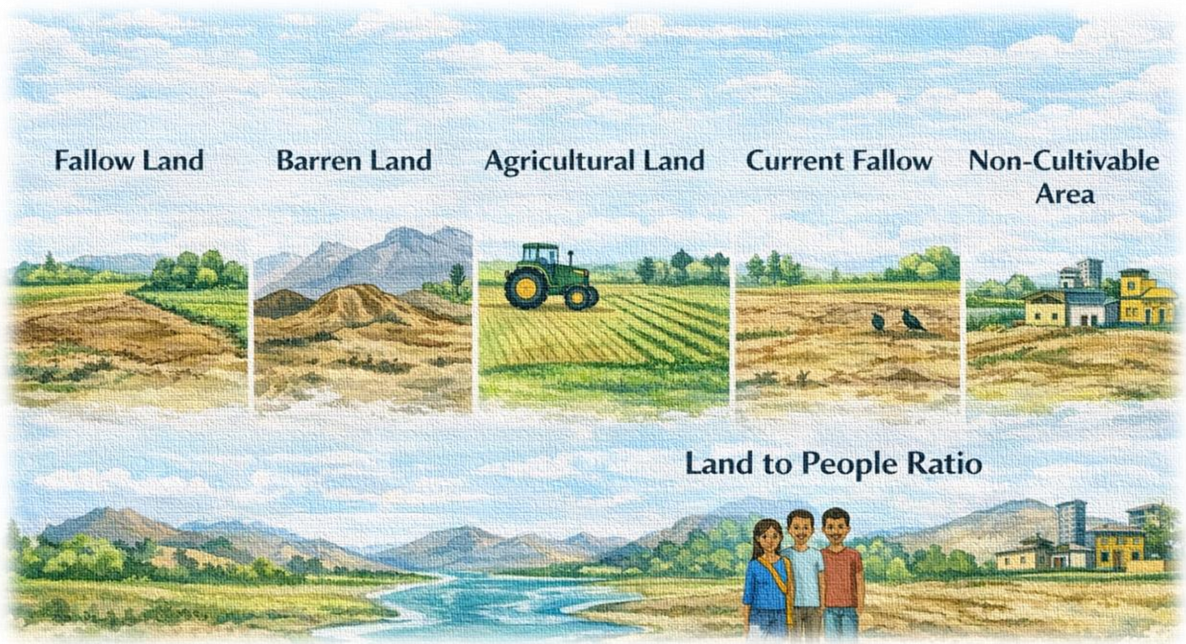
National River Conservation Directorate
Ministry of Jal Shakti,
Department of Water Resources,
River Development and Ganga Rejuvenation
Government of India

Revenue Map of

Cauvery River Basin



March 2025

Revenue Map of

Cauvery River Basin

National River Conservation Directorate (NRCD)

The National River Conservation Directorate, functioning under the Department of Water Resources, River Development and 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.

www.nrcd.nic.in

Centres for Cauvery River Basin Management Studies (cCauvery)

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

www.ccauvery.org

Centre for Ganga River Basin Management and Studies (cGanga)

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.

www.cganga.org

Acknowledgment

This report is a comprehensive outcome of the project jointly executed by IISc Bengaluru (Lead Institute) and NIT Tiruchirappalli (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.

Team

Praveen C Ramamurthy, cCauvery, IISc Bengaluru
Shekhar M, cCauvery, IISc Bengaluru
Nagesh Kumar Dasika, cCauvery, IISc Bengaluru
Srinivas V V, cCauvery, IISc Bengaluru
Lakshminarayana Rao, cCauvery, IISc Bengaluru
Rajarshi Das Bhowmik, cCauvery, IISc Bengaluru
Bramha Dutt Vishwakarma, cCauvery, IISc Bengaluru
Debsunder Dutta, cCauvery, IISc Bengaluru
R Manjula, cCauvery, NIT Trichy
Nisha Radhakrishnan, cCauvery, NIT Trichy
S Saravanan, cCauvery, NIT Trichy
Aneesh Mathew, cCauvery, NIT Trichy
Laveti Satish, cCauvery, NIT Trichy
Prabu P, cCauvery, NIT Trichy
Vinod Tare, cGanga, IIT Kanpur

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 Cavery River Basin
Management Studies (cCauvery)
IISc Bengaluru (Lead Institute), NIT Tiruchirappalli (Fellow Institute)

Back of Preface/Blank Page

Blank/Continuation of Preface

Contents

List of Figures

List of Tables

Continuation of List of Tables/Blank Page

Abbreviations and Acronyms

≈	Approximately
a.s.l.	Above Sea Level
°	Degree
ha	Hectares
<	Less Than
m	meter
%	Percentage
yr^{-1}	Per Year
CAGR	Compound Annual Growth Rate
CCI	Climate Change Initiative
CRB	Cauvery River Basin
ESA	European Space Agency
GIS	Geographic Information System
GoI	Government of India
LULC	Land-Use and Land-Cover

1. Introduction

River basins constitute fundamental units for integrated land and water resource management, as they encompass interconnected hydrological, ecological, and socio-economic processes operating across administrative boundaries. In India, where agriculture, urban growth, and ecosystem services are closely tied to river systems, basin-scale assessments are essential for understanding land-use dynamics and informing sustainable development strategies. The Cauvery River Basin (CRB) is one of the most intensively utilized river basins in the country, supporting millions of livelihoods through agriculture, industry, and urban settlements while simultaneously sustaining ecologically sensitive regions such as the Western Ghats and deltaic wetlands.

Over recent decades, the CRB has experienced significant pressures from population growth, agricultural intensification, urban expansion, and climate variability, leading to pronounced changes in land-use and land-cover patterns. Studies across Indian river basins have shown that rapid urbanization and infrastructure development often occur at the expense of agricultural land and natural ecosystems, altering hydrological regimes, increasing water demand, and exacerbating resource conflicts (Seto et al., 2012; Foley et al., 2005). In the Cauvery basin, these challenges are further compounded by inter-state water-sharing disputes, groundwater overexploitation, and increasing frequency of droughts and extreme rainfall events.

While satellite-based Land-Use and Land-Cover (LULC) datasets provide valuable synoptic views of surface changes, revenue-based land classification remains a critical yet underutilized source of information for basin-scale planning in India. Revenue records capture administratively defined land categories, such as forest, agricultural land, fallow land, barren land, and built-up areas, that directly influence irrigation planning, agricultural statistics, taxation, and policy implementation (Altshuler and Gomez-Ibanez, 2000). Unlike purely remote-sensing-derived products, revenue data reflect how land is officially recorded, managed, and governed, making them particularly relevant for operational decision-making and institutional analysis (Turner et al., 2007).

Revenue mapping also enables the examination of long-term district-wise trends, revealing how land categories evolve in response to policy changes, administrative reorganization, irrigation development, and socio-economic transformation (Satheesh and Joseph, 2025). Previous research highlights that apparent land-use changes in official records may arise not only from physical transformation but also from reclassification, boundary modifications, and methodological revisions, emphasizing the importance of careful interpretation at the district level (Lambin et al., 2003). In a heterogeneous basin such as the Cauvery, spanning forested uplands, rainfed interiors, and irrigated deltaic systems, such analyses are essential for distinguishing structural trends from administrative artifacts.

Against this backdrop, the present report undertakes a comprehensive revenue-based assessment of land-use dynamics in the CRB, focusing on complete administrative districts falling within the basin boundary.

1.1. Study Area

The present report focuses on the CRB, located in southern India and extending across the states of Karnataka, Tamil Nadu, Kerala, and the Union Territory of Puducherry. The basin covers diverse physiographic zones, ranging from the forested highlands of the Western Ghats to the semi-arid interior plains and the intensively cultivated deltaic regions along the Bay of Bengal. Supporting millions of livelihoods through agriculture, hydropower, industry, and urban settlements, the basin also sustains ecologically sensitive regions such as montane forests, riparian corridors, and deltaic wetlands. The Cauvery River and its major tributaries, including the Kabini, Hemavathi, Shimsha, Arkavathi, and Bhavani rivers, form a complex drainage network that supports extensive irrigation systems, reservoirs, and urban centers. Fig. 1 illustrates the spatial extent of the basin, its administrative coverage, and the drainage network that underpins hydrological and land-use processes within the study area.

2. Land-revenue Categories

2.1. Area Under Forest

District-wise temporal variation in forest area (hectares (ha)) from 1998-99 to 2023-24 across the CRB is illustrated in Fig. 2. Each row represents a district, and each column corresponds to a year, while colour intensity denotes the magnitude of forest area, with darker shades indicating higher forest cover. This heatmap provides a comprehensive visual overview of spatial heterogeneity and temporal dynamics in forest distribution across the basin. Substantial inter-district variability in forest cover reflects differences in physiography, climatic conditions,

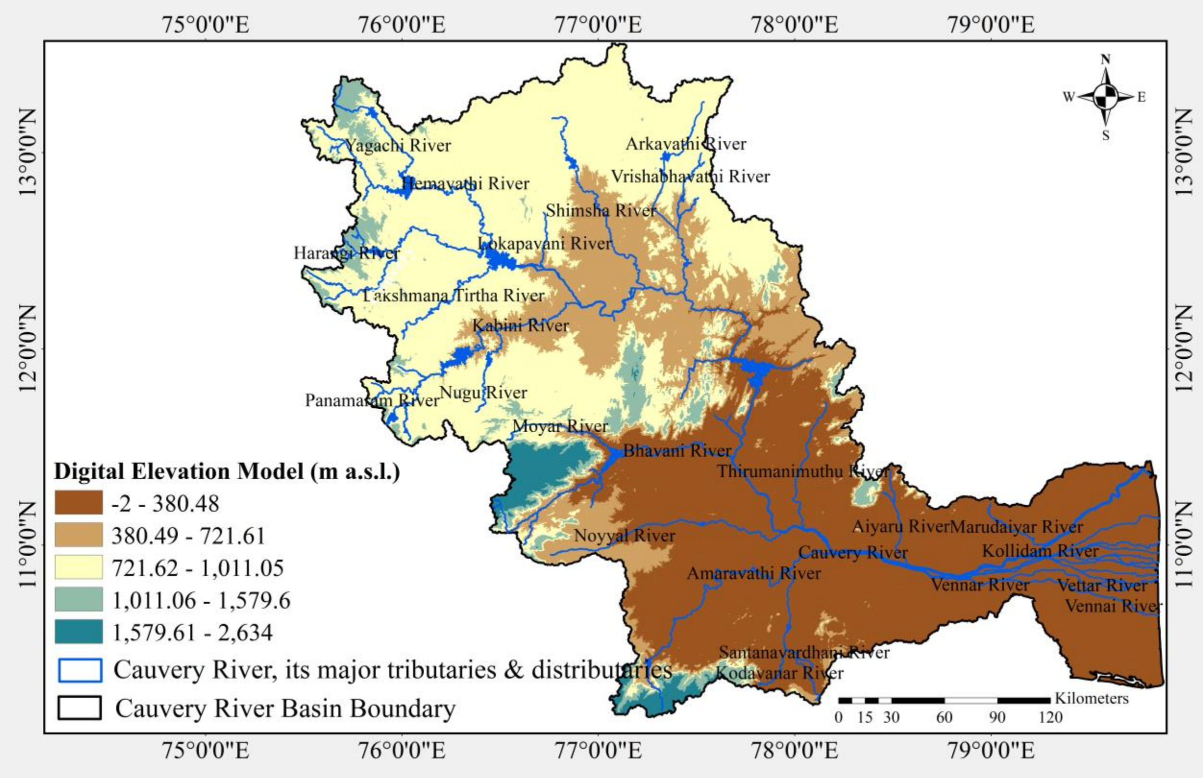


Fig. 1. Spatial extent of the CRB showing the basin boundary and the network of major tributaries and distributaries

land-use patterns, population pressure, and the extent of protected and reserved forest areas. Forest area data were sourced from the Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India (GoI). Here, the entire administrative area of each district is considered to the extent that it falls within the CRB, rather than only the proportionate area lying strictly within the basin boundary. Among the districts within the CRB, Nilgiris (58.28%) consistently exhibited the highest forest cover, owing to its location along the forested landscapes of the Western Ghats, whereas Ariyalur (0.38%) recorded the lowest forest cover, reflecting its predominantly agricultural and semi-arid character. Forest area data for Karaikal were unavailable for the study period.

An examination of Fig. 2 together with the district-wise time-series plots presented in Figs. 3-7 indicates that forest cover decline in the CRB was confined to a limited number of districts and was largely characterised by abrupt, stepwise changes rather than gradual, continuous deforestation. The most substantial reduction occurred in Dharmapuri, where forest area declined from 366,226 ha to 164,177 ha, amounting to a net loss of 202,049 ha, primarily after the early 2000s. This sharp decline is likely associated with administrative reorganization and reclassification of forest categories. Bengaluru Rural experienced a significant decrease of 69,946 ha (from 81,268 ha to 11,322 ha), closely linked to district bifurcation and rapid urban expansion. Pronounced declines were also observed in Idukki (-62,494 ha) and Coimbatore (-46,429 ha), both displaying sudden reductions followed by prolonged periods of stability, suggesting the influence of revised forest boundary definitions rather than progressive forest degradation.

Moderate declines were identified in Perambalur (-9,008 ha) and Namakkal (-6,931 ha), while relatively minor reductions were noted in Nagapattinam (-1,102 ha), Erode (-1,239 ha), Nilgiris (-839 ha), Pudukkottai (-568 ha), and Thanjavur (-36 ha). In these districts, the magnitude of decline is small relative to total area, indicating that forest cover has remained largely stable over the study period, with observed variations likely reflecting localized land-use adjustments or changes in forest accounting practices.

Conversely, forest cover increases were observed in several districts, including Hassan, which recorded the highest net gain of 4,735 ha, followed by Chikkamagaluru (+1,543 ha), Krishnagiri (+1,555 ha), and Bengaluru Urban (+1,752 ha). Smaller increases were noted in Tiruchirappalli (+527 ha) and Tumakuru (+193 ha). These stepwise increases, evident in Figs. 2-6, are likely attributable to afforestation and plantation programmes, improved protection of forest lands, and localized natural regeneration in selected regions, rather than uniform or widespread natural forest expansion. In contrast, forest cover remained largely stable throughout the study period in Tiruppur, Thiruvarur, Salem, Ramanagara, Palakkad, Mysuru, Mandya, Mayiladuthurai, Kodagu, Karur, Dindigul, Cuddalore, Chikkaballapura, and Chamarajanagar, indicating limited large-scale land-use change or consistent forest classification in these districts.

Overall, the integrated spatial and temporal assessment demonstrates that forest cover dynamics within the CRB are strongly influenced by administrative restructuring, land-use policy decisions, and methodological revisions in forest assessment, rather than widespread, continuous deforestation. These findings highlight the need for district-specific forest conservation and management strategies, particularly in districts that experienced substantial forest loss, to ensure long-term ecological stability, biodiversity conservation, and sustainable land-use planning across the basin.

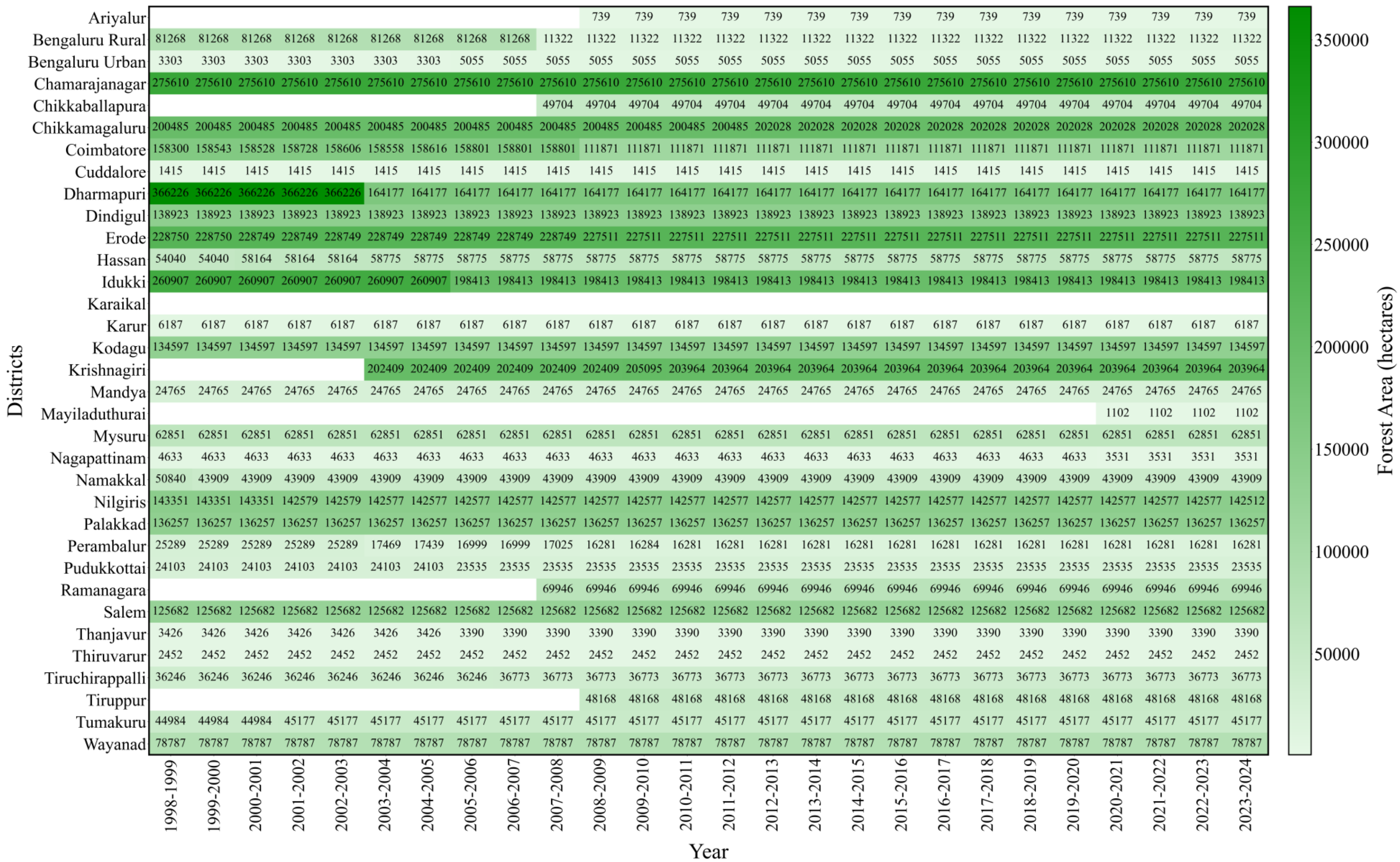


Fig. 2. District-wise temporal variation in forest area (ha) from 1998-99 to 2023-24 across the CRB

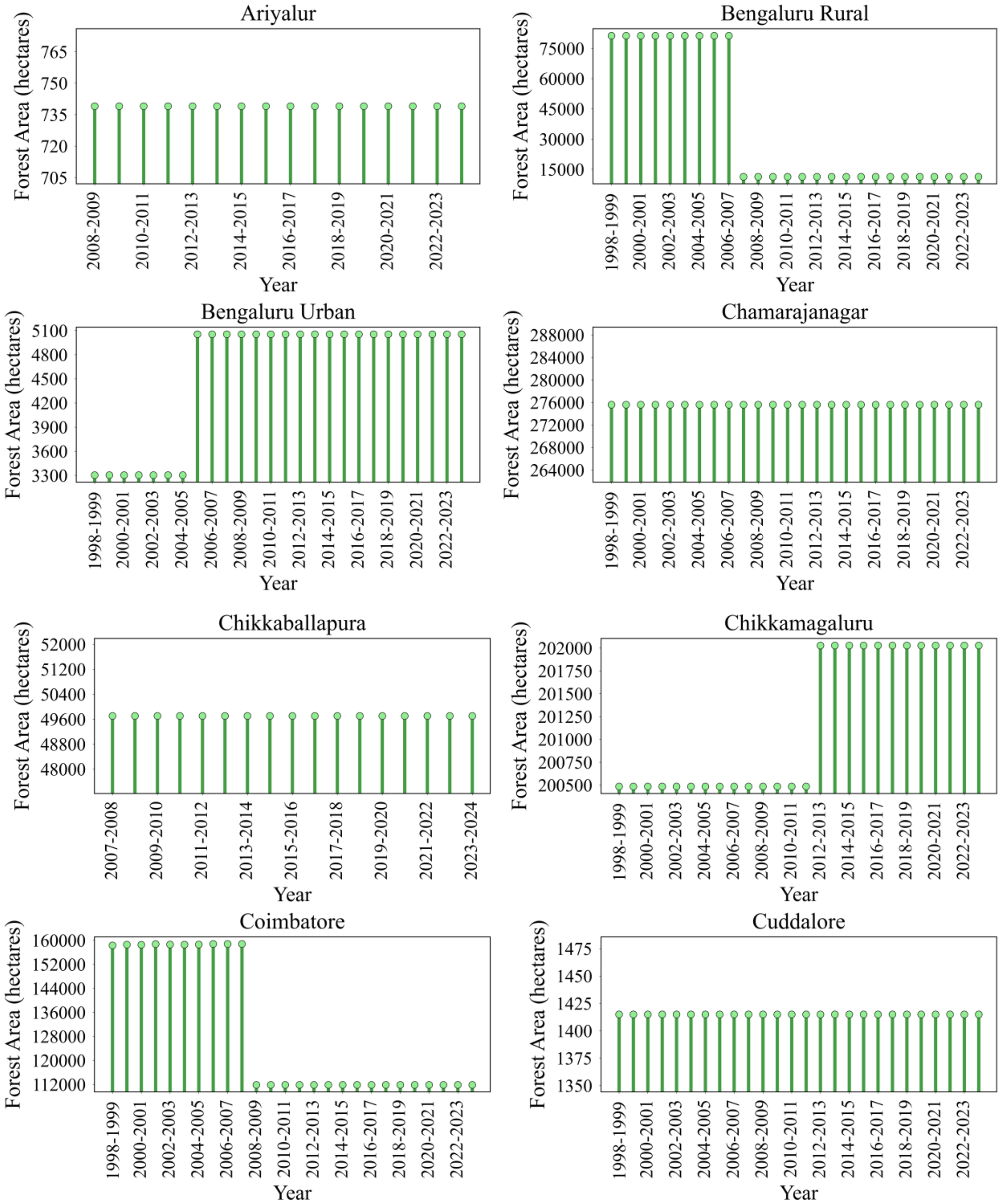


Fig. 3. Time-series plots of forest area (ha) for Ariyalur, Bengaluru Rural, Bengaluru Urban, Chamarajanagar, Chikkaballapura, Chikkamagaluru, Coimbatore, and Cuddalore districts

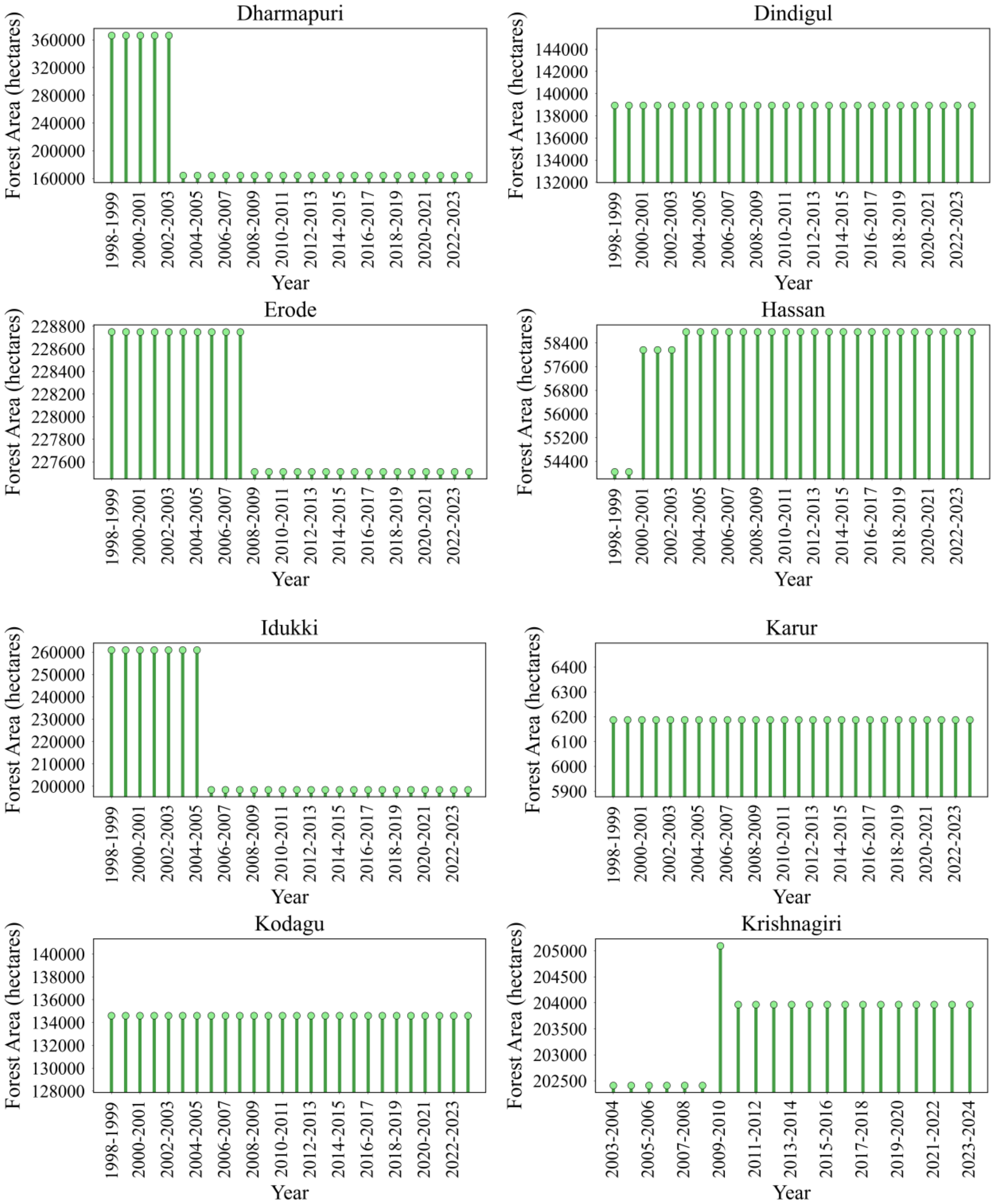


Fig. 4. Time-series plots of forest area (ha) for Dharmapuri, Dindigul, Erode, Hassan, Idukki, Karur, Kodagu, and Krishnagiri districts

