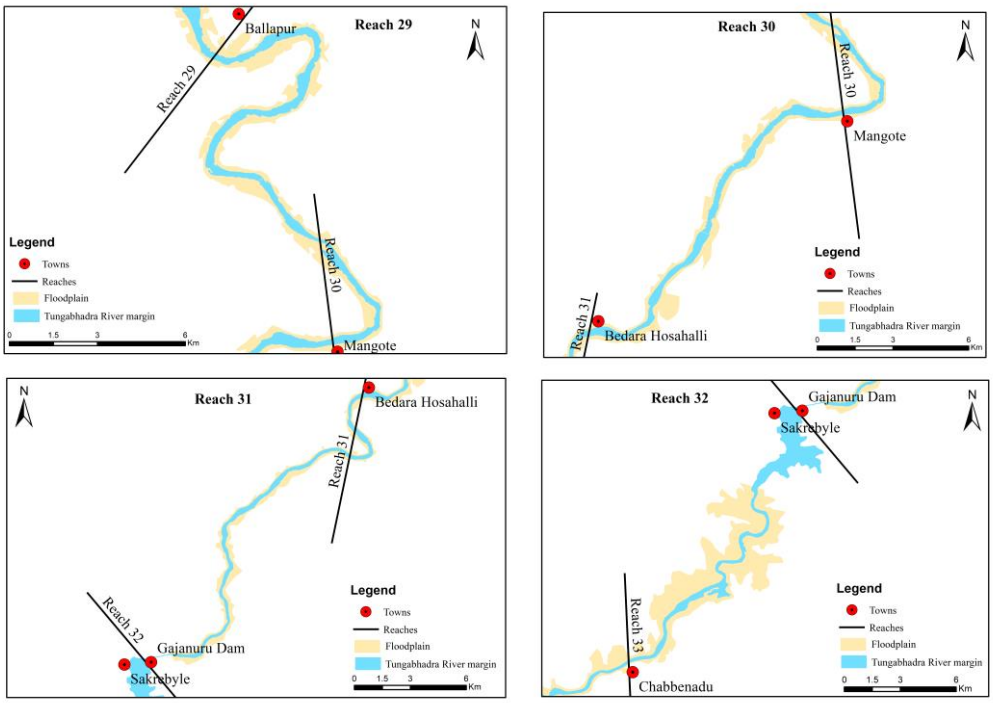

Figure A48. Floodplain extent of the Tungabhadra River from Reach 29 to Reach 32, showing river margins, floodplains and vulnerable settlements

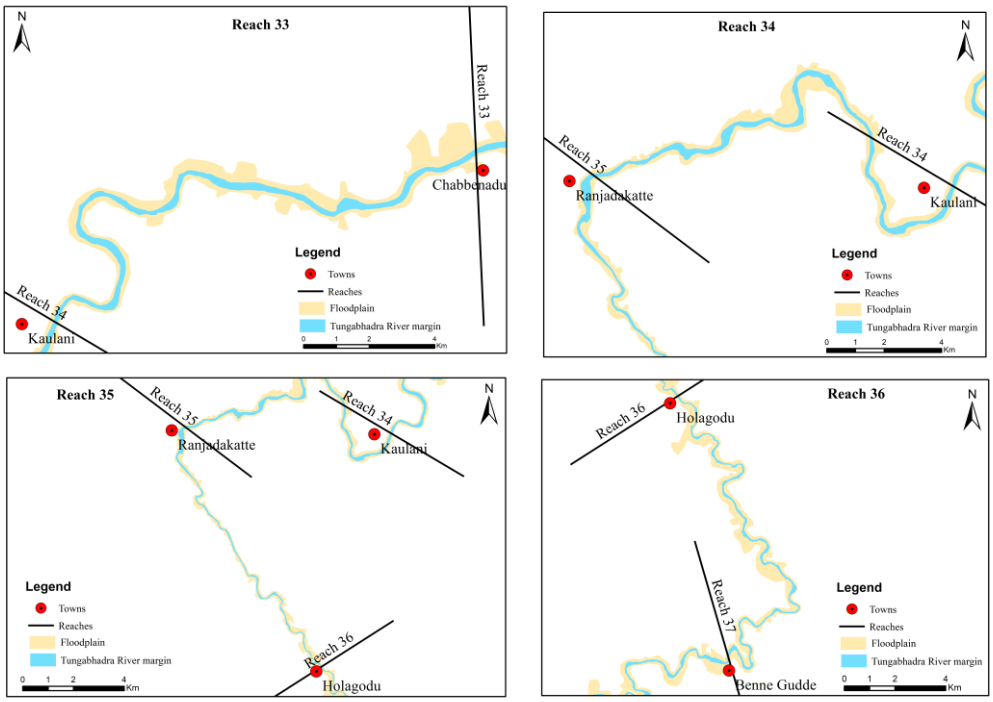

Figure A49. Floodplain extent of the Tungabhadra River from Reach 33 to Reach 36, showing river margins, floodplains and vulnerable settlements

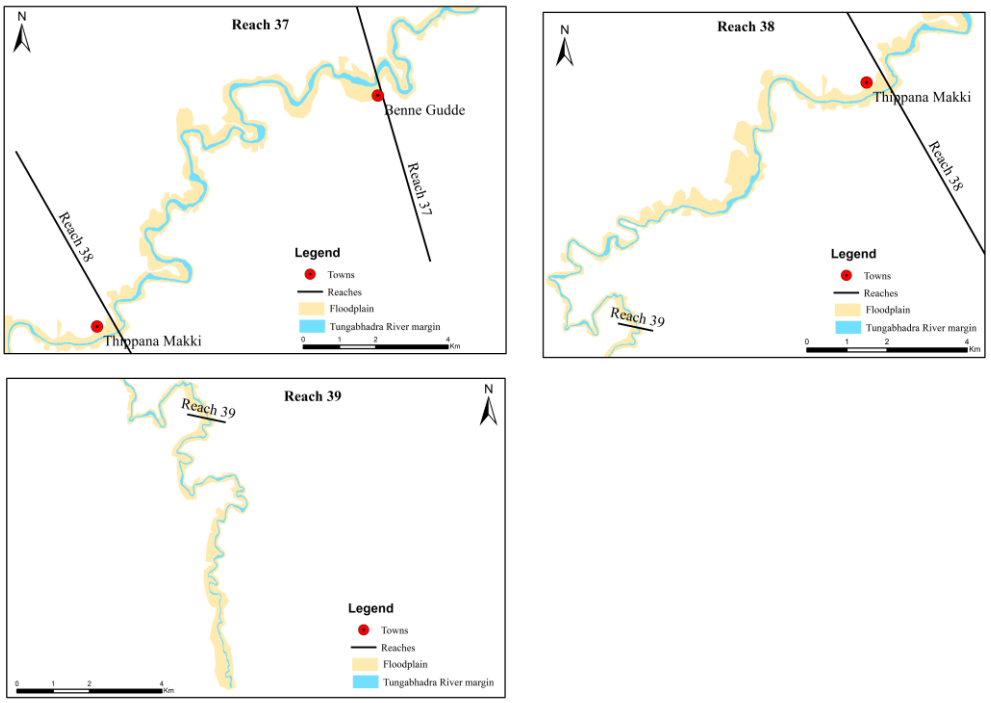

Figure A50. Floodplain extent of the Tungabhadra River from Reach 33 to Reach 36, showing river margins, floodplains and vulnerable settlements

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