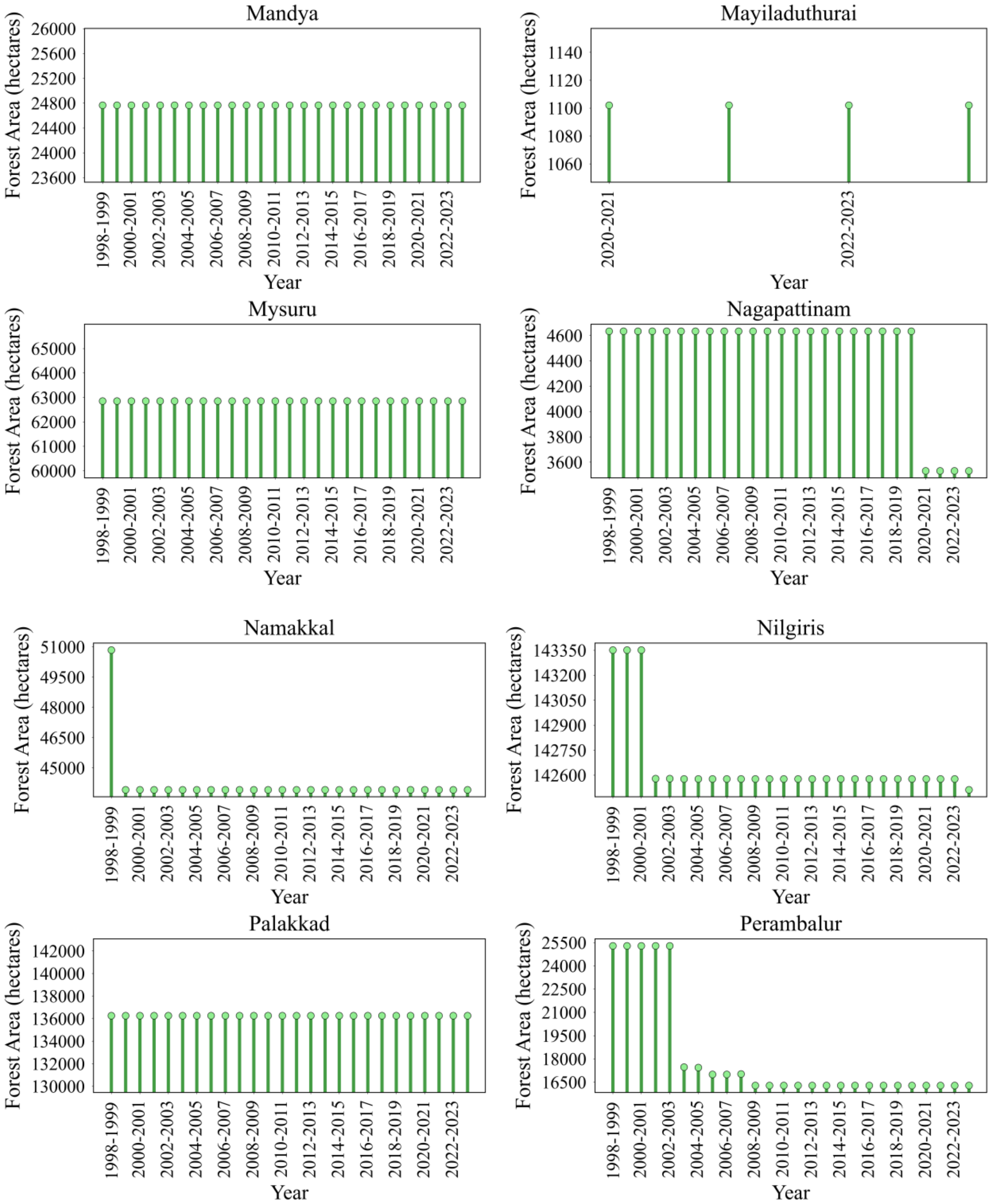


Fig. 5. Time-series plots of forest area (ha) for Mandya, Mayiladuthurai, Mysuru, Nagapattinam, Namakkal, Nilgiris, Palakkad, and Perambalur districts

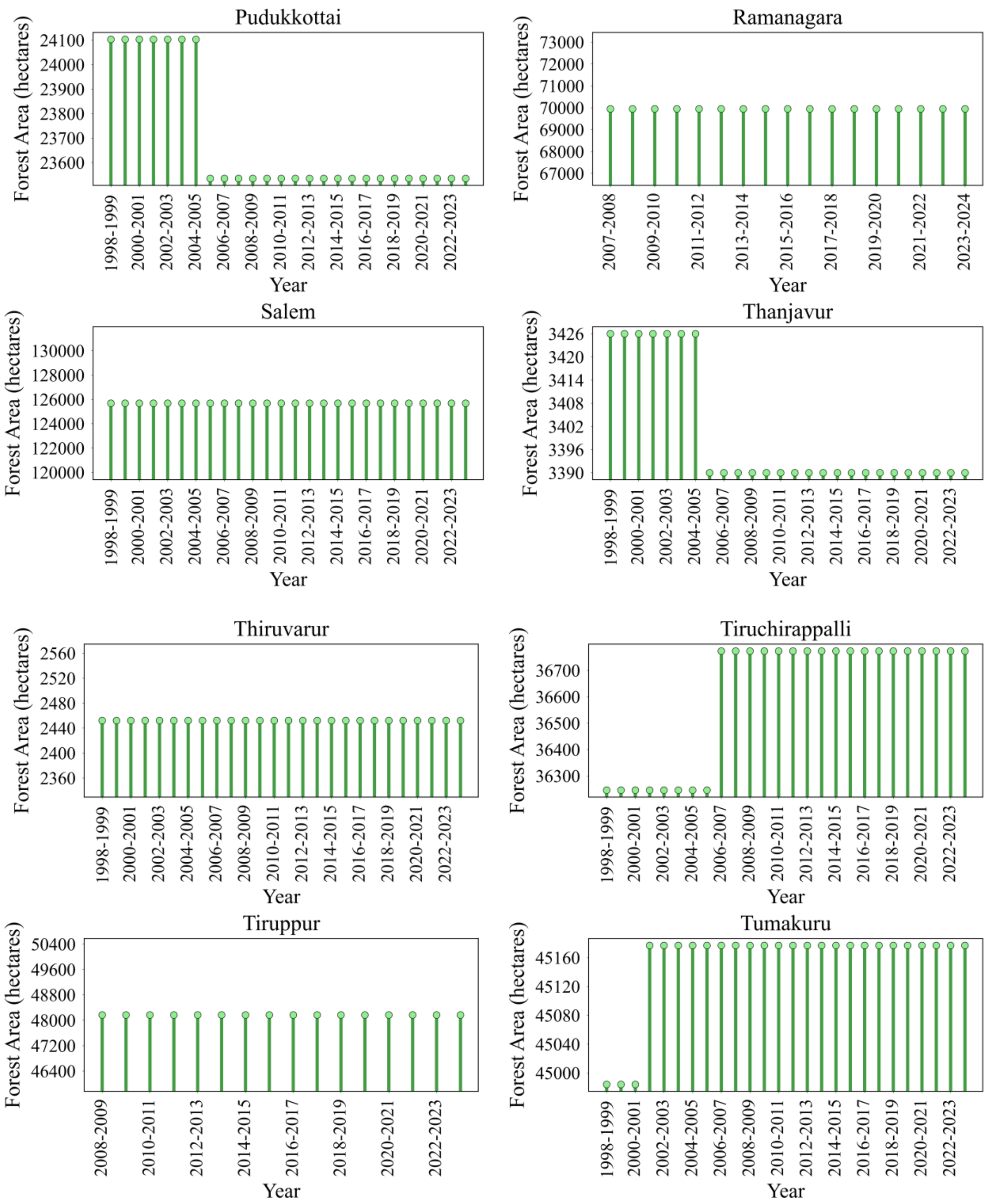


Fig. 6. Time-series plots of forest area (ha) for Pudukkottai, Ramanagara, Salem, Thanjavur, Thiruvarur, Tiruchirappalli, Tiruppur, and Tumakuru districts

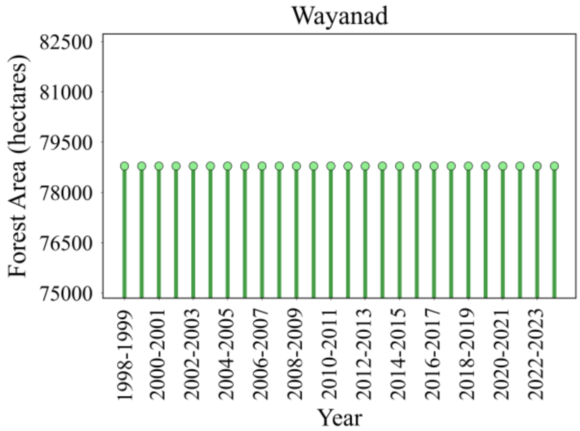


Fig. 7. Time-series plots of forest area (ha) for Wayanad district

2.2. Agricultural Land

Temporal variation in agricultural area (ha) of complete administrative districts lying within the CRB boundary from 1998-99 to 2023-24 is shown in Fig. 8. Each row represents a district, and each column corresponds to a year, while colour intensity denotes the magnitude of agricultural land area, with darker shades indicating a larger extent under cultivation. The dataset was obtained from the Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, GoI.

An analysis of Fig. 8, together with the district-wise time-series plots presented in Figs. 9-13, indicates that sharp declines in agricultural area are concentrated in rapidly urbanising districts, most notably Bengaluru Urban, where agricultural land decreased from 95,509 ha to 34,292 ha, representing a net loss of 61,217 ha. Bengaluru Rural experienced an even larger contraction of 207,530 ha (from 323,152 ha to 115,622 ha). Substantial reductions were also recorded in Dharmapuri (-201,725 ha), Coimbatore (-186,702 ha), and Erode (-164,118 ha), each characterised by abrupt declines followed by prolonged periods of relative stability, suggesting the influence of land-use reclassification, irrigation stress, and conversion to non-agricultural uses.

In contrast, sharp increases in agricultural land were observed in agriculturally dominant districts. Hassan recorded a significant expansion of 103,435 ha (from 433,072 ha to 536,507 ha), while Kodagu exhibited a strong increase of 86,926 ha (from 143,314 ha to 230,240 ha), particularly after 2018-19. Mandya also showed a marked rise of 60,737 ha, reflecting intensified irrigation-supported cultivation. Chikkamagaluru experienced a net increase of 43,657 ha, despite interannual variability.

Fig. 8. District-wise temporal variation in agriculture area (ha) from 1998-99 to 2023-24 across the CRB

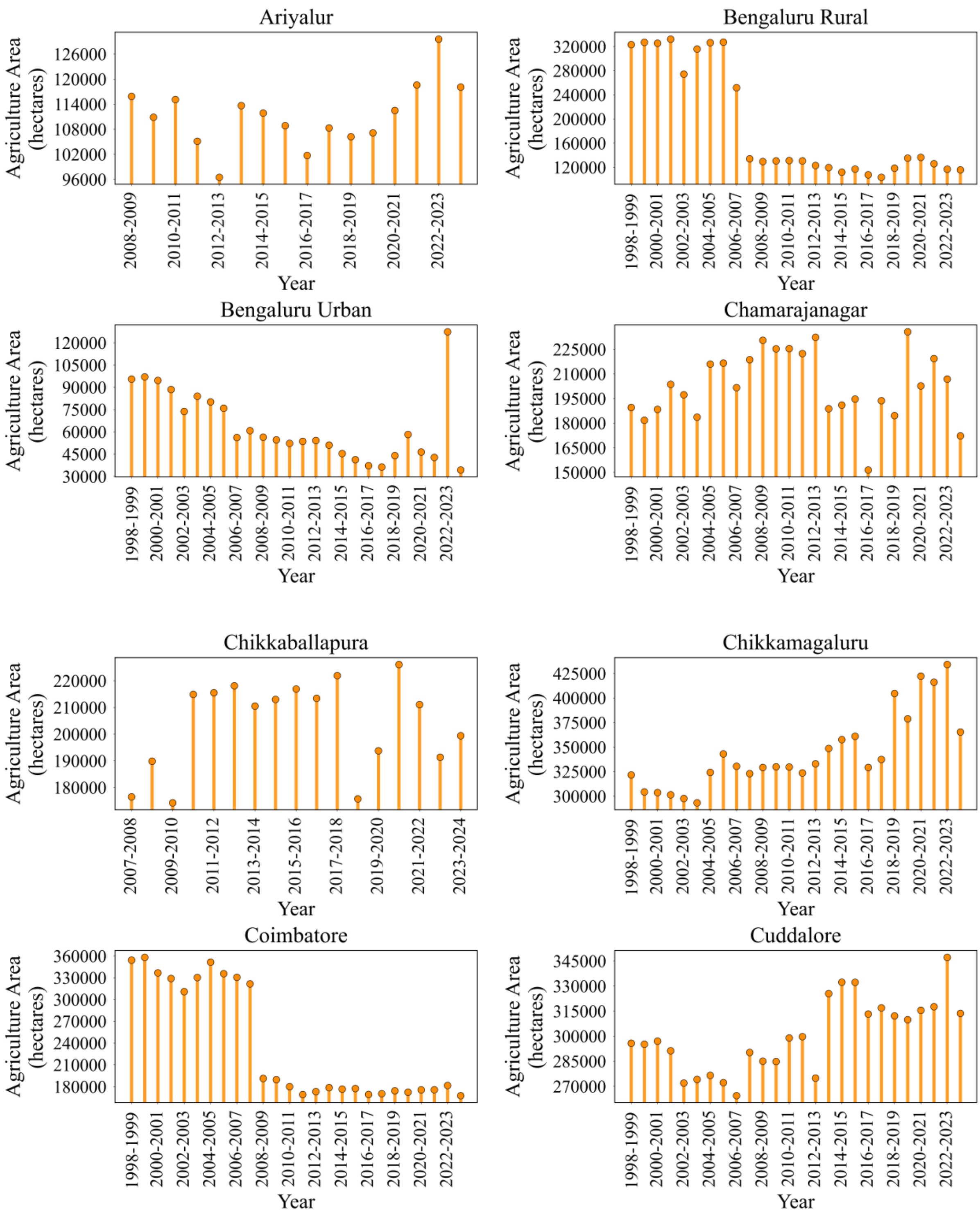


Fig. 9. Time-series plots of agriculture area (ha) for Ariyalur, Bengaluru Rural, Bengaluru Urban, Chamarajanagar, Chikkaballapura, Chikkamagaluru, Coimbatore, and Cuddalore districts

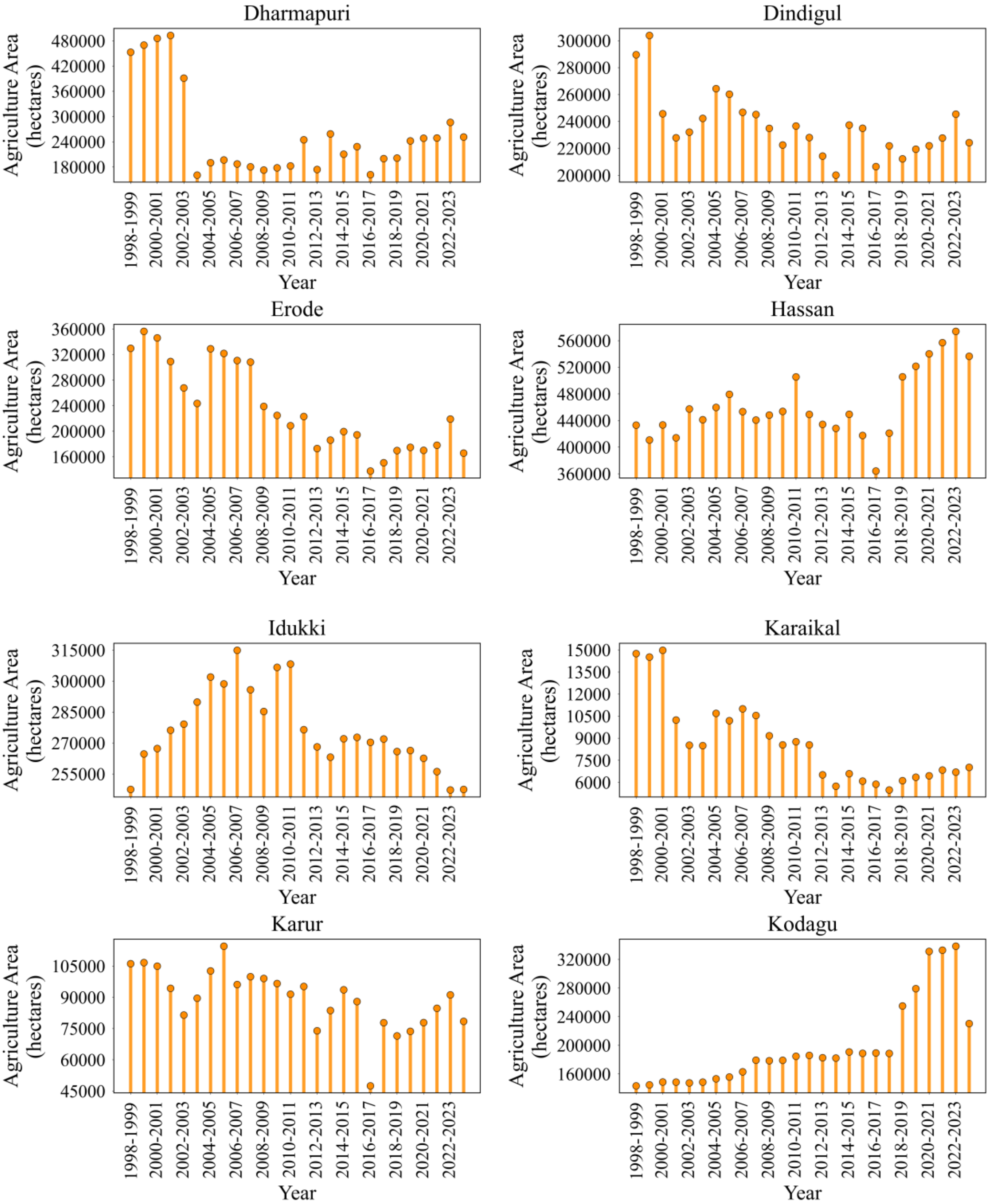


Fig. 10. Time-series plots of agriculture area (ha) for Dharmapuri, Dindigul, Erode, Hassan, Idukki, Karaikal, Karur, and Kodagu districts

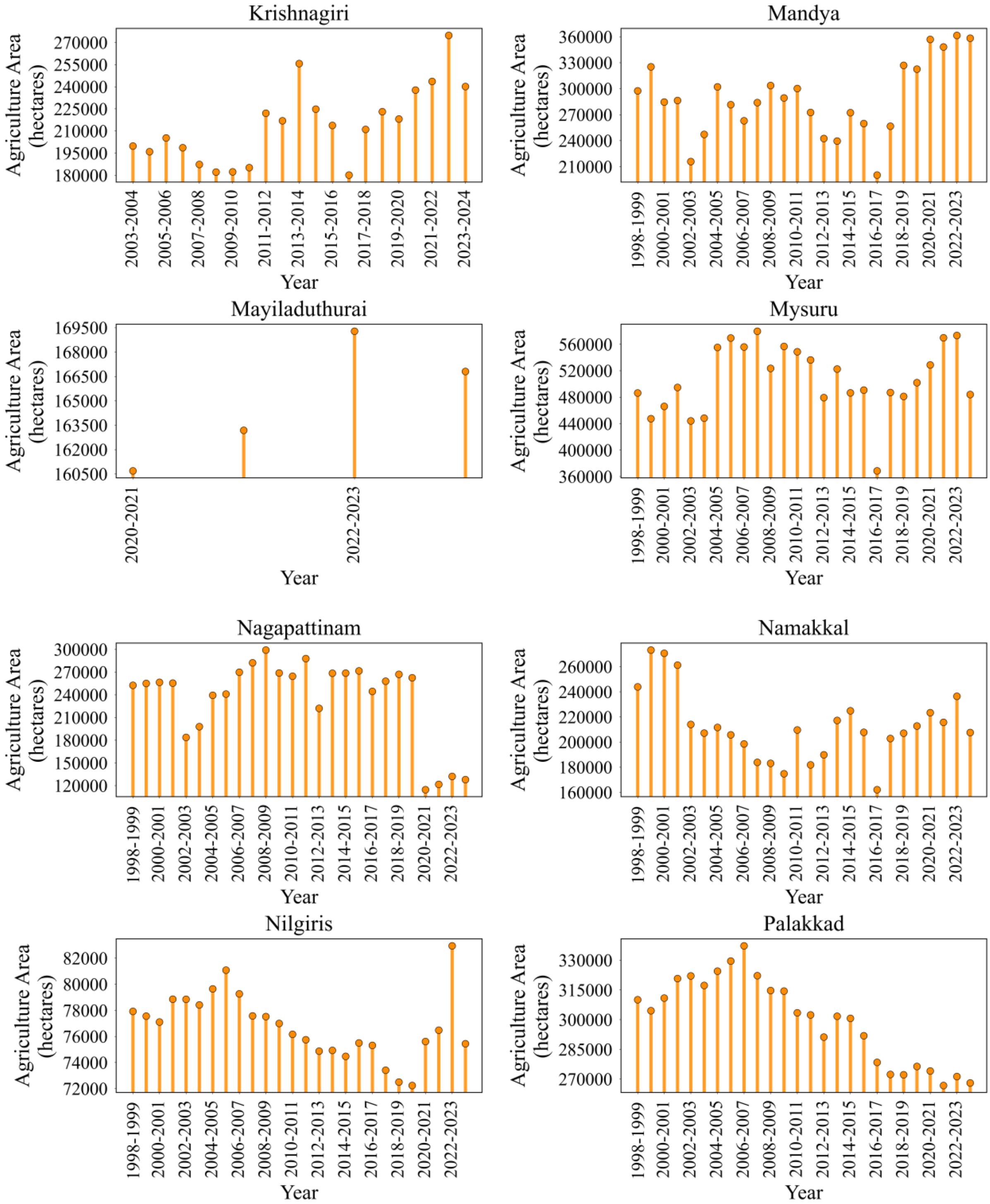


Fig. 11. Time-series plots of agriculture area (ha) for Krishnagiri, Mandya, Mayiladuthurai, Mysuru, Nagapattinam, Namakkal, Nilgiris, and Palakkad districts

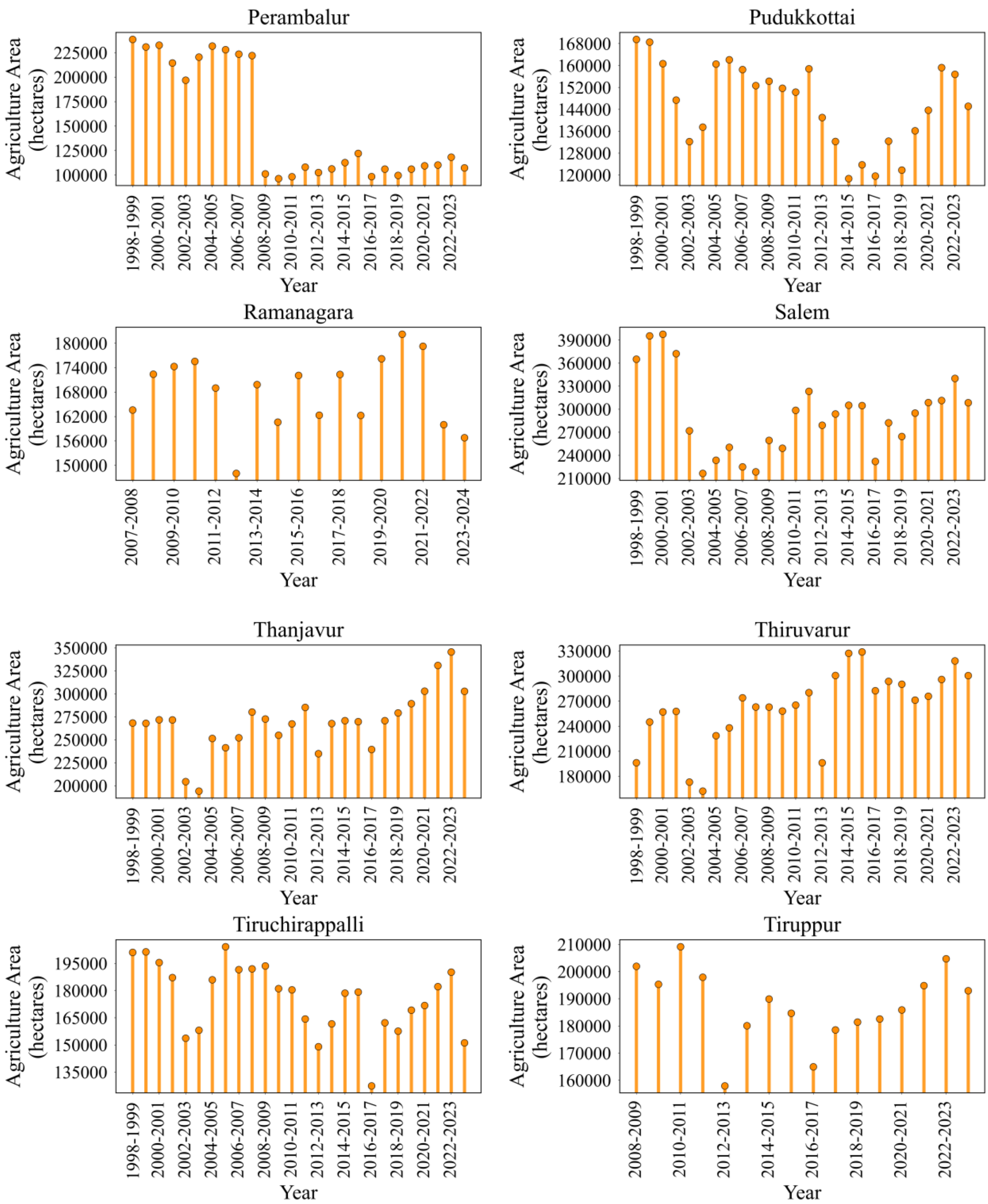


Fig. 12. Time-series plots of agriculture area (ha) for Perambalur, Pudukkottai, Ramanagara, Salem, Thanjavur, Thiruvarur, Tiruchirappalli, and Tiruppur districts

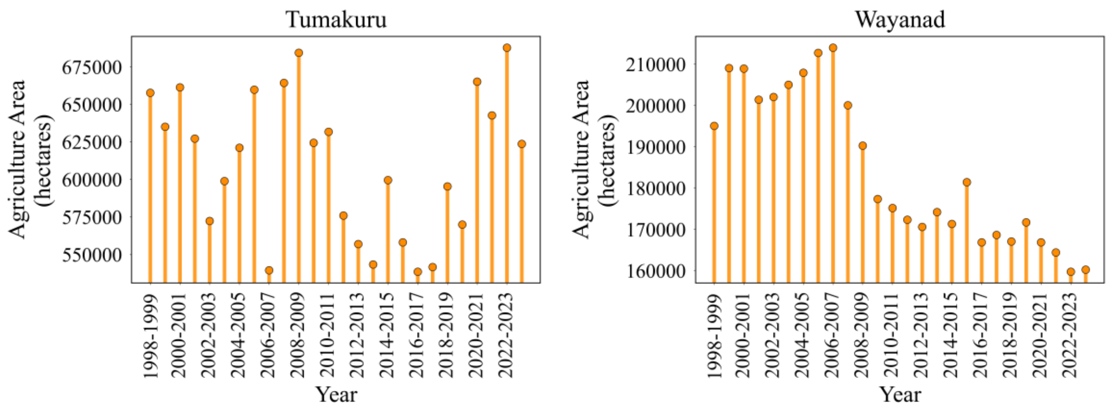


Fig. 13. Time-series plots of agriculture area (ha) for Tumakuru and Wayanad districts

2.2.1. Fallow Land

In this analysis, fallow land comprises "current fallow" and "fallow land other than current fallows." Fig. 14 presents the temporal variation in fallow land area (ha) across complete administrative districts lying within the CRB from 1998-99 to 2023-24. Each row represents a district, and each column corresponds to a year, while colour intensity denotes the magnitude of fallow land area, with darker shades indicating a larger extent of land lying fallow. The dataset was sourced from the Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, GoI.

Fig. 14 indicates substantial declines in Erode (−72,675 ha), Coimbatore (−45,454 ha), Hassan (−42,665 ha), Dharmapuri (−32,075 ha), Bengaluru Rural (−24,142 ha), and Perambalur (−16,558 ha), reflecting sustained reductions in fallow extent. Moderate declines were also recorded in Thiruvarur (−4,609 ha), Chikkaballapura (−4,048 ha), Nagapattinam (−1,972 ha), Mayiladuthurai (−1,031 ha), and Wayanad (−76 ha). In contrast, pronounced increases in fallow land occurred in Tumakuru (+64,257 ha), Dindigul (+58,210 ha), Mysuru (+55,331 ha), Tiruchirappalli (+54,460 ha), Namakkal (+41,668 ha), Pudukkottai (+34,361 ha), Salem (+31,812 ha), Karur (+27,577 ha), Ariyalur (+17,659 ha), and Chamarajanagar (+17,193 ha). Smaller but consistent increases were noted in Cuddalore (+15,422 ha), Chikkamagaluru (+11,208 ha), Thanjavur (+11,106 ha), Ramanagara (+7,147 ha), Palakkad (+4,989 ha), Tiruppur (+4,734 ha), Bengaluru Urban (+3,147 ha), Nilgiris (+432 ha), Karaikal (+247 ha), and Idukki (+656 ha). Overall, near-stability in fallow land area was limited to districts such as Wayanad, Nilgiris, Karaikal, and Idukki, where net changes remained below ±1,000 ha over the study period.

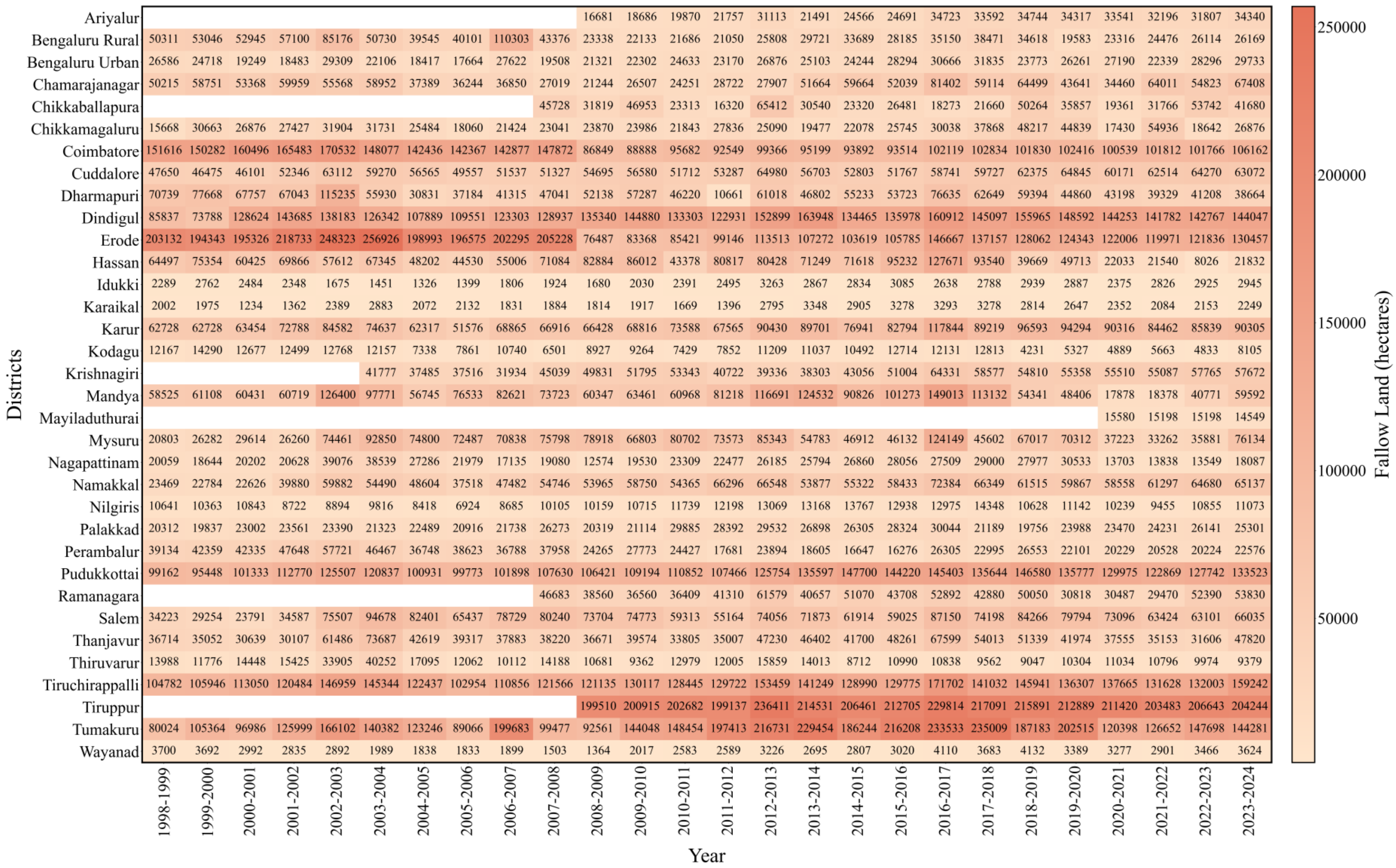


Fig. 14. District-wise temporal variation in fallow land (ha) from 1998-99 to 2023-24 across the CRB

2.2.1.1. Current Fallow Land

Fig. 15 illustrates the temporal variation in current fallow land (ha) across complete administrative districts lying within the CRB from 1998-99 to 2023-24. Each row corresponds to an individual district, and each column represents a specific year, while colour intensity denotes the magnitude of current fallow land area, with darker shades indicating a larger extent of land lying under current fallow. The dataset was sourced from the Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, GoI.

An examination of Fig. 15 together with the district-wise time-series plots (Figs. 16-20) reveals pronounced spatial contrasts in the evolution of current fallow land across the CRB. Tumakuru records the largest increase, with current fallow land expanding from 31,121 ha to 120,677 ha, representing a net gain of 89,556 ha. Mysuru also exhibits a substantial rise of 44,929 ha (from 12,106 ha to 57,035 ha), while Namakkal records a net increase of 31,698 ha (from 8,488 ha to 40,186 ha). Significant increases are further observed in Chamarajanagar (+25,618 ha), Karur (+24,583 ha), Salem (+18,428 ha), Thanjavur (+19,842 ha), Krishnagiri (+16,574 ha), and Chikkamagaluru (+9,291 ha). Moderate increases are noted in Mandya (+9,966 ha), Ramanagara (+7,925 ha), Pudukkottai (+6,791 ha), Nagapattinam (+3,318 ha), Palakkad (+1,653 ha), and Karaikal (+835 ha), collectively indicating an expanding short-term withdrawal of land from active cultivation in these districts.

In contrast, Erode shows the most pronounced reduction, with current fallow decreasing from 140,659 ha to 31,692 ha, amounting to a net decline of 108,967 ha. Coimbatore follows with a substantial decrease of 89,120 ha, while Dharmapuri records a reduction of 31,880 ha. Other notable declines occur in Tiruppur (−22,052 ha, based on data from 2008–09 onwards), Dindigul (−21,863 ha), Cuddalore (−8,520 ha), Perambalur (−7,102 ha), Hassan (−6,359 ha), Thiruvarur (−5,310 ha), Nilgiris (−2,436 ha), Tiruchirappalli (−2,297 ha), Bengaluru Rural (−2,000 ha), Kodagu (−998 ha), Idukki (−240 ha), and Wayanad (−79 ha). Newly formed districts such as Chikkaballapura (−11,773 ha), Mayiladuthurai (−1,466 ha), and Ariyalur (−459 ha), calculated from their first reported years, also exhibit net declines.

Bengaluru Urban displays a moderate net increase of 10,910 ha (from 2,325 ha to 13,235 ha) despite pronounced interannual variability, reflecting the combined effects of rapid urbanisation and residual agricultural activity. Overall, the basin-scale pattern highlights a substantial expansion of current fallow land in several core agricultural districts, contrasted by sharp contractions in others, most notably Erode and Coimbatore.

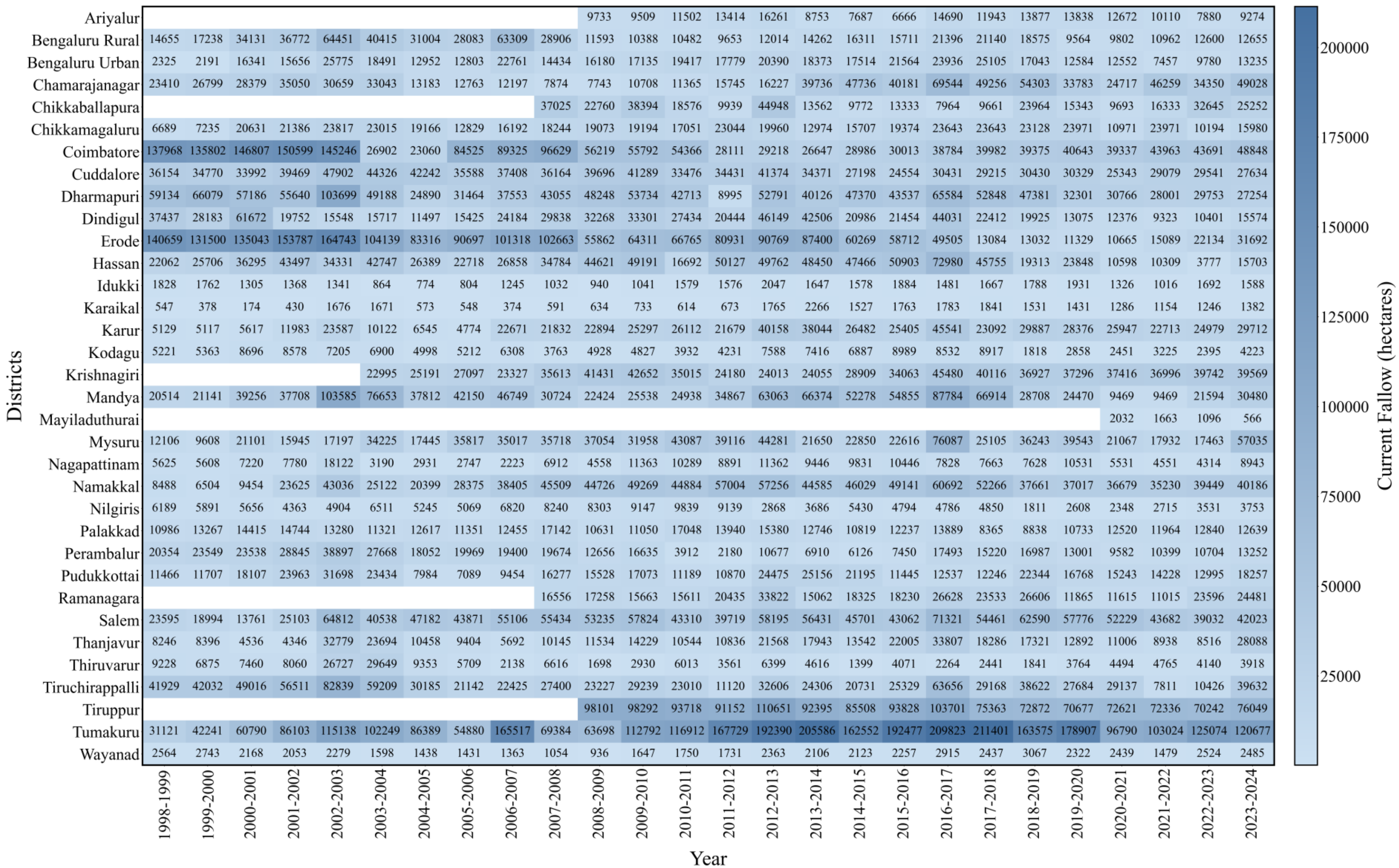


Fig. 15. District-wise temporal variation in current fallow land (ha) from 1998-99 to 2023-24 across the CRB

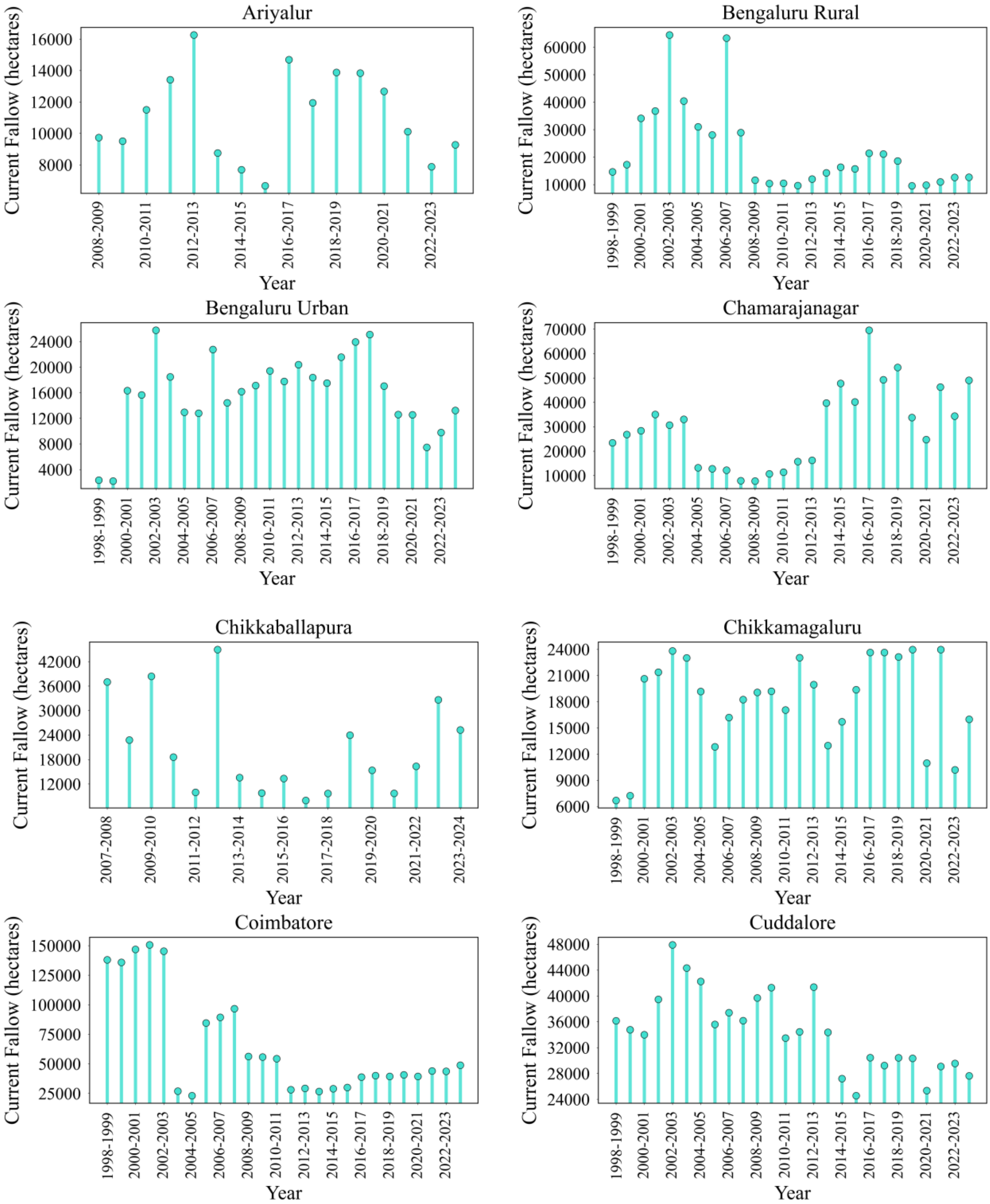


Fig. 16. Time-series plots of current fallow land (ha) for Ariyalur, Bengaluru Rural, Bengaluru Urban, Chamarajanagar, Chikkaballapura, Chikkamagaluru, Coimbatore, and Cuddalore districts

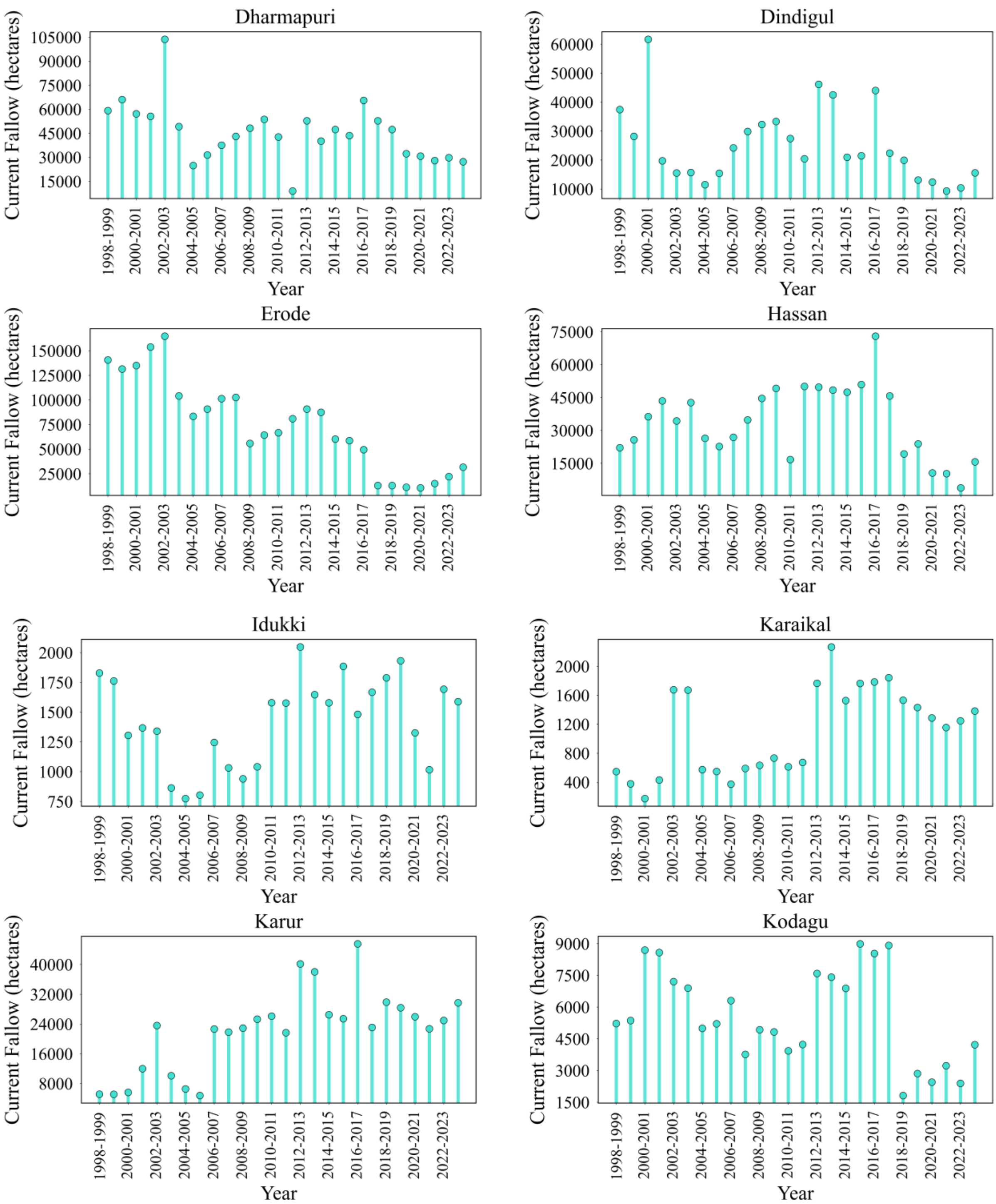


Fig. 17. Time-series plots of current fallow land (ha) for Dharmapuri, Dindigul, Erode, Hassan, Idukki, Karaikal, Karur, and Kodagu districts

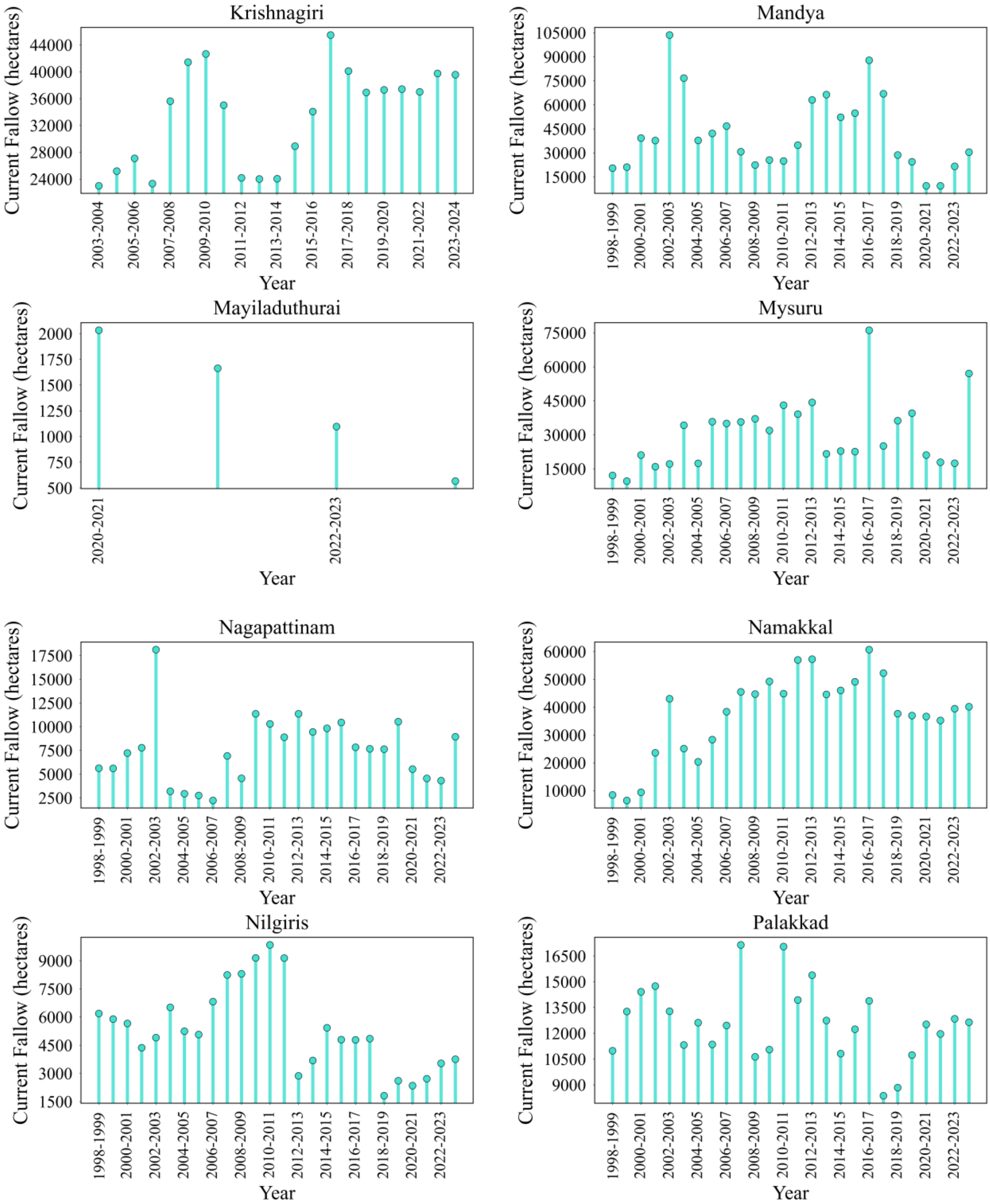


Fig. 18. Time-series plots of current fallow land (ha) for Krishnagiri, Mandya, Mayiladuthurai, Mysuru, Nagapattinam, Namakkal, Nilgiris, and Palakkad districts

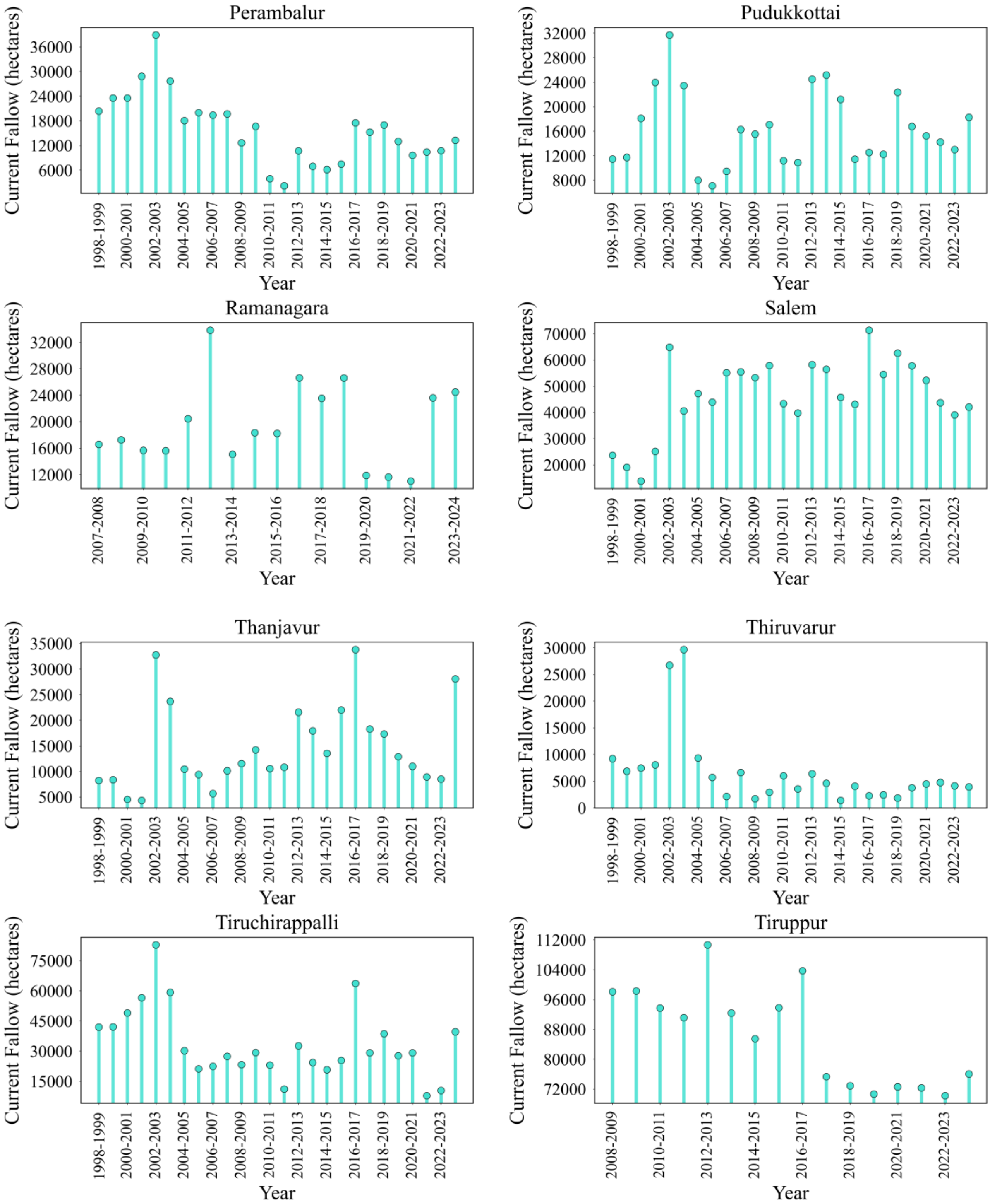


Fig. 19. Time-series plots of current fallow land (ha) for Perambalur, Pudukkottai, Ramanagara, Salem, Thanjavur, Thiruvarur, Tiruchirappalli, and Tiruppur districts

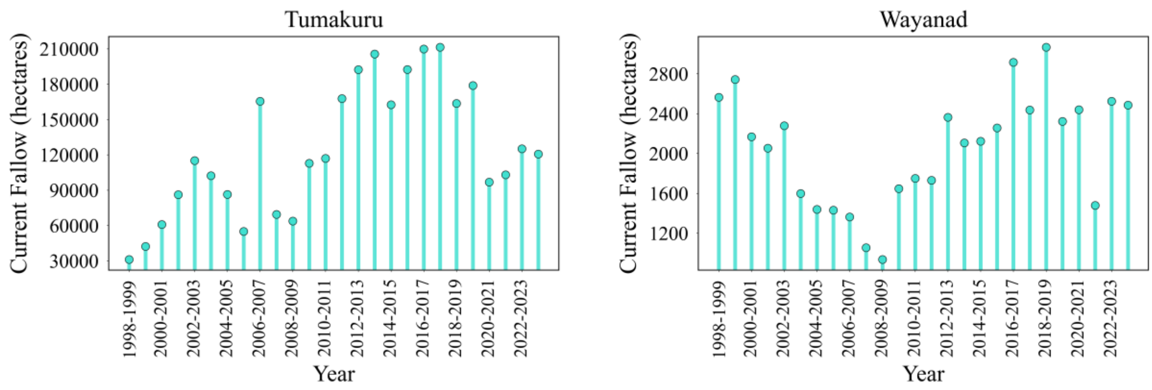


Fig. 20. Time-series plots of current fallow land (ha) for Tumakuru and Wayanad districts

2.2.1.2. Fallow Lands Other Than Current Fallow

Fig. 21 depicts the temporal variation in fallow lands other than current fallow (ha) across complete administrative districts located within the CRB for the period 1998-99 to 2023-24. The dataset was obtained from the Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, GoI.

The analysis of fallow lands other than current fallow indicates a pronounced increase in fallow area in several districts, most notably Dindigul, where fallow land expanded from 48,400 ha in 1998-99 to 128,473 ha in 2023-24, registering a net increase of 80,073 ha. Substantial increases are also evident in Tiruchirappalli (+56,757 ha), Coimbatore (+43,666 ha), Erode (+36,292 ha), Pudukkottai (+27,570 ha), and Tiruppur (+26,786 ha). Moderate but consistent increases are recorded in Cuddalore (+23,942 ha), Salem (+13,384 ha), Namakkal (+9,970 ha), Mysuru (+10,402 ha), and Nilgiris (+2,868 ha), while smaller increases are seen in Palakkad (+3,335 ha), Mayiladuthurai (+435 ha), Thiruvarur (+701 ha), Idukki (+896 ha), and Wayanad (+3 ha).

In contrast, several districts exhibit a decline in fallow land area, with the most pronounced reduction occurring in Hassan, where fallow land decreased sharply from 42,435 ha to 6,129 ha, amounting to a net loss of 36,306 ha. Significant declines are also observed in Bengaluru Rural (-22,142 ha), Mandya (-8,899 ha), Perambalur (-9,456 ha), Thanjavur (-8,736 ha), and Chamarajanagar (-8,425 ha). Smaller but persistent reductions characterize Nagapattinam (-5,290 ha), Kodagu (-3,064 ha), Karur (-2,006 ha), and Krishnagiri (-679 ha). A few districts display relative stability, with marginal net changes over the study period, including Dharmapuri (-195 ha) and Ramanagara (-778 ha), suggesting limited long-term shifts in non-current fallow extent.

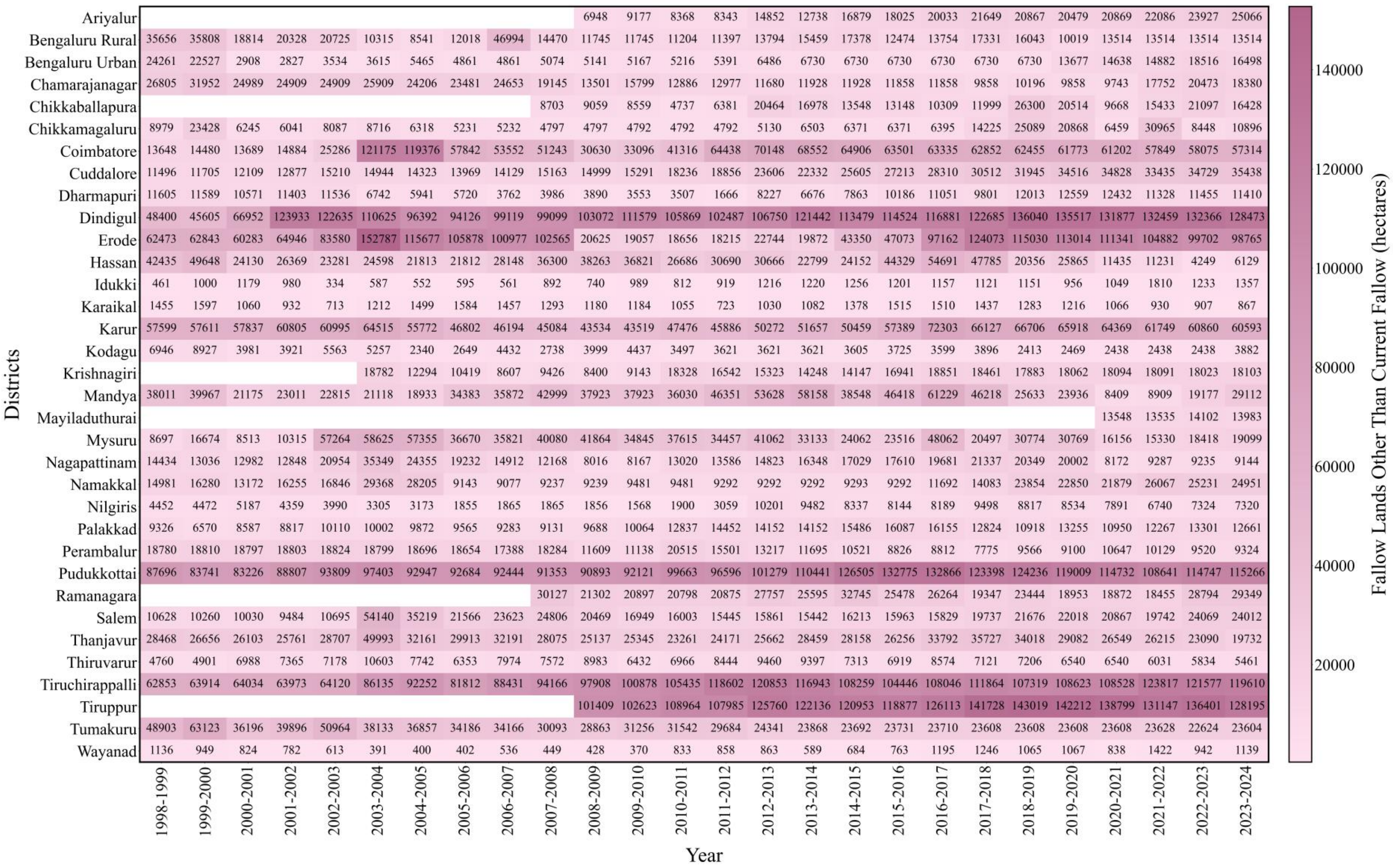


Fig. 21. District-wise temporal variation in fallow lands other than current fallow (ha) from 1998-99 to 2023-24 across the CRB

2.2.2. Net Sown Area

Fig. 22 illustrates the temporal variation in net sown area (ha) across complete administrative districts lying within the CRB from 1998-99 to 2023-24. Each row corresponds to an individual district, and each column represents a specific year, while colour intensity denotes the magnitude of net sown area, with darker shades indicating a larger extent under cultivation. The dataset was obtained from the Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, GoI.

The spatial pattern evident in Fig. 22 indicates that Nagapattinam consistently records the highest net sown area, whereas Bengaluru Urban exhibits the lowest net sown area. Further insights from Fig. 22 in conjunction with the district-wise time-series plots (Figs. 23-27) reveal Chikkamagaluru, records the most pronounced rise, increasing from 292,605 ha to 328,778 ha, a net gain of 36,173 ha. Hassan also shows a substantial increase of 43,378 ha, rising from 375,473 ha to 418,851 ha, while Kodagu increases by 61,333 ha (from 141,713 ha to 203,046 ha). Mandya records a net increase of 22,865 ha, rising from 248,825 ha to 271,690 ha.

Districts experiencing a net decrease in net sown area dominate the basin. Tumakuru, despite large absolute values, declines from 614,221 ha to 580,862 ha, a net loss of 33,359 ha. Bengaluru Rural shows a sharp reduction of 187,510 ha (from 297,792 ha to 110,282 ha), while Bengaluru Urban records a decline of 48,040 ha (from 82,332 ha to 34,292 ha), reflecting rapid urbanisation. Coimbatore decreases by 168,686 ha, Erode by 150,873 ha, Dharmapuri by 231,668 ha, and Karur by 28,950 ha. Deltaic and interior Tamil Nadu districts such as Nagapattinam (-79,156 ha), Thanjavur (-16,369 ha), Tiruchirappalli (-51,732 ha), Pudukkottai (-30,953 ha), Namakkal (-44,987 ha), and Salem (-43,337 ha) also show sustained long-term contraction.

Districts with relatively stable net sown area, showing only minor long-term fluctuations (generally within ±10,000 ha), include Nilgiris (-5,120 ha), Wayanad (-4,237 ha), Idukki (-15,551 ha), Karaikal (-3,705 ha), and Thiruvarur (+5,730 ha). These districts exhibit strong interannual variability but limited net long-term change, suggesting structural stability in land use, often supported by perennial crops or regulated irrigation.

Fig. 22. District-wise temporal variation in net sown area (ha) from 1998-99 to 2023-24 across the CRB

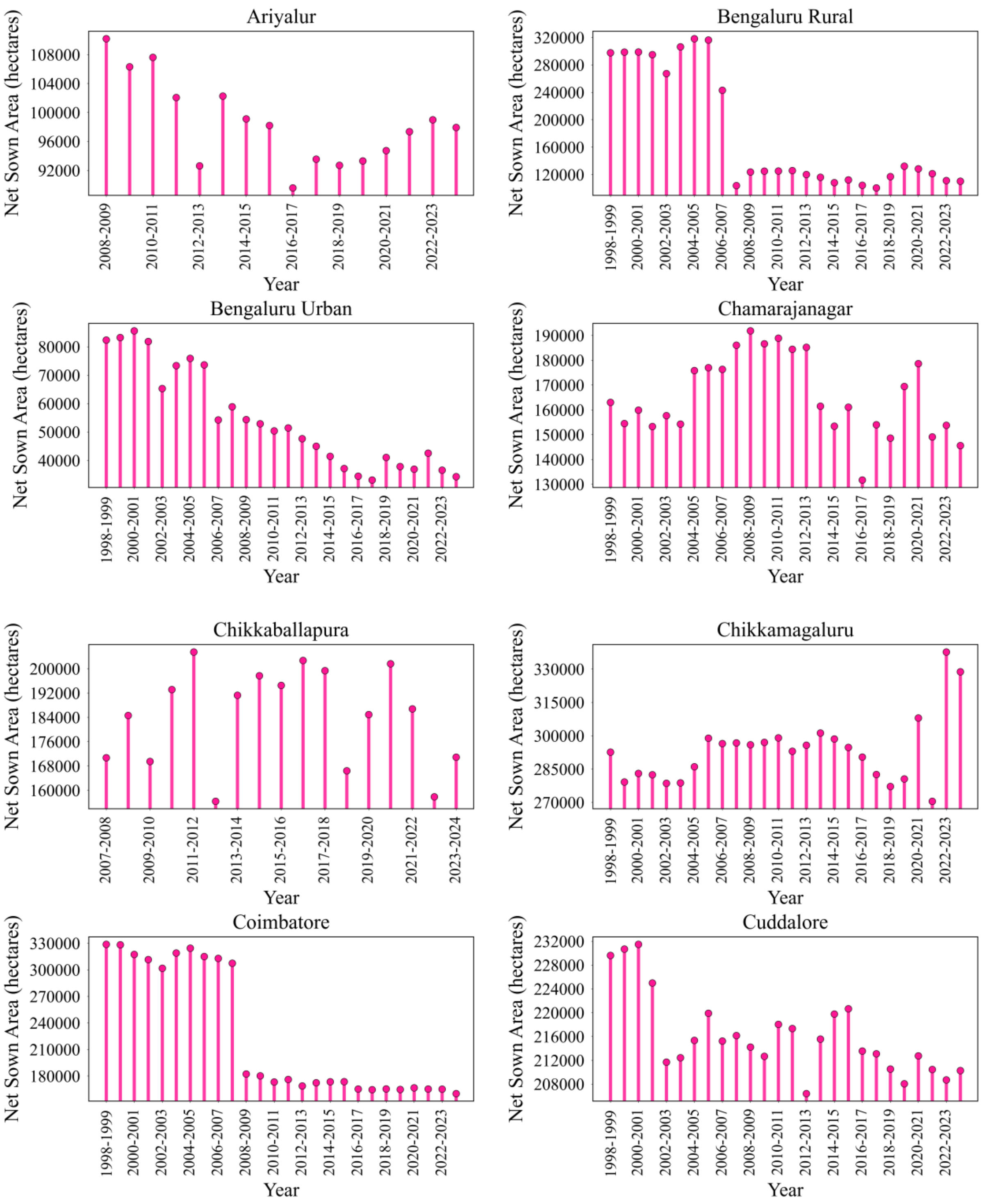


Fig. 23. Time-series plots of net sown area (ha) for Ariyalur, Bengaluru Rural, Bengaluru Urban, Chamarajanagar, Chikkaballapura, Chikkamagaluru, Coimbatore, and Cuddalore districts

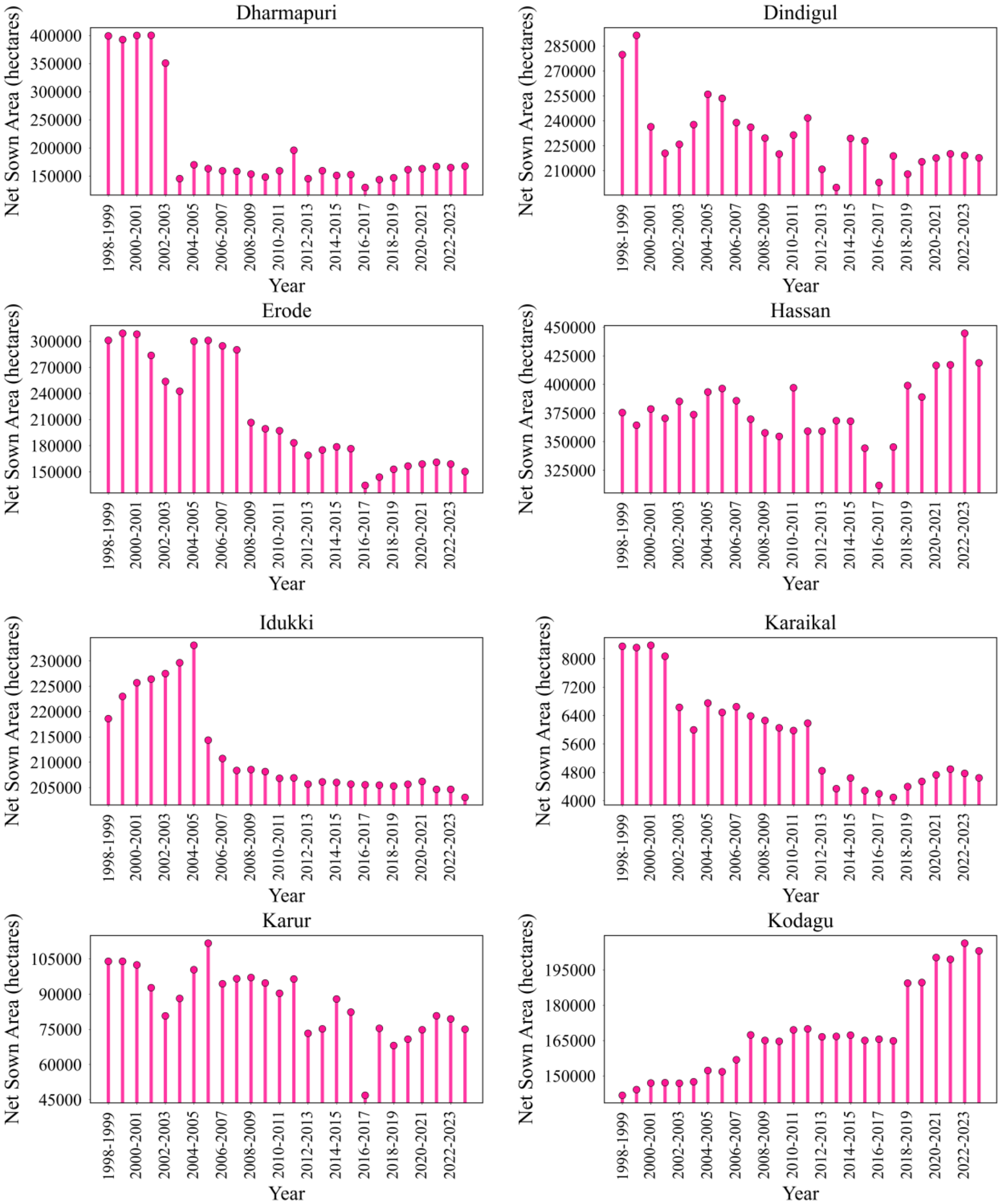


Fig. 24. Time-series plots of net sown area (ha) for Dharmapuri, Dindigul, Erode, Hassan, Idukki, Karaikal, Karur, and Kodagu districts

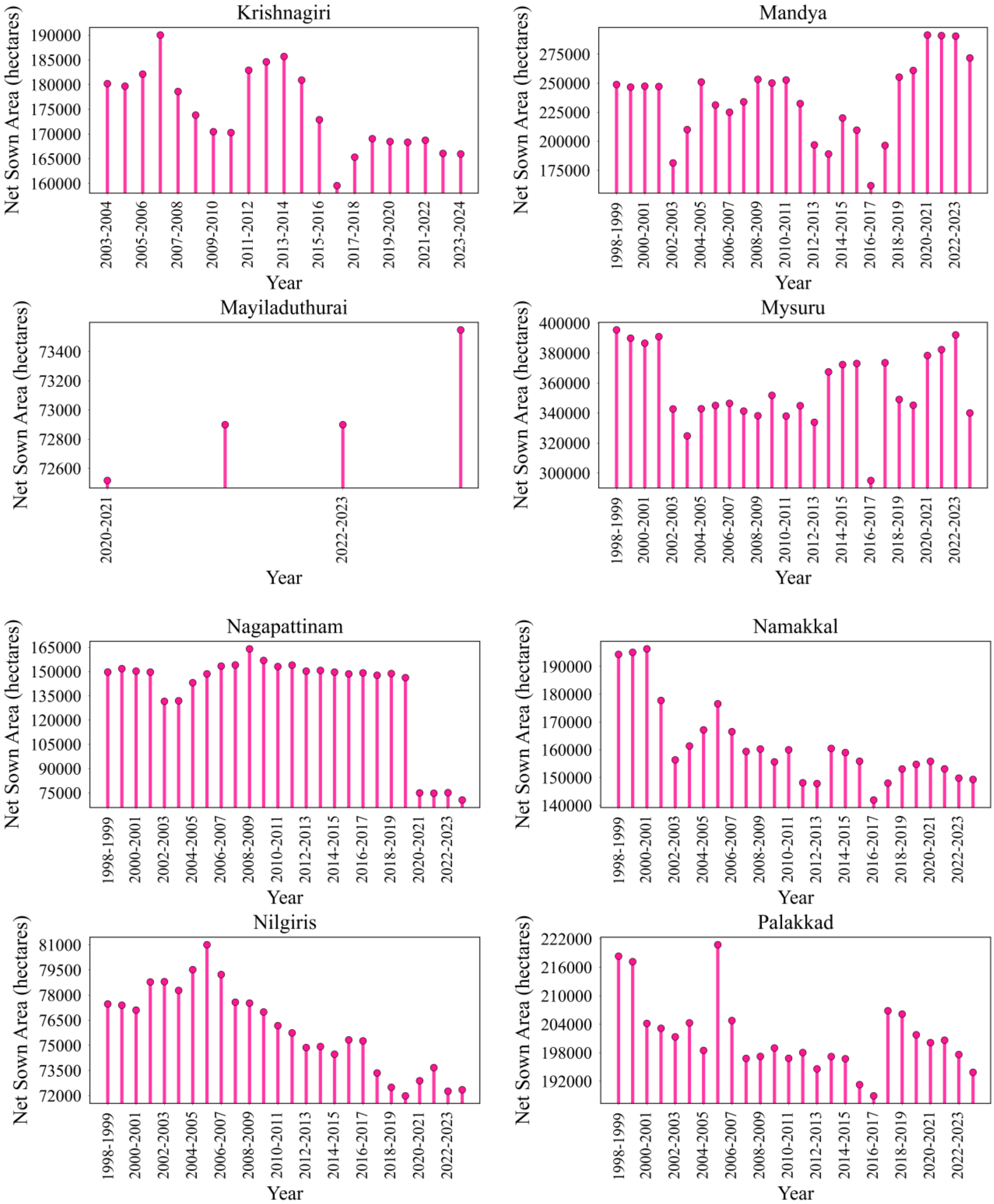


Fig. 25. Time-series plots of net sown area (ha) for Krishnagiri, Mandya, Mayiladuthurai, Mysuru, Nagapattinam, Namakkal, Nilgiris, and Palakkad districts

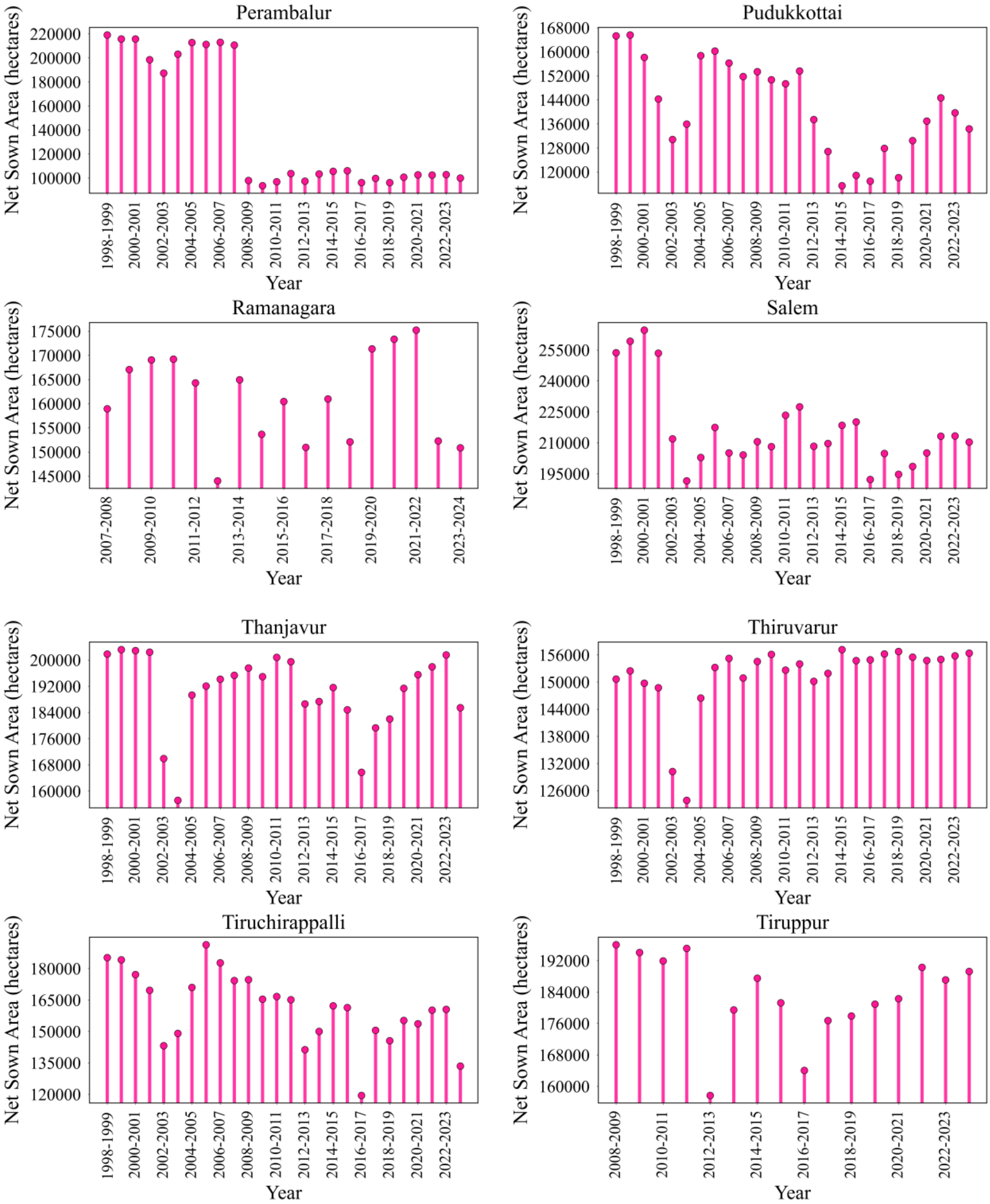


Fig. 26. Time-series plots of net sown area (ha) for Perambalur, Pudukkottai, Ramanagara, Salem, Thanjavur, Thiruvarur, Tiruchirappalli, and Tiruppur districts

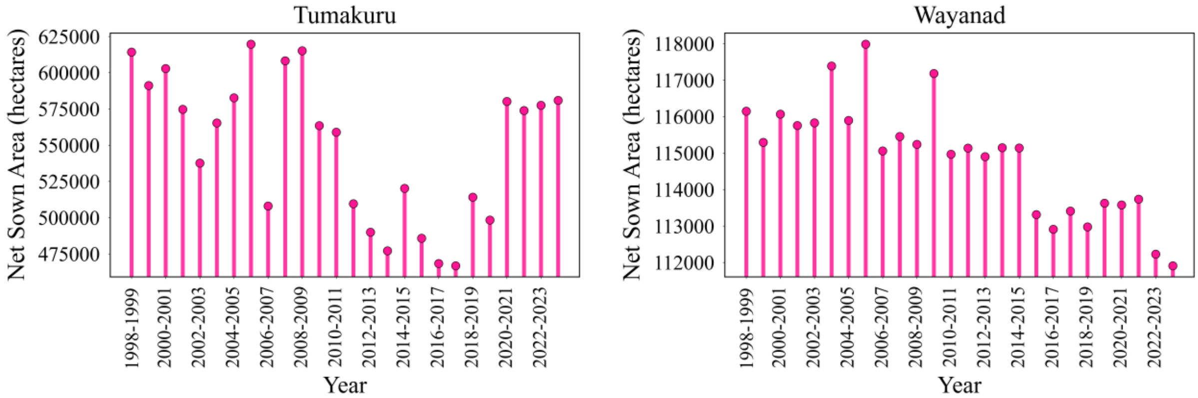


Fig. 27. Time-series plots of net sown area (ha) for Tumakuru and Wayanad districts

2.2.3. Irrigated and Non-Irrigated Land

2.2.3.1. Irrigated Land

Fig. 28 presents the temporal variation in irrigated land (ha) across complete administrative districts lying within the CRB from 1998-99 to 2023-24. Each row represents a district, and each column corresponds to a year, while colour intensity denotes the magnitude of irrigated area, with darker shades denoting a larger extent of irrigated area. The dataset was sourced from the Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, GoI.

A substantial increase in irrigated area is evident across several districts of the CRB (Figs. 29-33). Tumakuru records the most dramatic expansion, with irrigated area rising from 137,613 ha in 1998-99 to 302,810 ha in 2023-24, representing a net increase of 165,197 ha. Chikkamagaluru shows a pronounced rise, nearly quadrupling from 31,258 ha to 118,563 ha (+87,305 ha). Hassan also exhibits strong long-term growth despite mid-period fluctuations, increasing from 92,912 ha to 145,639 ha (+52,727 ha).

Significant expansions are further observed in Mandya (+48,900 ha), Idukki (+50,276 ha), Thanjavur (+71,831 ha), and Thiruvarur (+82,168 ha), highlighting sustained irrigation intensification in deltaic and canal-fed regions. Moderate increases are recorded in Pudukkottai (+23,037 ha), Cuddalore (+23,998 ha), Salem (+12,325 ha), Namakkal (+8,092 ha), and Nilgiris (+7,717 ha). Newly formed districts such as Ariyalur, Chikkaballapura, Tiruppur, and Mayiladuthurai also display clear post-formation growth trajectories; for instance, Ariyalur increased from 34,849 ha (first available year, 2008-09) to 52,231 ha (+17,382 ha), while Chikkaballapura expanded from 47,180 ha to 73,356 ha (+26,176 ha).

Several districts show a net decline in irrigated area over the study period. Bengaluru Rural experiences a marked reduction from 70,364 ha to 33,482 ha, amounting to a net loss of 36,882 ha, reflecting sustained contraction after 2007-08. Coimbatore and Erode record substantial declines of 59,070 ha and 59,812 ha, respectively. Tiruchirappalli also shows a notable reduction, decreasing from 117,609 ha to 81,637 ha (-35,972 ha).

Other districts characterised by persistent declines include Perambalur (-41,817 ha), Nagapattinam (-75,832 ha), Karur (-5,760 ha), Kodagu (-2,841 ha), and Dharmapuri (-43,241 ha), with Nagapattinam exhibiting an especially sharp contraction after 2019-20.

A few districts exhibit relative stability with moderate net change despite pronounced interannual variability. Dindigul declines marginally from 114,879 ha to 102,874 ha (-12,005 ha), suggesting a near-stable long-term irrigation extent. Similarly, districts such as Ramanagara and Bengaluru Urban show limited net change relative to large year-to-year fluctuations, indicating constrained long-term expansion or contraction of irrigated areas.

2.2.3.2. Non-Irrigated Land

Non-irrigated area was calculated as the difference between "total cropped area" and "total irrigated area." Fig. 34 illustrates the temporal variation in non-irrigated land (ha) across complete administrative districts within the CRB for the period 1998-99 to 2023-24. Each row represents an individual district and each column corresponds to a specific year. The colour gradient indicates the magnitude of non-irrigated area, with darker shades denoting a larger extent of non-irrigated land. The datasets of total cropped area and total irrigated area were obtained from the Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India (GoI).

A sustained increase in non-irrigated area is observed in several districts, indicating either contraction of irrigation coverage or expansion of rainfed cultivation (Figs. 35-39). Kodagu records the most pronounced increase, with non-irrigated area rising from 138,780 ha in 1998-99 to 228,547 ha in 2023-24, registering a net increase of 89,767 ha. Hassan also exhibits a strong rise, expanding from 340,160 ha to 390,868 ha (+50,708 ha).

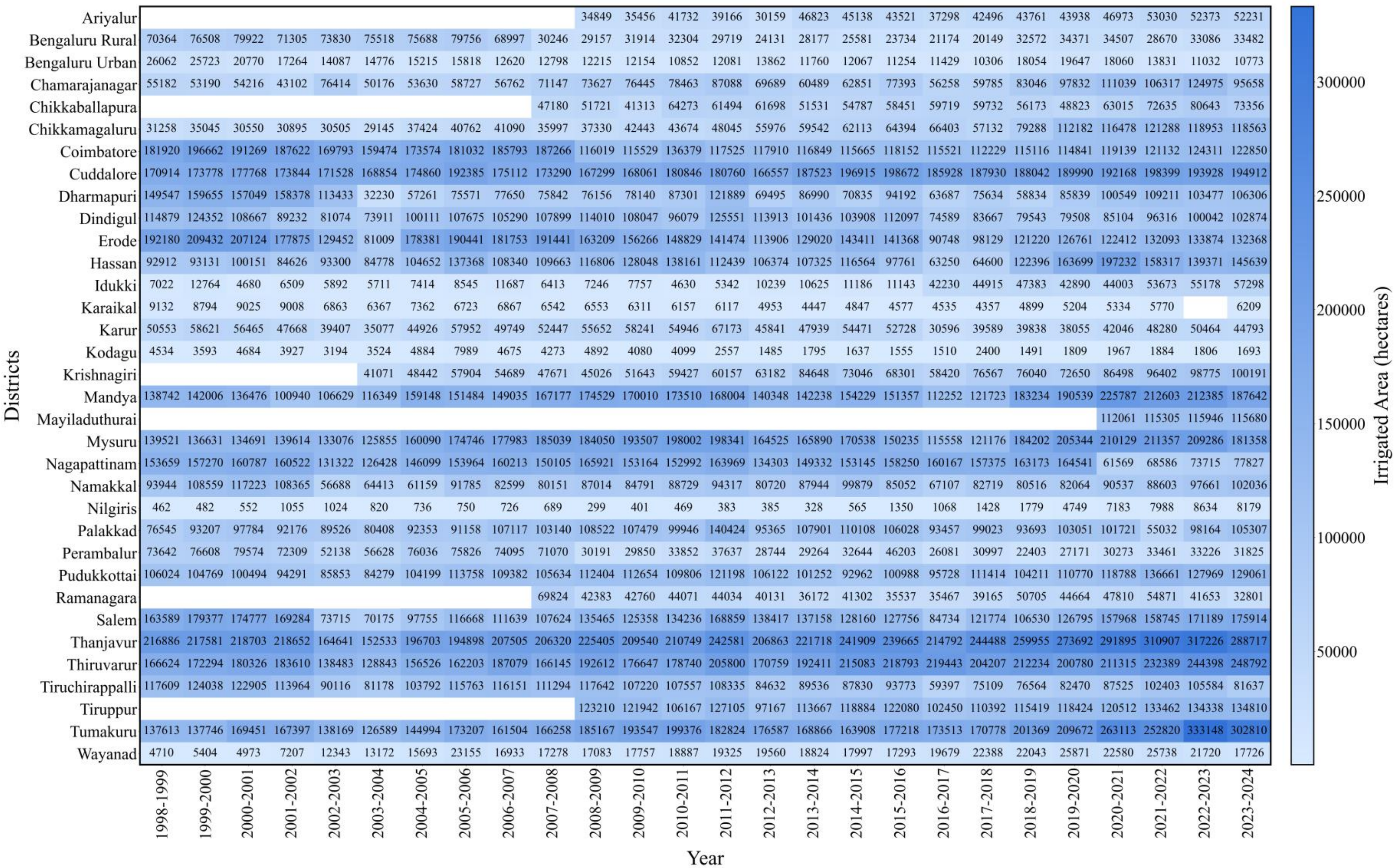


Fig. 28. District-wise temporal variation in irrigated area (ha) from 1998-99 to 2023-24 across the CRB

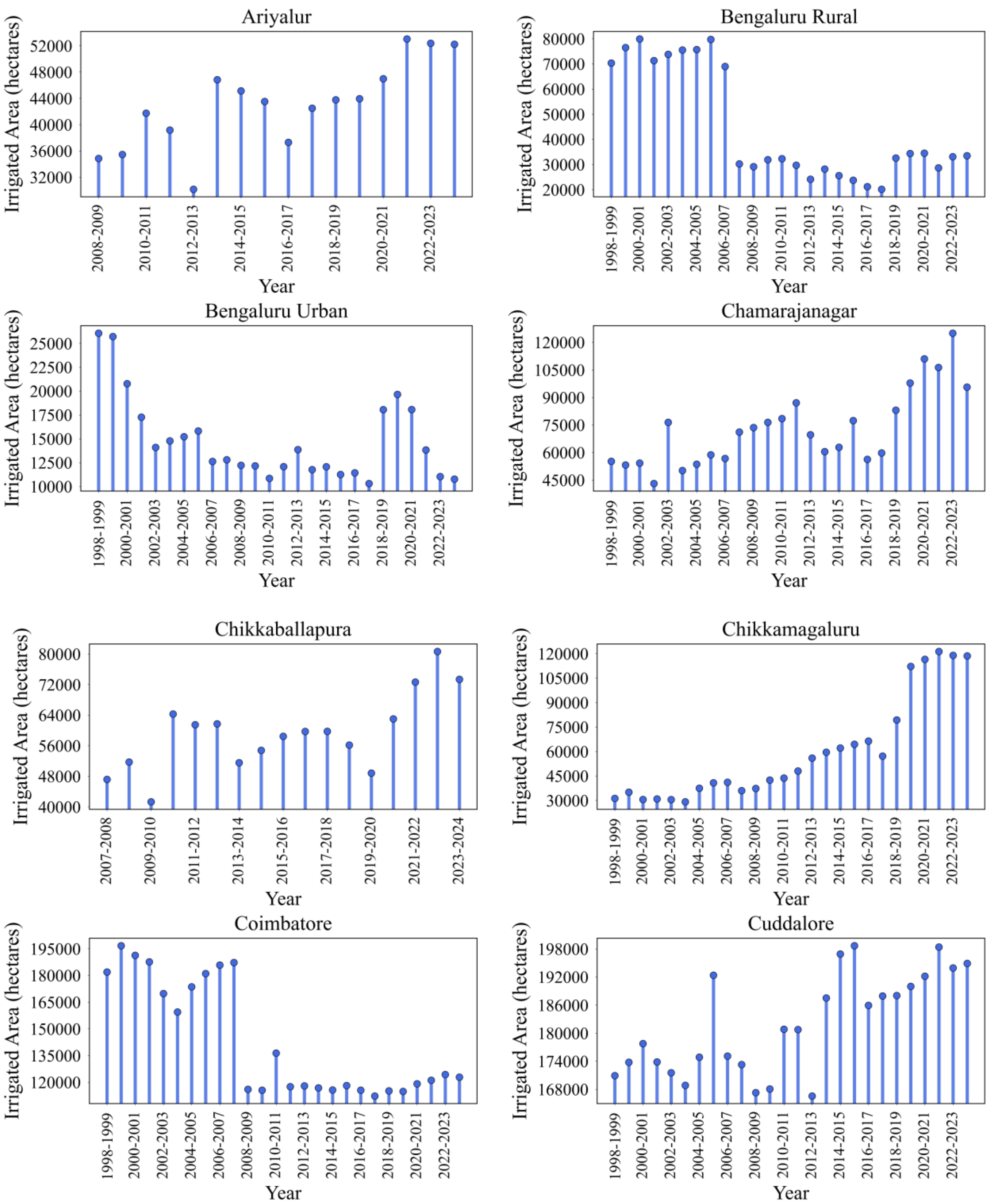


Fig. 29. Time-series plots of irrigated area (ha) for Ariyalur, Bengaluru Rural, Bengaluru Urban, Chamarajanagar, Chikkaballapura, Chikkamagaluru, Coimbatore, and Cuddalore districts

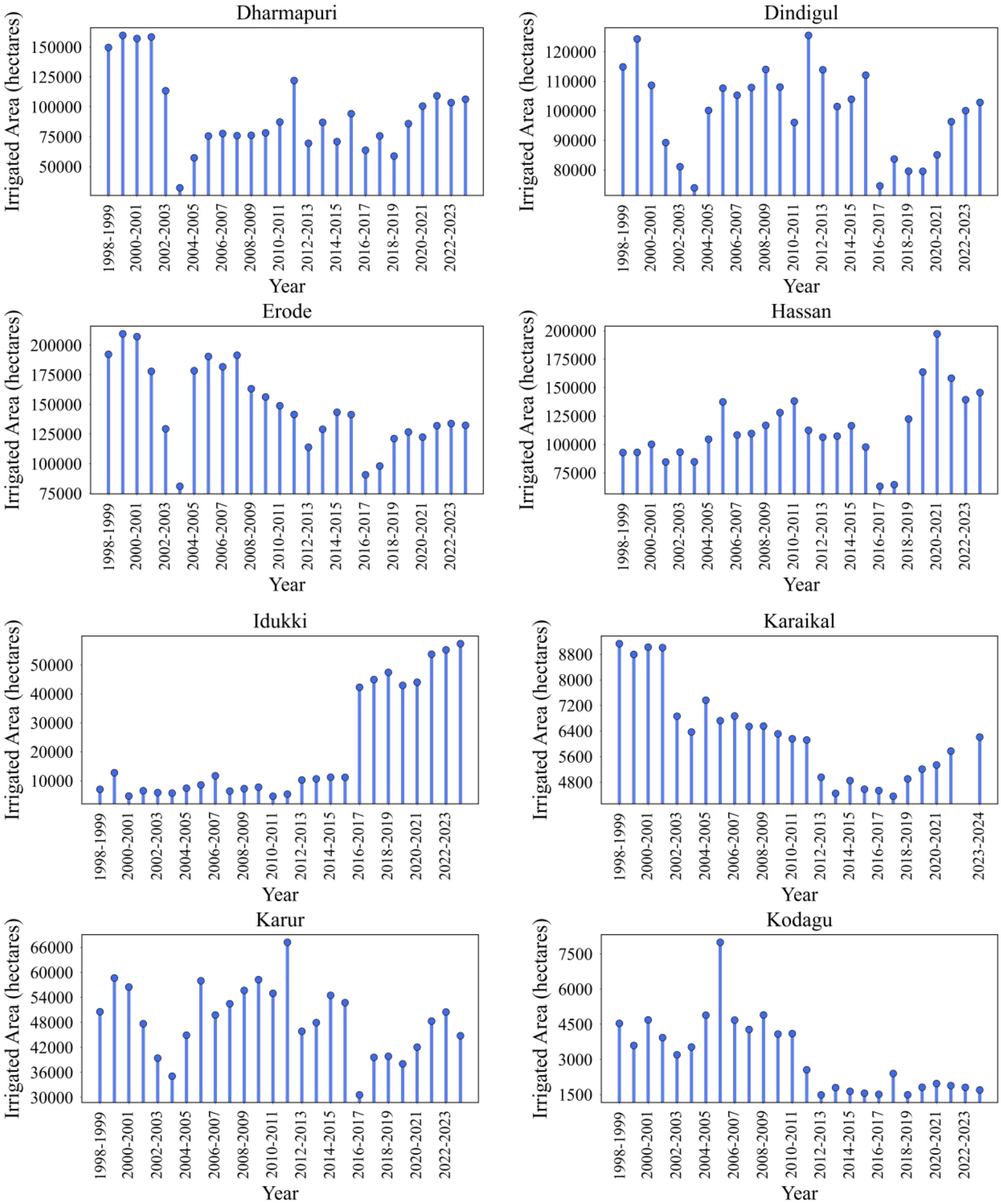


Fig. 30. Time-series plots of irrigated area (ha) for Dharmapuri, Dindigul, Erode, Hassan, Idukki, Karaikal, Karur, and Kodagu districts

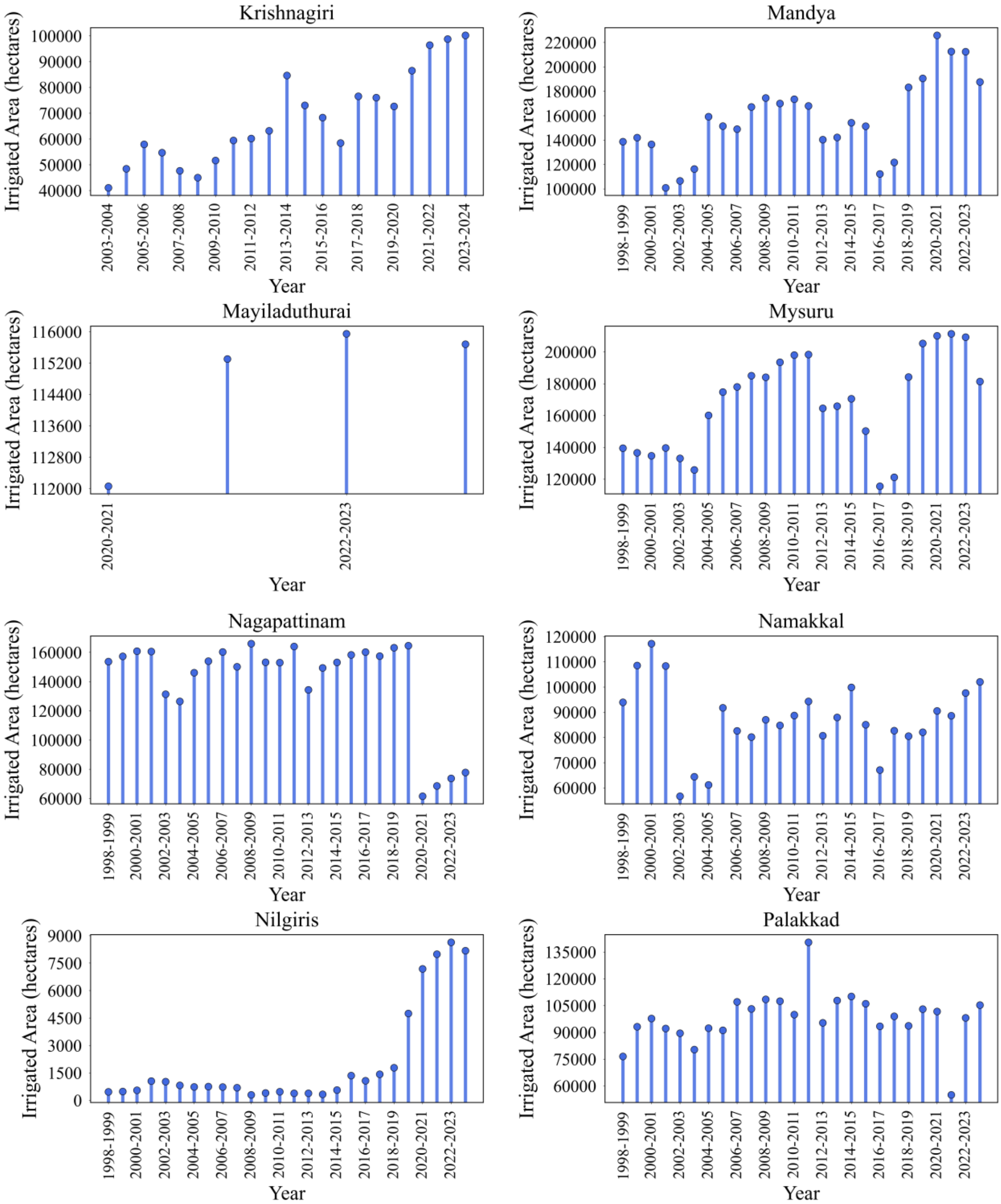


Fig. 31. Time-series plots of irrigated area (ha) for Krishnagiri, Mandya, Mayiladuthurai, Mysuru, Nagapattinam, Namakkal, Nilgiris, and Palakkad districts

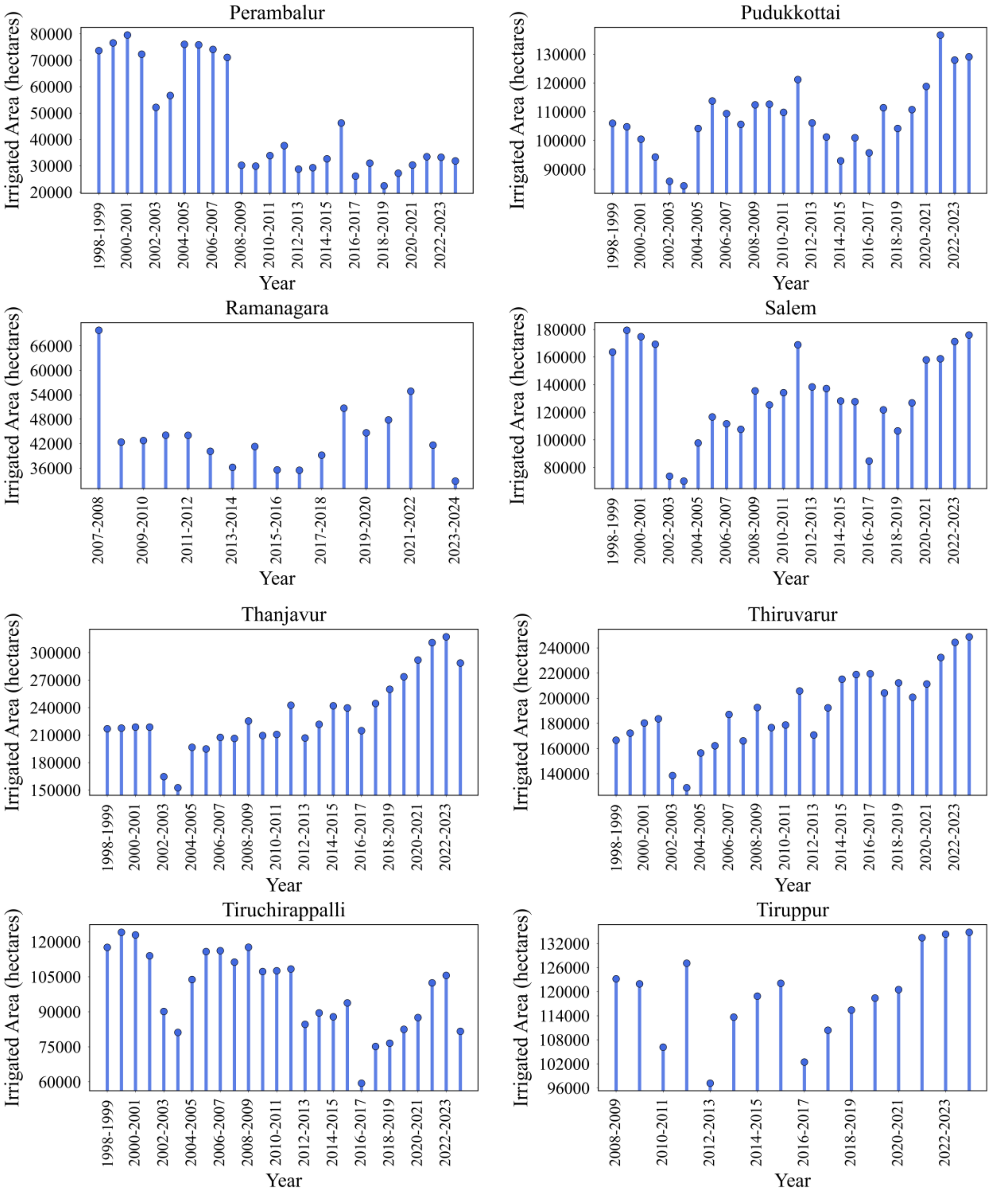


Fig. 32. Time-series plots of irrigated area (ha) for Perambalur, Pudukkottai, Ramanagara, Salem, Thanjavur, Thiruvarur, Tiruchirappalli, and Tiruppur districts

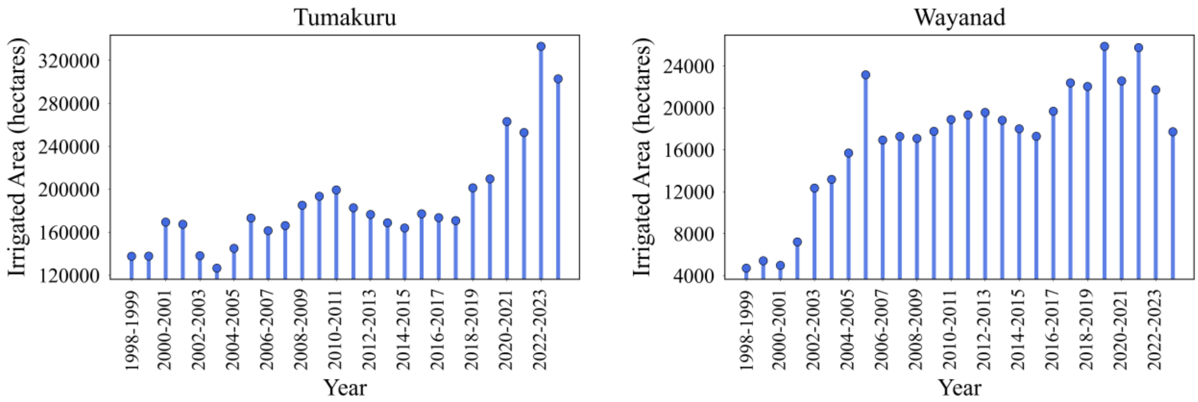


Fig. 33. Time-series plots of irrigated area (ha) for Tumakuru and Wayanad districts

Notable increases are further evident in Mandya (+11,837 ha), Ramanagara (from first available year 93,771 ha to 123,975 ha; +30,204 ha). Ariyalur, Chikkaballapura, Tiruppur, and Mayiladuthurai also show post-formation increases, suggesting gradual expansion of non-irrigated cropland in newly constituted districts.

Several districts display a clear long-term decline in non-irrigated area, consistent with irrigation expansion or improved water availability. Tumakuru shows the largest reduction, decreasing from 520,088 ha in 1998-99 to 320,855 ha in 2023-24, a net decline of 199,233 ha. Mysuru also records a substantial reduction from 346,747 ha to 302,668 ha (-44,079 ha).

Significant decreases are observed in Chikkamagaluru (-43,648 ha), Coimbatore (-127,632 ha), Erode (-104,306 ha), Salem (-69,097 ha), Namakkal (-44,350 ha), Palakkad (-70,756 ha), Wayanad (-47,808 ha), and Dharmapuri (-158,484 ha). Deltaic districts such as Thanjavur (-37,286 ha), and Nilgiris (-10,198 ha) also show marked declines, indicating progressive conversion of rainfed land to irrigated agriculture.

A few districts exhibit relative stability in non-irrigated area, despite considerable interannual variability. Dindigul shows a moderate decline from 174,621 ha to 121,373 ha (-53,248 ha), suggesting partial stabilization in recent years. Cuddalore remains broadly stable, changing marginally from 124,877 ha to 118,714 ha (-6,163 ha). Tiruchirappalli also displays limited long-term change, decreasing from 83,471 ha to 69,523 ha (-13,948 ha).

Similarly, Karur (-21,926 ha), Perambalur (-89,282 ha), and Pudukkottai (-47,448 ha) exhibit moderate net changes relative to their large year-to-year fluctuations, indicating constrained long-term shifts in non-irrigated extent.

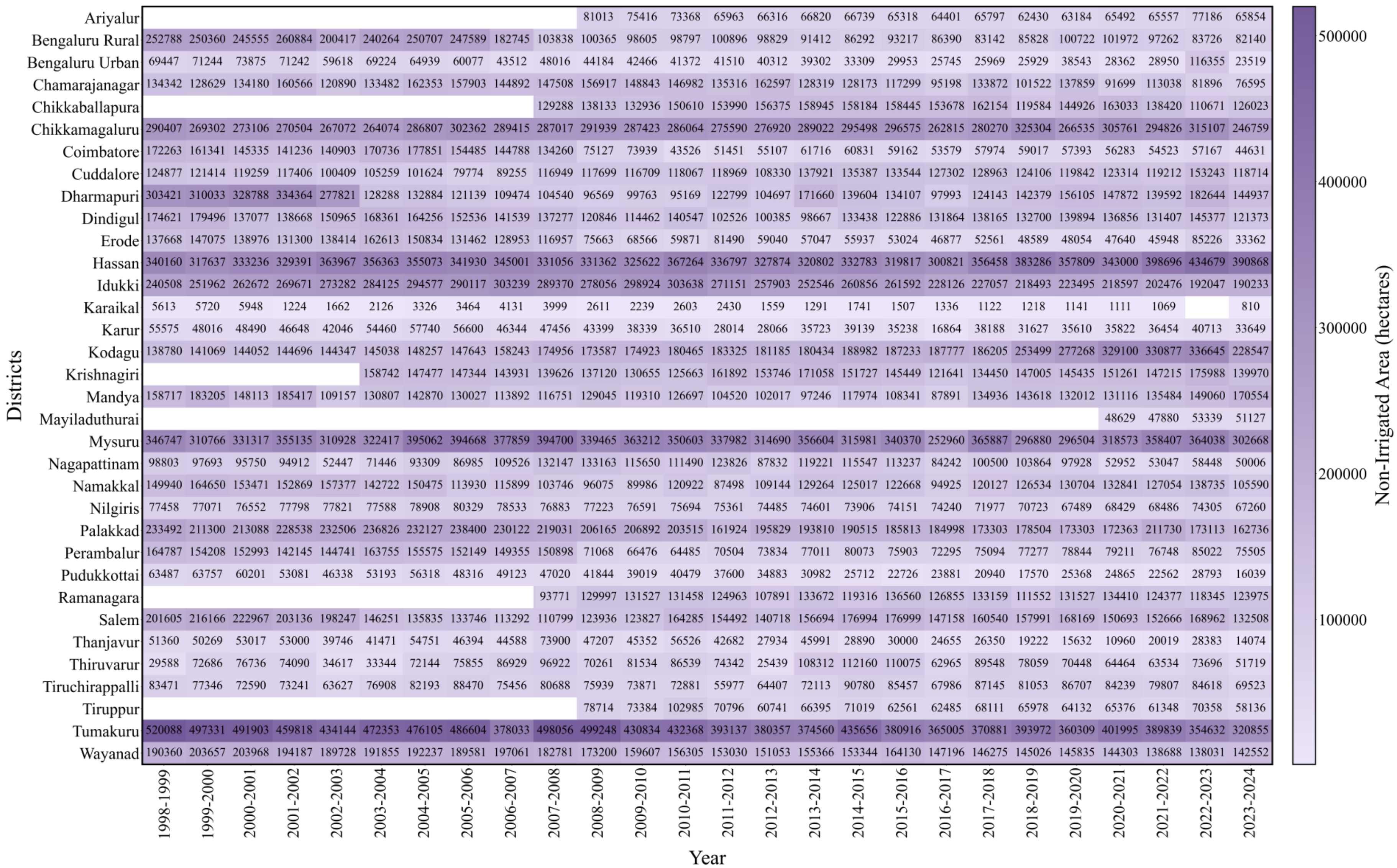


Fig. 34. District-wise temporal variation in non-irrigated area (ha) from 1998-99 to 2023-24 across the CRB

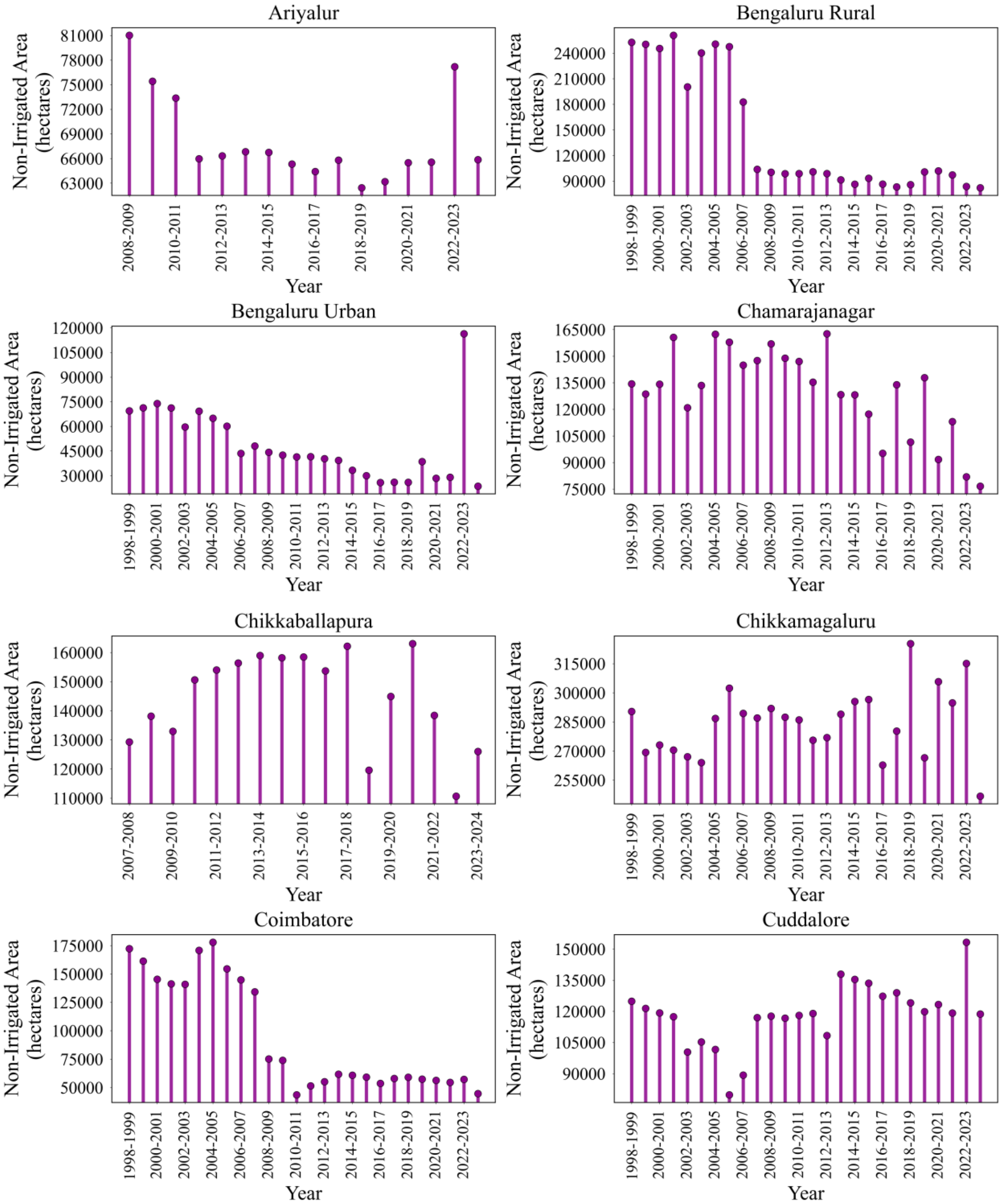


Fig. 35. Time-series plots of non-irrigated area (ha) for Ariyalur, Bengaluru Rural, Bengaluru Urban, Chamarajanagar, Chikkaballapura, Chikkamagaluru, Coimbatore, and Cuddalore districts

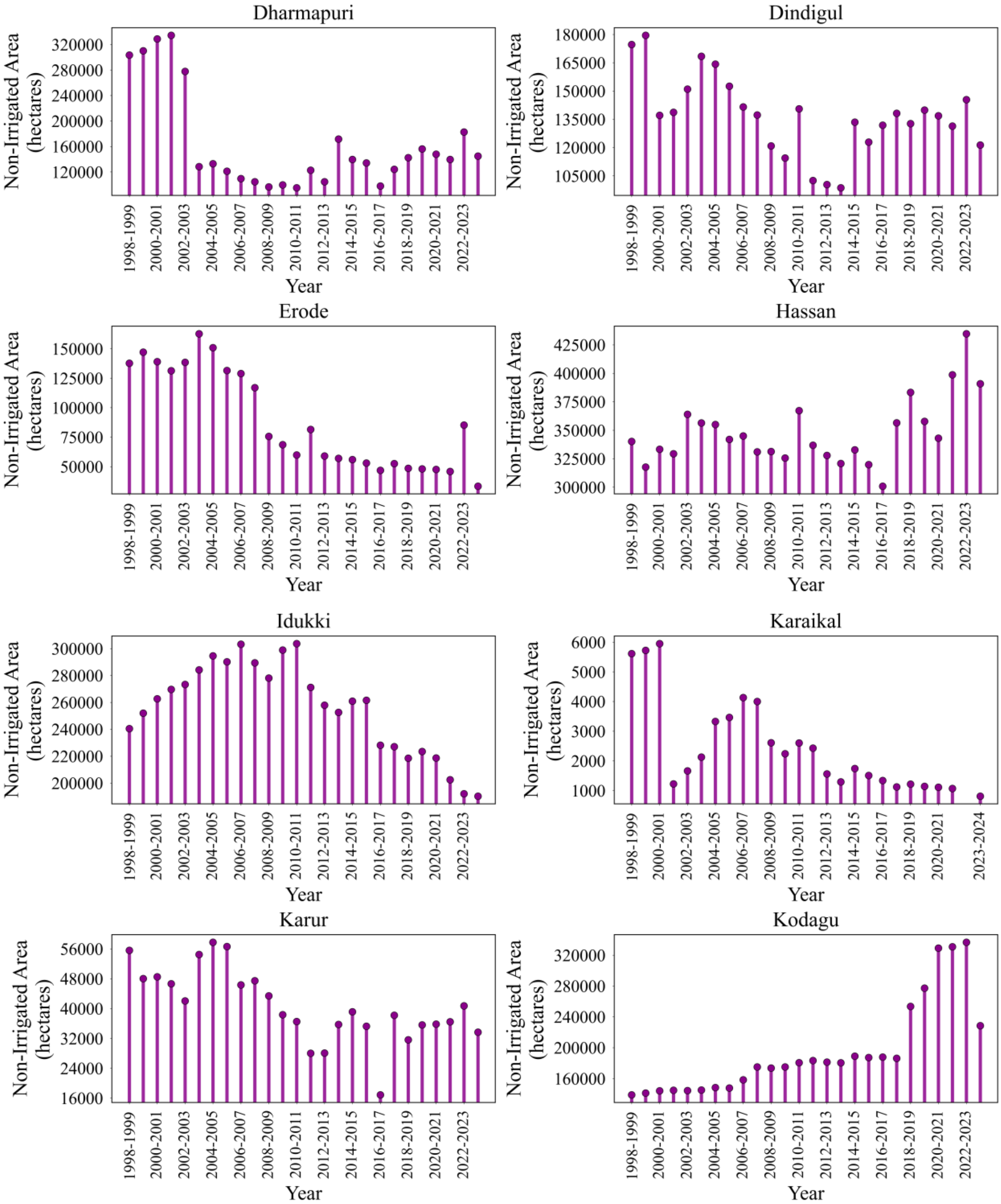


Fig. 36. Time-series plots of non-irrigated area (ha) for Dharmapuri, Dindigul, Erode, Hassan, Idukki, Karaikal, Karur, and Kodagu districts

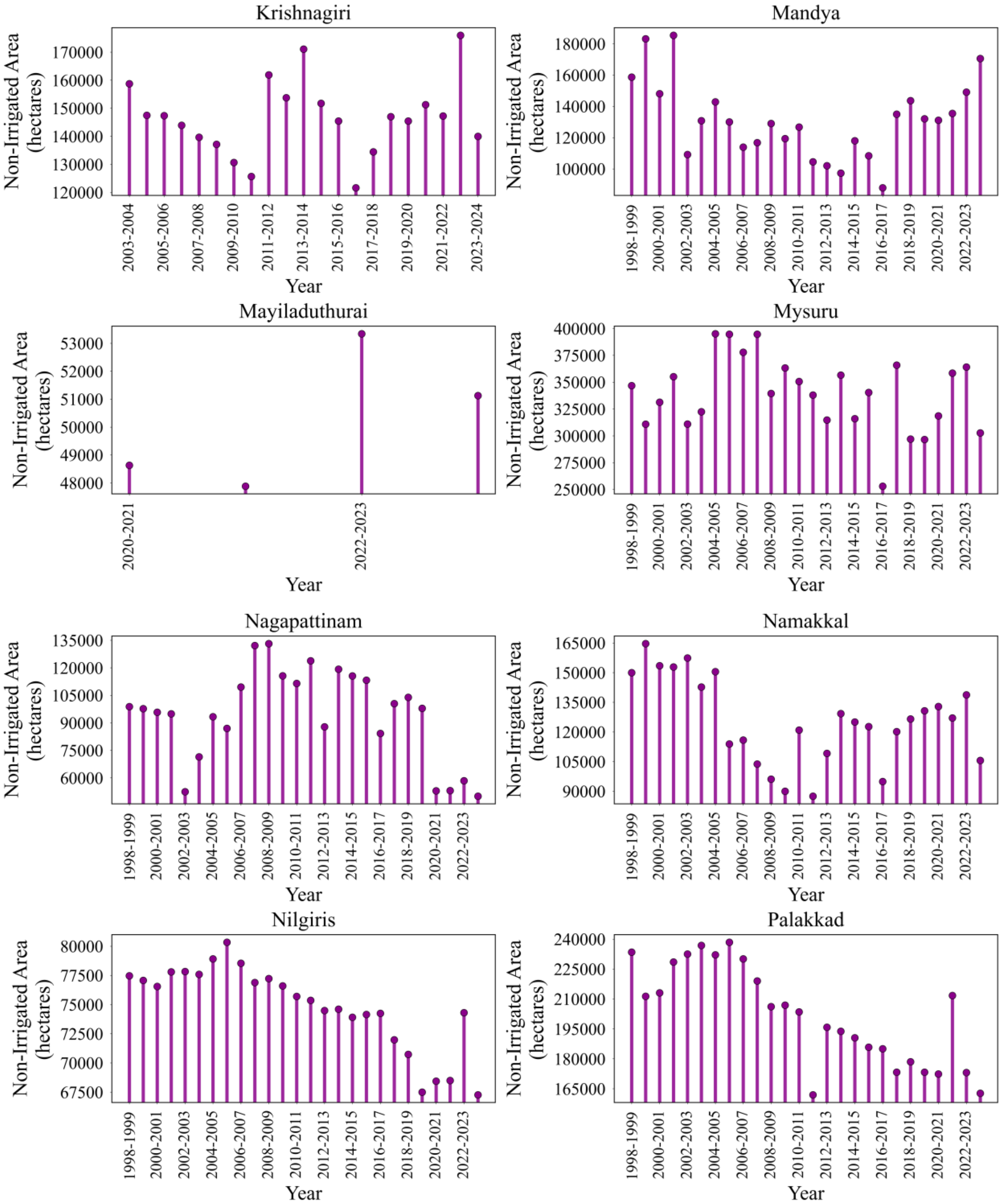


Fig. 37. Time-series plots of non-irrigated area (ha) for Krishnagiri, Mandya, Mayiladuthurai, Mysuru, Nagapattinam, Namakkal, Nilgiris, and Palakkad districts

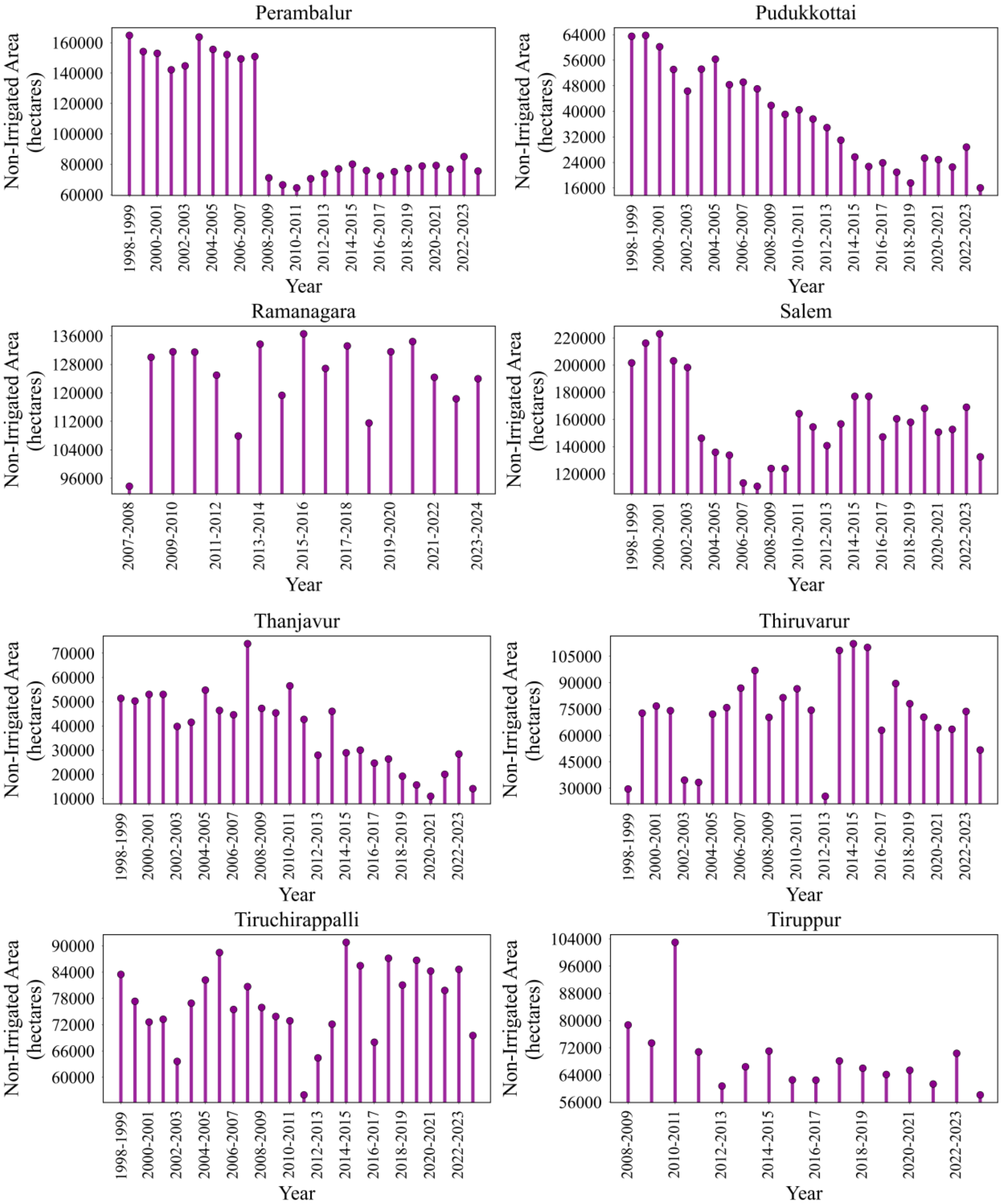


Fig. 38. Time-series plots of non-irrigated area (ha) for Perambalur, Pudukkottai, Ramanagara, Salem, Thanjavur, Thiruvarur, Tiruchirappalli, and Tiruppur districts

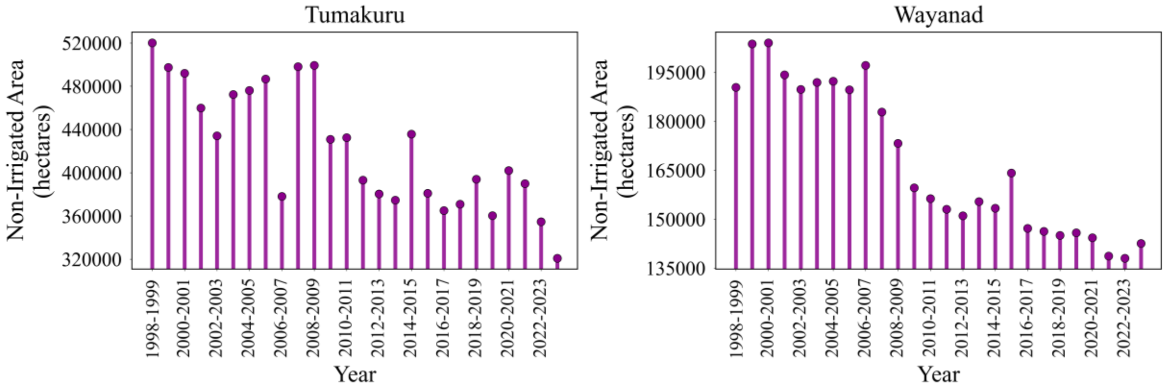


Fig. 39. Time-series plots of non-irrigated area (ha) for Tumakuru and Wayanad districts

2.3. Area Not Available for Cultivation

Area not available for cultivation comprises "area under non-agricultural uses" and "barren and unculturable land." Fig. 40 presents the temporal variation in area not available for cultivation (ha) across complete administrative districts lying within the CRB from 1998-99 to 2023-24. The dataset was sourced from the Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, GoI.

Figs. 41-45 reveals a net increase in non-cultivable areas observed in most districts, with the most substantial expansion occurring in Bengaluru Urban, where the area increased from 86,816 ha to 131,900 ha, representing a net gain of 45,084 ha. Other districts exhibiting notable increases include Palakkad (+22,954 ha), Hassan (+15,481 ha), Salem (+14,872 ha), Cuddalore (+11,723 ha), Idukki (+11,280 ha), Mysuru (+10,434 ha), and Pudukkottai (+9,257 ha).

Moderate increases are evident in Tiruchirappalli (+7,900 ha), Tumakuru (+7,643 ha), Wayanad (+6,745 ha), Namakkal (+6,337 ha), Thanjavur (+4,697 ha), Karur (+4,095 ha), and Mandya (+3,928 ha), while smaller but consistent increases characterize Ramanagara, Dindigul, Tiruppur, Nilgiris, Karaikal, Chikkamagaluru, Chikkaballapura, Thiruvarur, Ariyalur, and Chamarajanagar.

In contrast, a net decrease in area not available for cultivation is observed in a limited number of districts. The most pronounced reduction occurs in Perambalur, where non-cultivable area declined by 37,739 ha over the study period. Substantial decreases are also recorded in Bengaluru Rural (-27,197 ha), Dharmapuri (-26,088 ha), Nagapattinam (-23,986 ha), Erode (-22,023 ha), and Coimbatore (-17,523 ha). Smaller but persistent declines in Kodagu (-6,152 ha) and Krishnagiri (-1,349 ha) suggest localized reclassification or stabilization of land use in these districts.

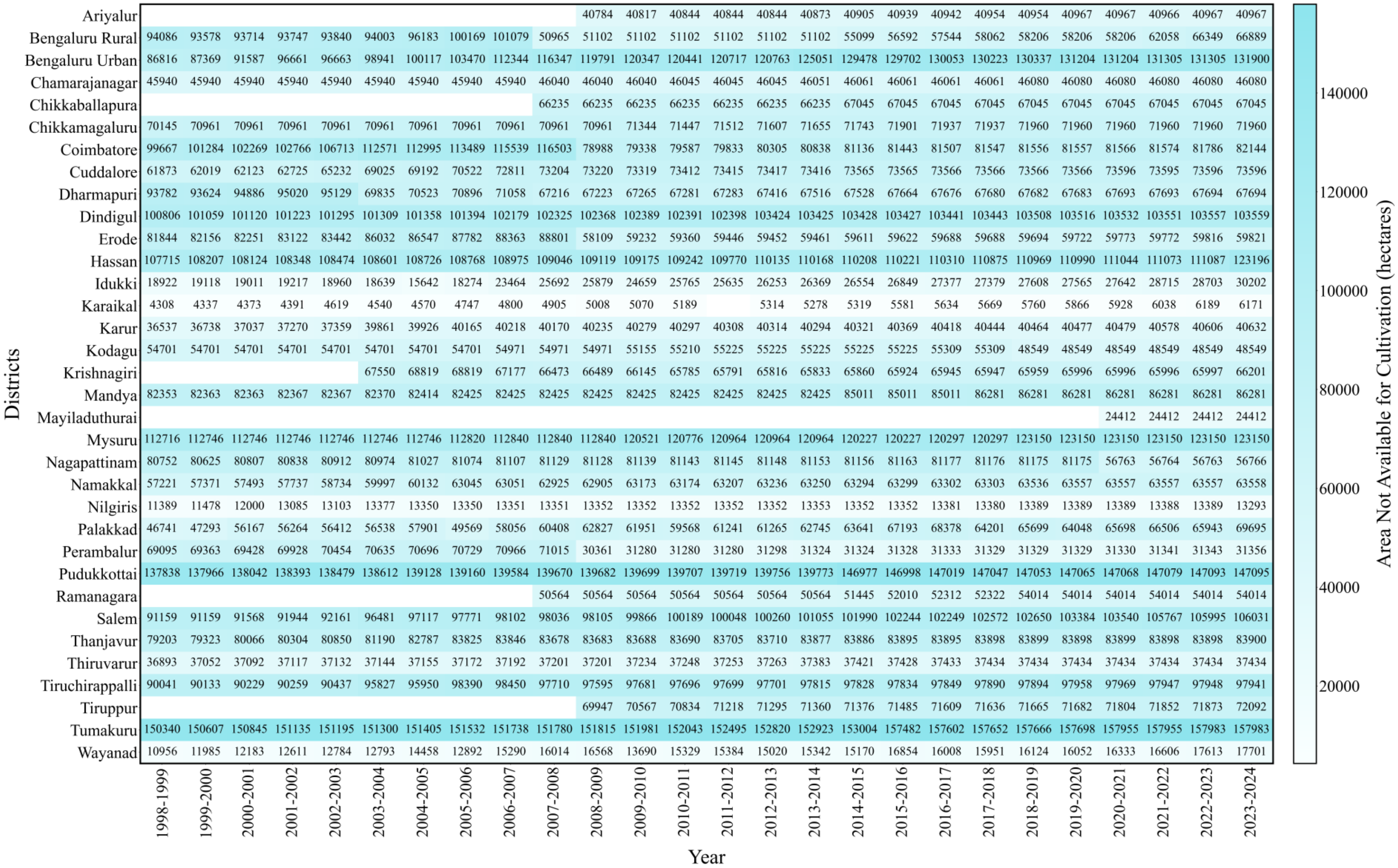


Fig. 40. District-wise temporal variation in non-cultivable area (ha) from 1998-99 to 2023-24 across the CRB

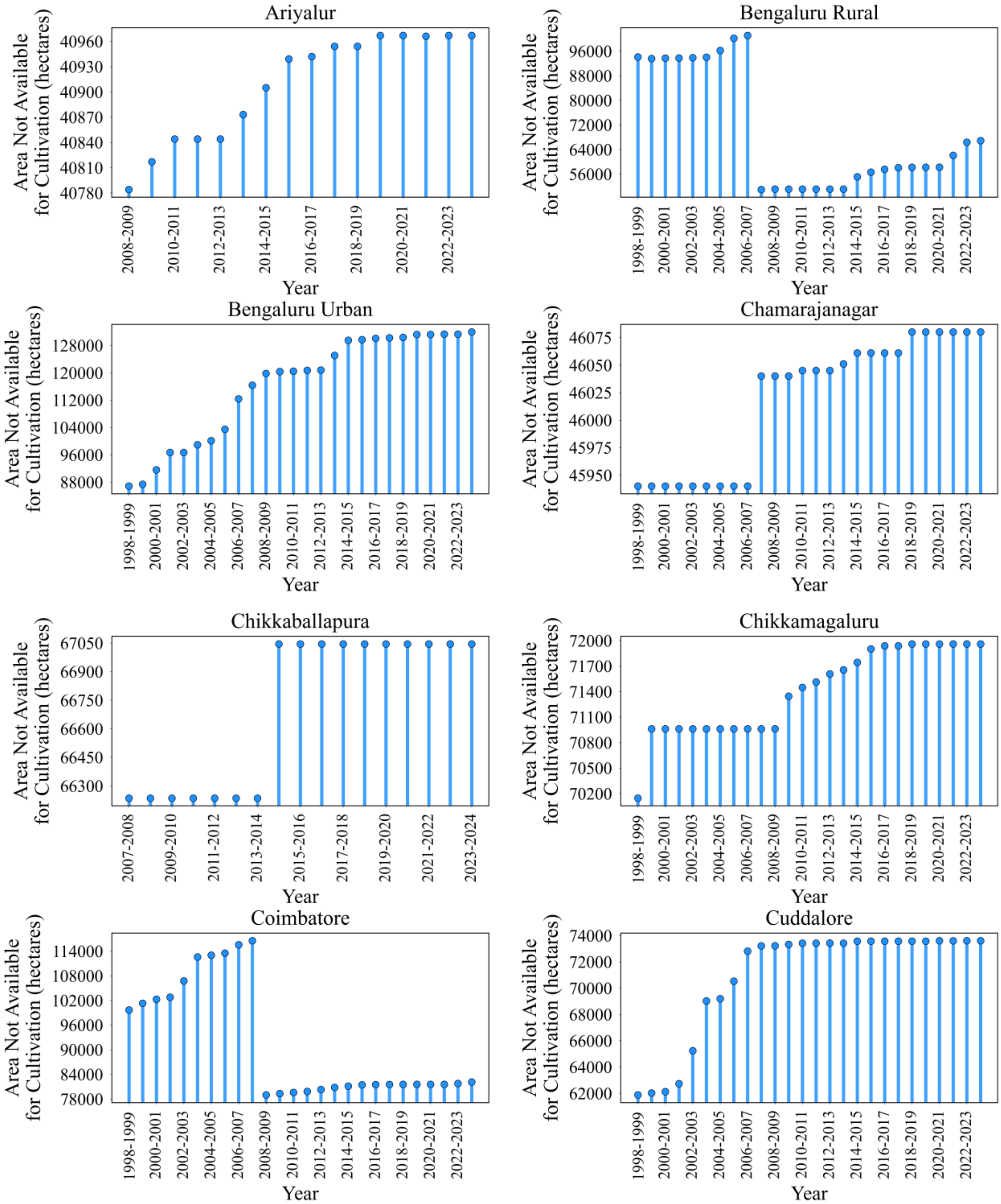


Fig. 41. Time-series plots of non-cultivable area (ha) for Ariyalur, Bengaluru Rural, Bengaluru Urban, Chamarajanagar, Chikkaballapura, Chikkamagaluru, Coimbatore, and Cuddalore districts

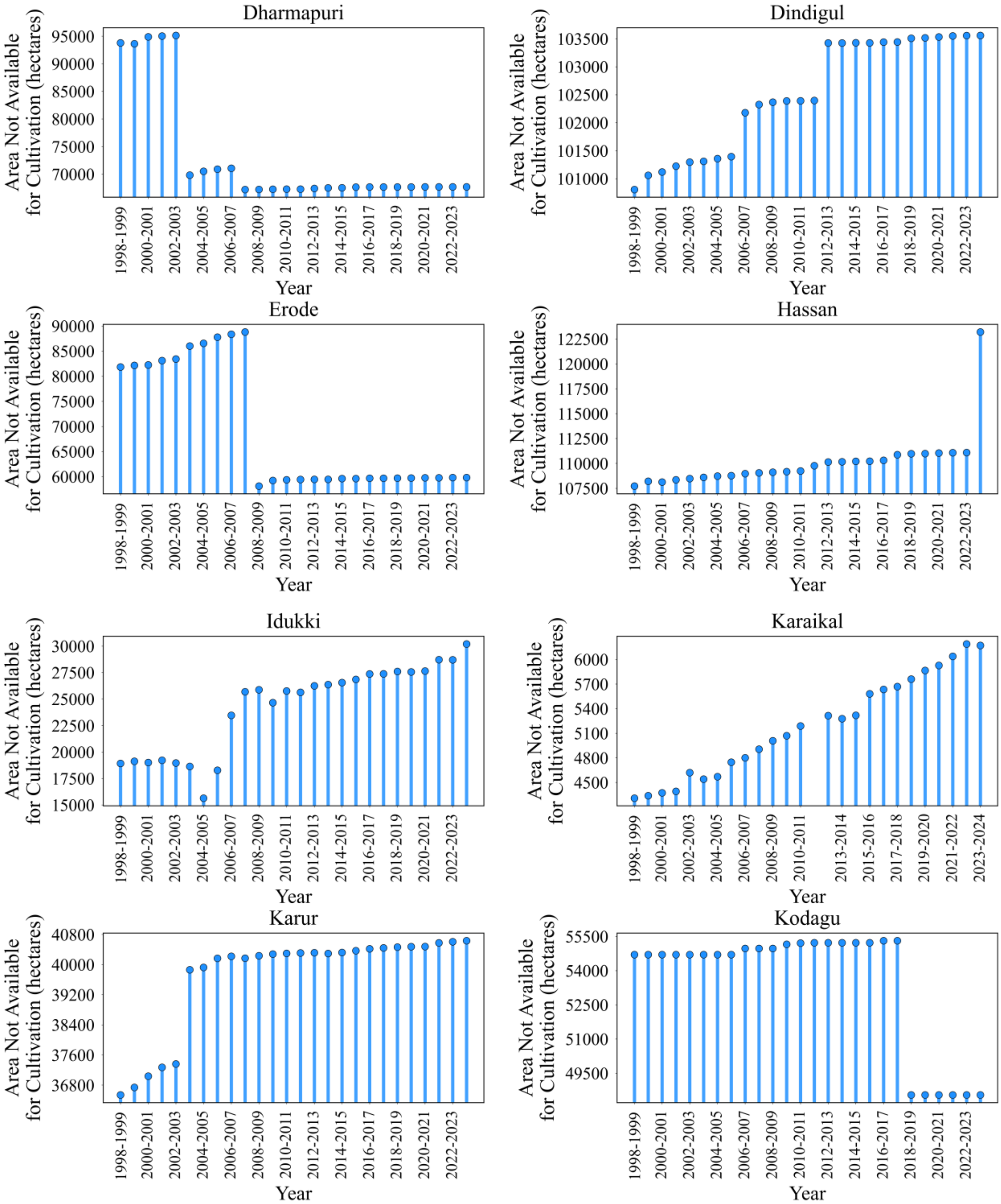


Fig. 42. Time-series plots of non-cultivable area (ha) for Dharmapuri, Dindigul, Erode, Hassan, Idukki, Karaikal, Karur, and Kodagu districts

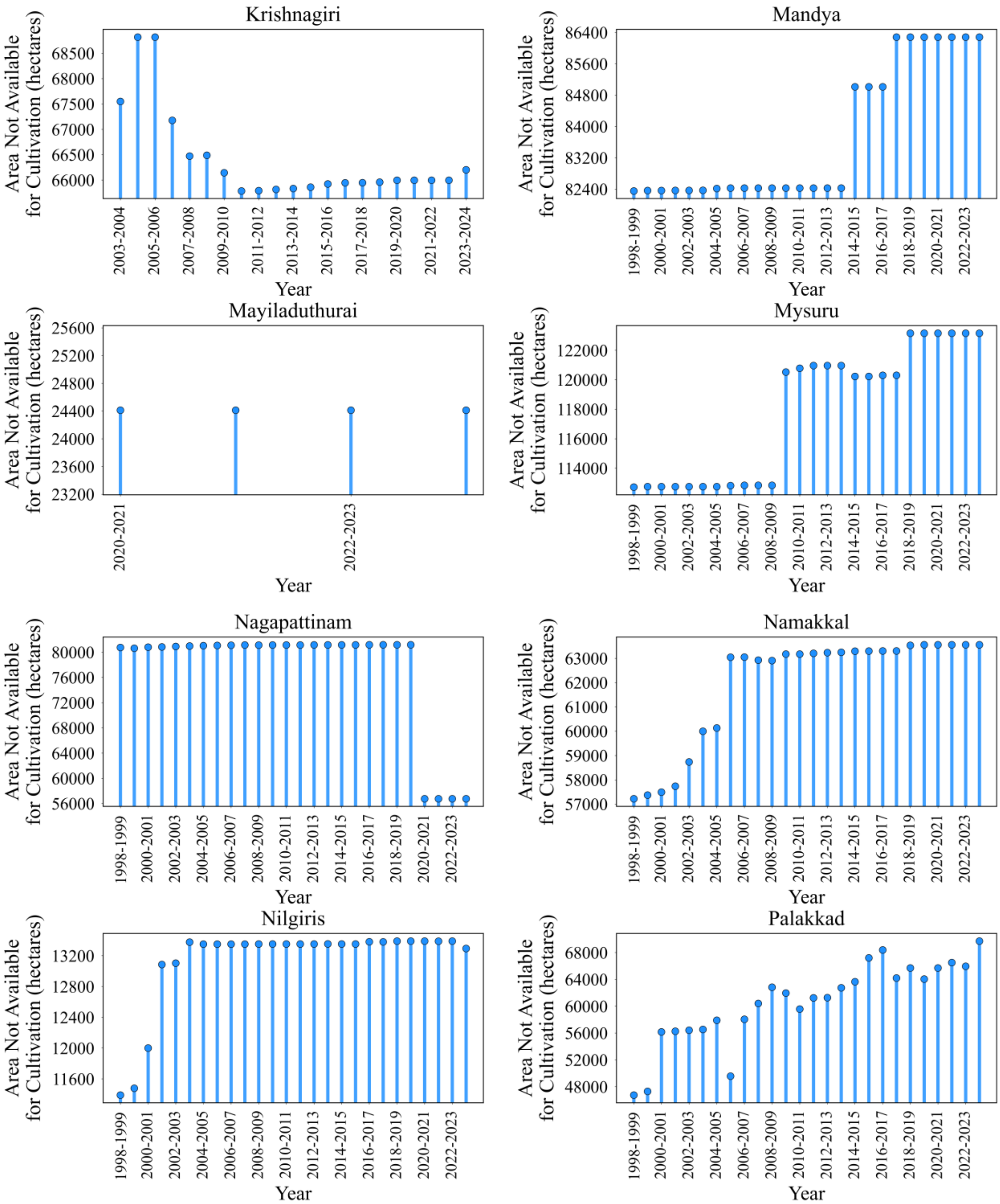


Fig. 43. Time-series plots of non-cultivable area (ha) for Krishnagiri, Mandya, Mayiladuthurai, Mysuru, Nagapattinam, Namakkal, Nilgiris, and Palakkad districts

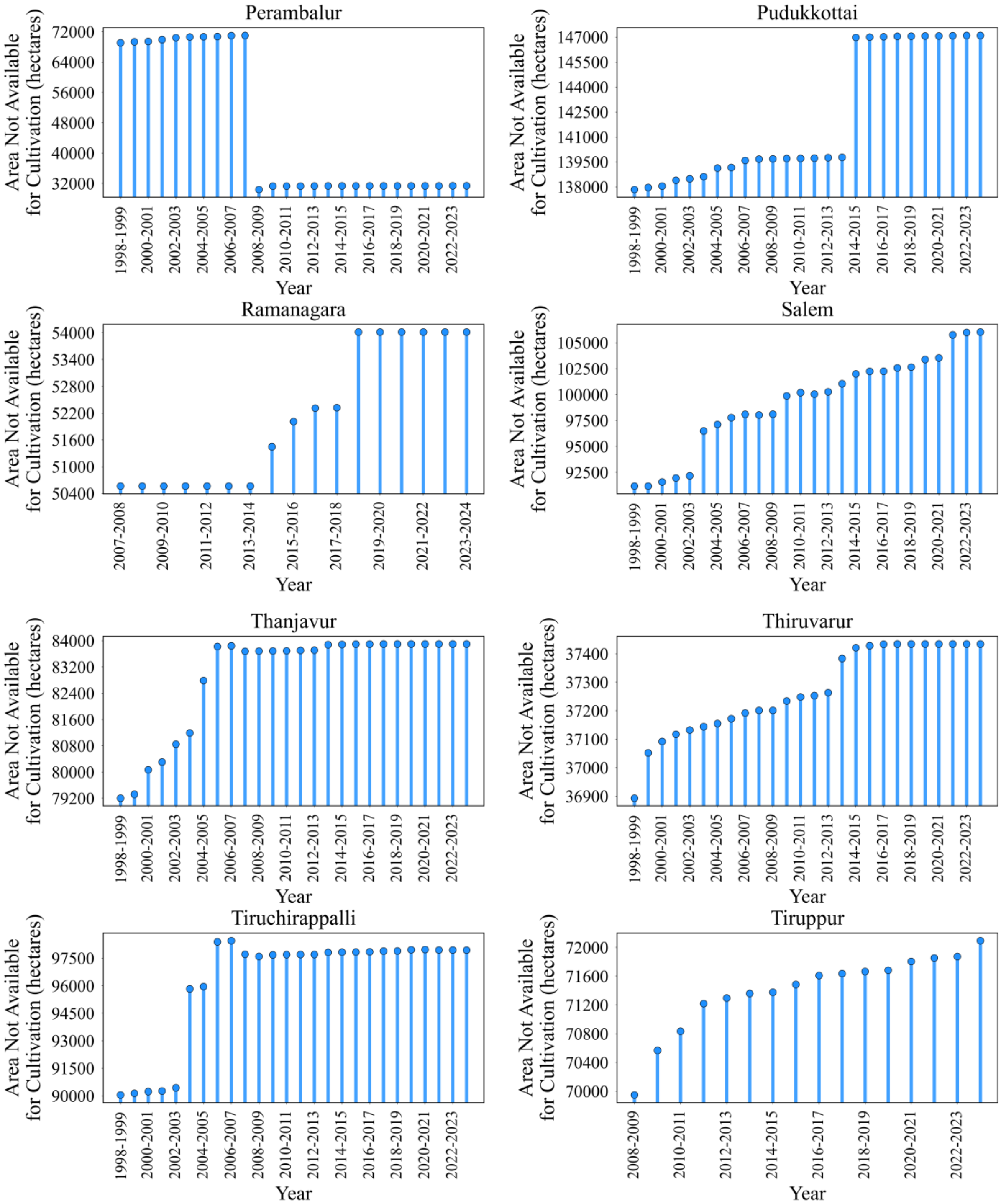


Fig. 44. Time-series plots of non-cultivable area (ha) for Perambalur, Pudukkottai, Ramanagara, Salem, Thanjavur, Thiruvarur, Tiruchirappalli, and Tiruppur districts

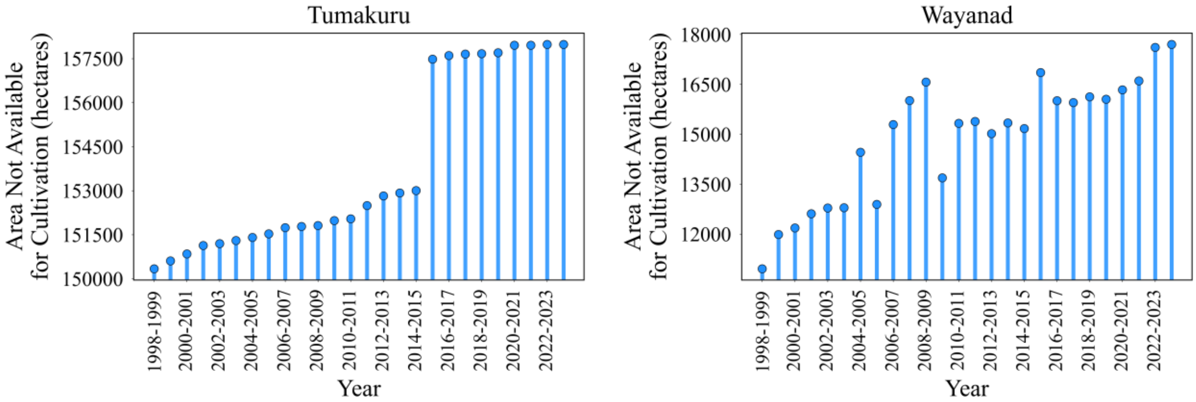


Fig. 45. Time-series plots of non-cultivable area (ha) for Tumakuru and Wayanad districts

2.4. Area Under Waterbodies

The spatial distribution of major LULC classes, namely waterbodies, built-up land, barren land, cropland, and forest for the CRB is illustrated for 1992 in Fig. 46a and for 2022 in Fig. 46b. The LULC data were derived from the European Space Agency (ESA) Climate Change Initiative (CCI) dataset at a spatial resolution of 300 m.

Over the study period, the area under waterbodies remains largely stable, exhibiting only minor interannual variability (Fig. 47). The areal extent of waterbodies fluctuates within a narrow range, from approximately 155,900 ha in the early 1990s to a maximum of 159,499 ha in 2022. Slight declines are evident during the late 1990s and mid-2000s, while modest increases are observed after 2011. Overall, waterbodies show negligible long-term expansion, with a compound annual growth rate (CAGR) of only ~0.08%, corresponding to an average increase of approximately 120 ha yr^{-1}.

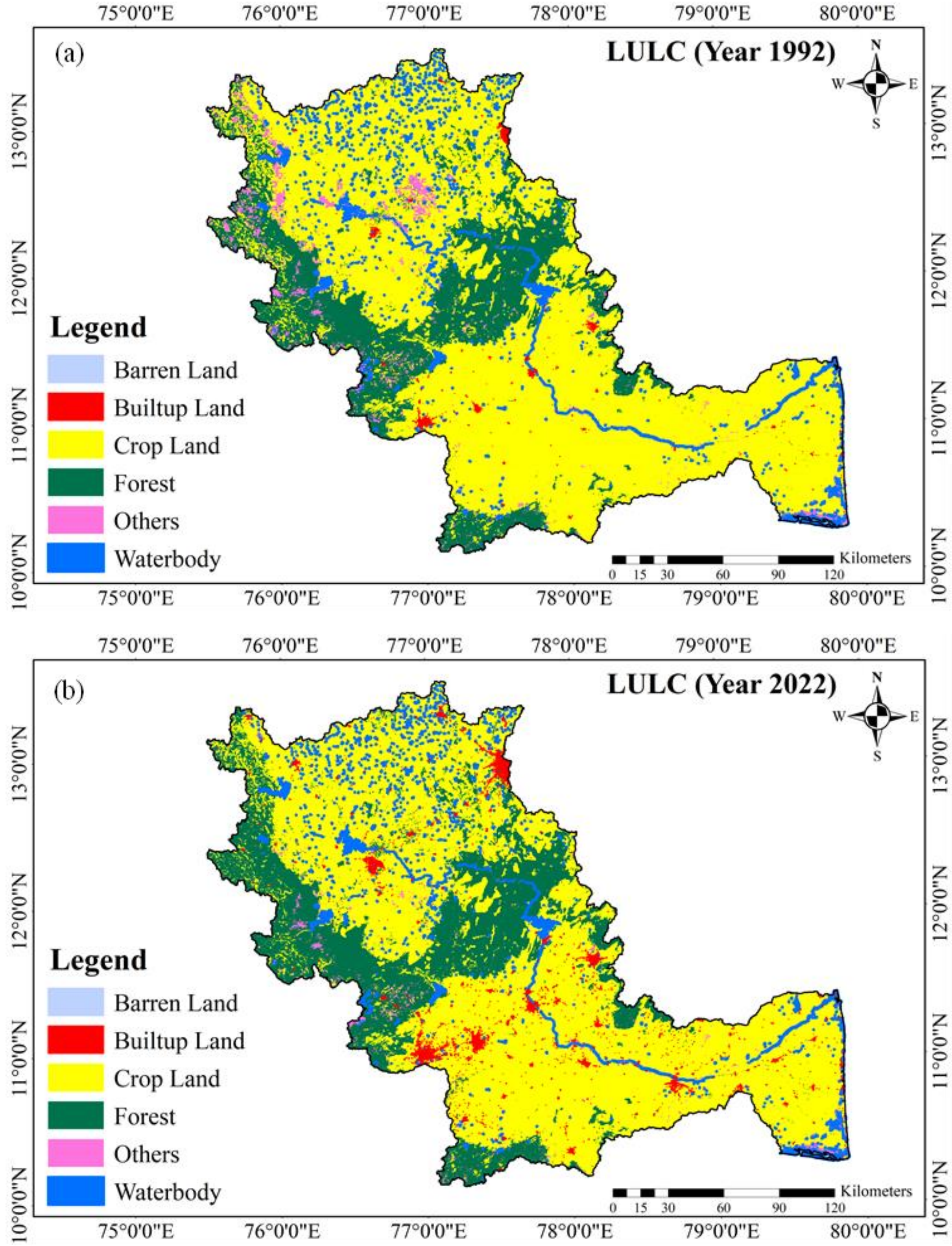


Fig. 46. LULC maps depicting the spatial distribution of waterbodies and built-up areas during (a) 1992 and (b) 2022

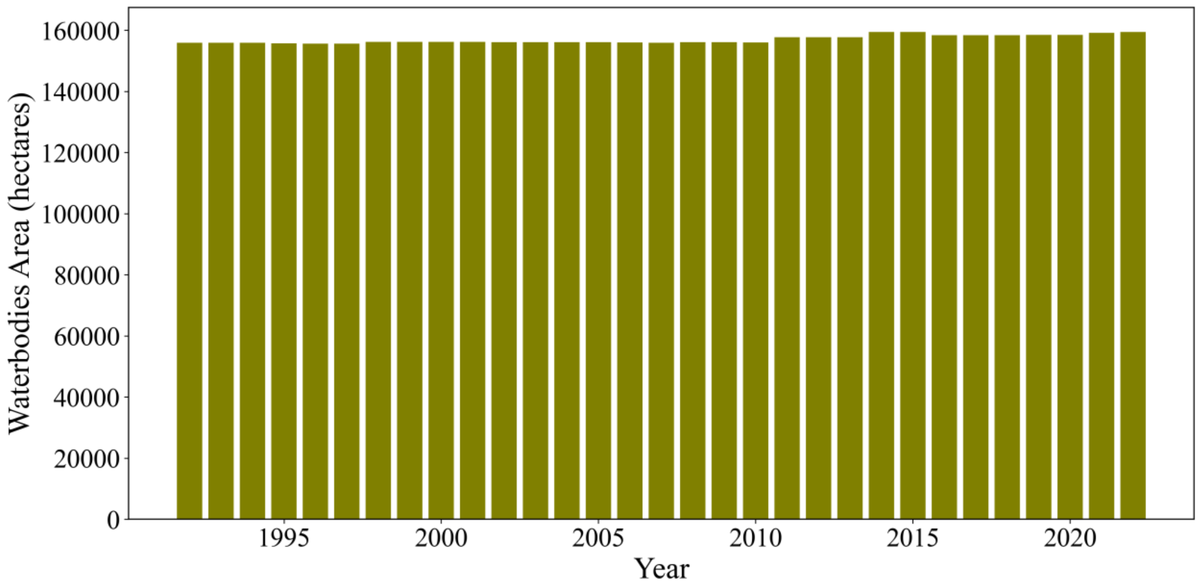


Fig. 47. Time-series plots showing changes in waterbody area (ha) across the CRB from 1992 to 2022

2.5. Area Under Built-Up Land

The built-up area within the CRB exhibits a strong and persistent expansion over the period 1992-2022, reflecting rapid urbanisation and land transformation. The analysis is based on the ESA CCI land cover dataset, which provides consistent long-term observations of the dynamics of different LULC classes. The total built-up extent increased from 30,430.6 ha in 1992 to 132,449 ha in 2022, corresponding to a net increase of over 102,000 ha (Fig. 48).

Temporal analysis reveals distinct phases in the expansion of built-up land. During the 1990s, growth was relatively gradual, consistent with moderate urban expansion and limited industrial development. However, a marked acceleration is observed after 2000, coinciding with economic liberalization, infrastructural investments, and population growth across major urban and peri-urban centres. Particularly rapid expansion phases are evident during 2001-2007, 2011-2015, and 2020-2022, suggesting episodic surges.

The pronounced increase in built-up area during the last decade highlights escalating anthropogenic pressure on land resources, often at the expense of agricultural land, fallow land, and other natural or semi-natural surfaces. This expansion has important implications for regional hydrology, including reduced infiltration, increased surface runoff, and heightened vulnerability to urban flooding, as well as potential impacts on groundwater recharge and water demand.

Overall, the built-up area expanded at a CAGR of approximately 5.0%, equivalent to an average increase of about 3,400 ha yr^{-1} between 1992 and 2022. The sustained and accelerating nature of this trend emphasizes the need for integrated land-use planning and water-resource management to mitigate the long-term environmental consequences of rapid urban growth in the basin.

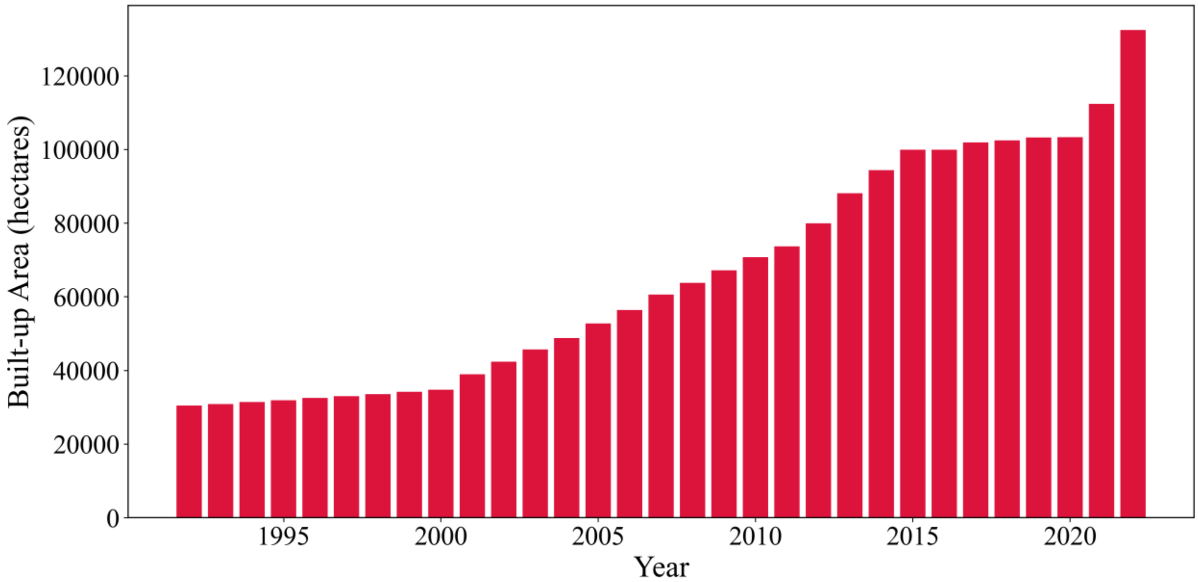


Fig. 48. Time-series plots showing changes in built-up area (ha) across the CRB from 1992 to 2022

2.6. Area Under Barren Land

Fig. 49 presents the temporal variation in barren land (ha) across complete administrative districts lying within the CRB from 1998-99 to 2023-24. The dataset was sourced from the Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, GoI.

Overall, a net decline in barren land area is observed in several districts (Figs. 50-54). The most pronounced reduction occurs in Bengaluru Rural, where barren land decreased sharply from 36,760 ha to 11,124 ha, representing a decline of 25,636 ha. Dharmapuri also shows a substantial decrease of 28,042 ha (from 43,846 ha to 15,804 ha). Other districts exhibiting notable declines include Perambalur (-8,597 ha), Coimbatore (-5,474 ha), Idukki (-2,848 ha), Tiruchirappalli (-3,206 ha), Salem (-3,405 ha), Erode (-1,231 ha), Palakkad (-1,662 ha), and Wayanad (-270 ha). These declines suggest progressive reclamation, land-use conversion, or reclassification of previously barren lands.

In contrast, net increases in barren land are limited to only two districts. Mysuru shows an increase from 45,812 ha to 47,871 ha, amounting to 2,059 ha, while Nilgiris records a rise from 2,915 ha to 3,295 ha, corresponding to an increase of 380 ha.

Several districts exhibit complete long-term stability, with identical barren land areas over the study period. These include Ariyalur (8,523 ha), Chamarajanagar (21,434 ha), Chikkamagaluru (28,322 ha), Dindigul (36,210 ha), Pudukkottai (9,863 ha), Tumakuru (67,539 ha), and Thiruvarur (113 ha). Such stability indicates minimal land-use transformation within the barren land category in these districts.

Area Under Barren Land (hectares)

Districts	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
Ariyalur											8523	8523	8523
Bengaluru Rural	36760	35663	35663	35663	35663	35663	35663	35463	35463	11124	11124	11124	11124
Bengaluru Urban	7358	5558	4747	4885	4885	4885	4885	4931	4911	4911	4911	4911	4911
Chamarajanagar	21434	21434	21434	21434	21434	21434	21434	21434	21434	21434	21434	21434	21434
Chikkaballapura										34302	34302	34302	34302
Chikkamagaluru	28322	28322	28322	28322	28322	28322	28322	28322	28322	28322	28322	28322	28322
Coimbatore	10271	10257	10265	10182	10185	10155	10144	7464	7475	6639	4787	4787	4793
Cuddalore	14647	14647	14647	14647	14647	14647	14647	14647	14647	14647	14647	14647	14623
Dharmapuri	43846	42846	43846	43846	43842	19648	19648	19648	19648	15804	15804	15804	15804
Dindigul	36210	36210	36210	36210	36210	36210	36210	36210	36210	36210	36210	36210	36210
Erode	7501	7246	7073	7073	7067	7055	7074	7074	7063	7006	6293	6270	6270
Hassan	31550	31550	30359	30359	30359	30365	30365	30365	30365	30365	30365	30365	30365
Idukki	4251	4136	3763	3893	3690	3328	2997	2702	2434	2615	2181	2116	1963
Karaikal													
Karur	2906	2906	2906	2906	2906	2906	2901	2901	2901	2814	2814	2814	2815
Kodagu	31010	31010	31010	31010	31010	31010	31010	31010	31010	31010	31010	31010	31010
Krishnagiri						26682	26679	26679	25016	24306	24307	23957	23937
Mandya	21602	21584	21569	21551	21538	21533	21529	21519	21519	21519	21519	21519	21519
Mayiladuthurai													
Mysuru	45812	45812	45812	45812	45812	45812	45812	45812	45812	45812	45812	45812	45018
Nagapattinam	33571	33419	33419	33419	33419	33419	33419	33419	33419	33419	33419	33419	33418
Namakkal	24743	24743	24743	24743	24743	24743	24743	24743	24743	24576	24539	24539	24539
Nilgiris	2915	2915	2915	3368	3371	3384	3375	3375	3375	3375	3375	3375	3375
Palakkad	3037	3402	3600	3436	3393	3297	3912	3541	3121	2902	3213	3451	2756
Perambalur	11383	11382	11382	11382	11388	11388	11388	11388	11457	11313	2787	2787	2787
Pudukkottai	9863	9863	9863	9863	9863	9863	9863	9863	9863	9863	9863	9863	9863
Ramanagara										24339	24339	24339	24339
Salem	41603	41603	41603	41601	41599	39098	39098	39098	39044	38894	38894	38894	38894
Thanjavur	2201	2201	2201	2201	2201	2201	2197	2149	2149	2149	2149	2149	2149
Thiruvarur	113	113	113	113	113	113	113	113	113	113	113	113	113
Tiruchirappalli	15732	15732	15732	15732	15749	14863	14863	13599	13599	12745	12620	12598	12598
Tiruppur											2542	2542	2541
Tumakuru	67539	67539	67539	67539	67539	67539	67539	67539	67539	67539	67539	67539	67539
Wayanad	356	338	268	280	294	273	248	228	274	247	195	206	171

Districts	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
Ariyalur	8523	8523	8523	8523	8523	8523	8523	8523	8523	8523	8523	8523	8523
Bengaluru Rural	11124	11124	11124	11124	11124	11124	11124	11124	11124	11124	11124	11124	11124
Bengaluru Urban	4911	4911	4911	4911	4911	4911	4911	4911	5778	5778	5778	5778	5778
Chamarajanagar	21434	21434	21434	21434	21434	21434	21434	21434	21434	21434	21434	21434	21434
Chikkaballapura	34302	34302	34302	34302	34302	34302	34302	34302	34302	34302	34302	34302	34302
Chikkamagaluru	28322	28322	28322	28322	28322	28322	28322	28322	28322	28322	28322	28322	28322
Coimbatore	4793	4793	4793	4793	4798	4798	4798	4798	4798	4798	4797	4797	4797
Cuddalore	14623	14623	14623	14623	14623	14623	14623	14623	14623	14623	14623	14623	14623
Dharmapuri	15804	15804	15804	15804	15804	15803	15804	15804	15804	15804	15804	15804	15804
Dindigul	36210	36210	36210	36210	36210	36209	36210	36210	36210	36210	36210	36210	36210
Erode	6270	6270	6270	6270	6270	6270	6270	6270	6270	6270	6270	6270	6270
Hassan	30365	30365	30365	30365	30365	30365	30365	30365	30365	30365	30365	30365	30365
Idukki	1808	1807	1833	1606	1515	1440	1404	1364	1338	1338	1368	1270	1403
Karaikal				0	0		0	0	0				
Karur	2815	2815	2785	2785	2785	2786	2785	2785	2786	2786	2786	2786	2786
Kodagu	31010	31010	31010	31010	31010	31010	31010	24250	24250	24250	24250	24250	24250
Krishnagiri	23937	23937	23937	23937	23937	23937	23937	23937	23938	23938	23938	23938	23938
Mandya	21519	21519	21519	21519	21519	21519	21519	21519	21519	21519	21519	21519	21519
Mayiladuthurai										751	751	751	751
Mysuru	45018	45018	45018	45018	45018	45018	45018	47871	47871	47871	47871	47871	47871
Nagapattinam	33418	33418	33418	33418	33418	33419	33418	33418	33418	32667	32667	32667	32669
Namakkal	24539	24539	24539	24539	24539	24539	24539	24539	24539	24539	24539	24539	24539
Nilgiris	3375	3375	3375	3375	3375	3402	3402	3402	3402	3402	3402	3402	3295
Palakkad	2458	2175	1795	1912	2459	2003	1538	1498	1286	1334	1487	1171	1375
Perambalur	2787	2787	2786	2786	2786	2787	2786	2786	2786	2786	2786	2786	2786
Pudukkottai	9863	9863	9863	9863	9863	9863	9863	9863	9863	9863	9863	9863	9863
Ramanagara	24339	24339	24339	24339	24339	24339	24339	24339	24339	24339	24339	24339	24339
Salem	38198	38198	38198	38198	38198	38198	38198	38198	38198	38198	38198	38198	38198
Thanjavur	2149	2149	2149	2149	2149	2149	2149	2149	2149	2149	2149	2149	2149
Thiruvarur	113	113	113	113	113	113	113	113	113	113	113	113	113
Tiruchirappalli	12598	12598	12598	12598	12598	12598	12598	12598	12598	12598	12534	12534	12526
Tiruppur	2541	2541	2541	2541	2548	2548	2548	2548	2548	2548	2548	2548	2548
Tumakuru	67539	67539	67539	67539	67539	67539	67539	67539	67539	67539	67539	67539	67539
Wayanad	137	112	71	59	78	87	97	41	59	39	33	59	86

Fig. 49. District-wise temporal variation in barren land (ha) from 1998-99 to 2023-24 across the CRB

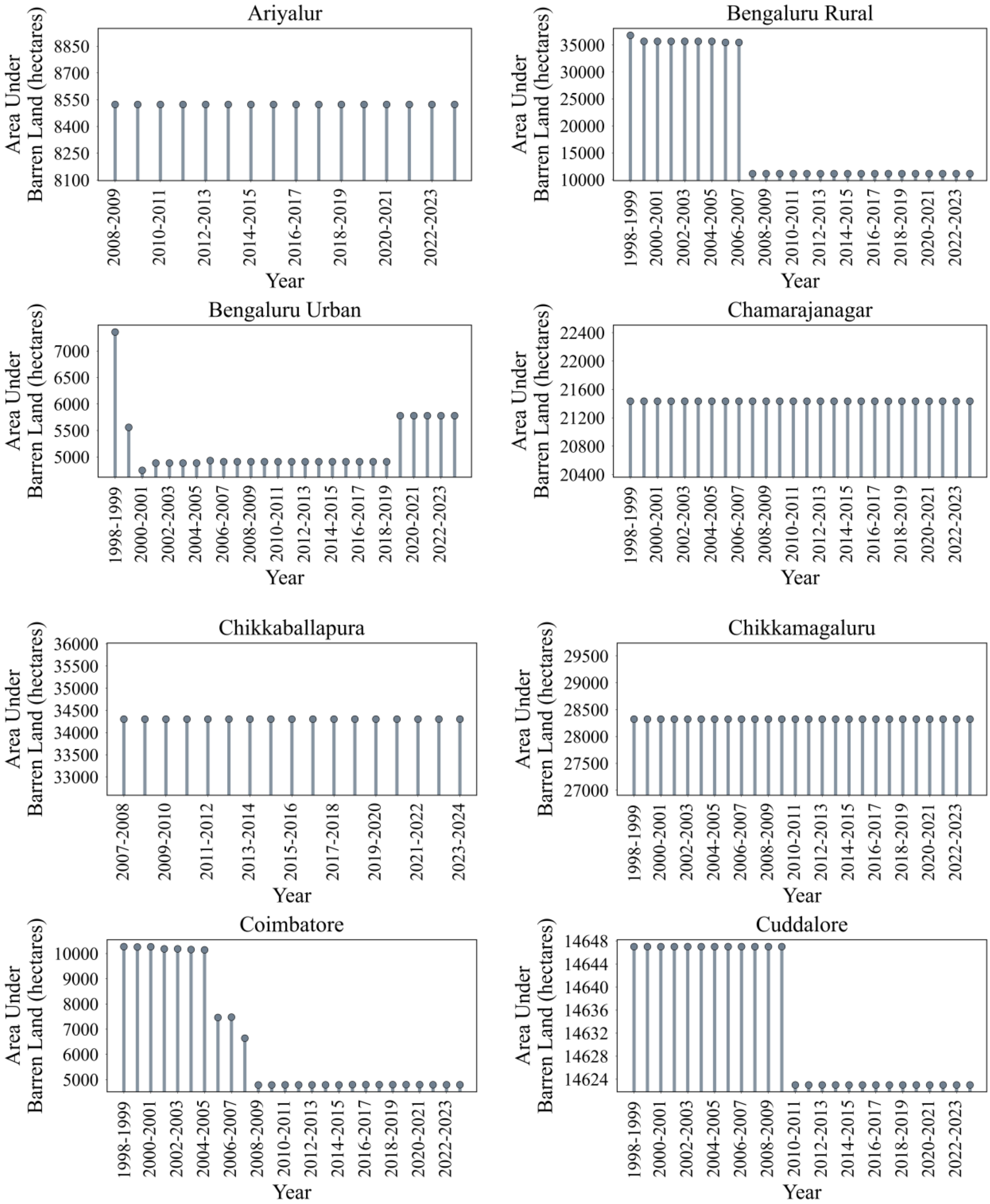


Fig. 50. Time-series plots of barren land (ha) for Ariyalur, Bengaluru Rural, Bengaluru Urban, Chamarajanagar, Chikkaballapura, Chikkamagaluru, Coimbatore, and Cuddalore districts

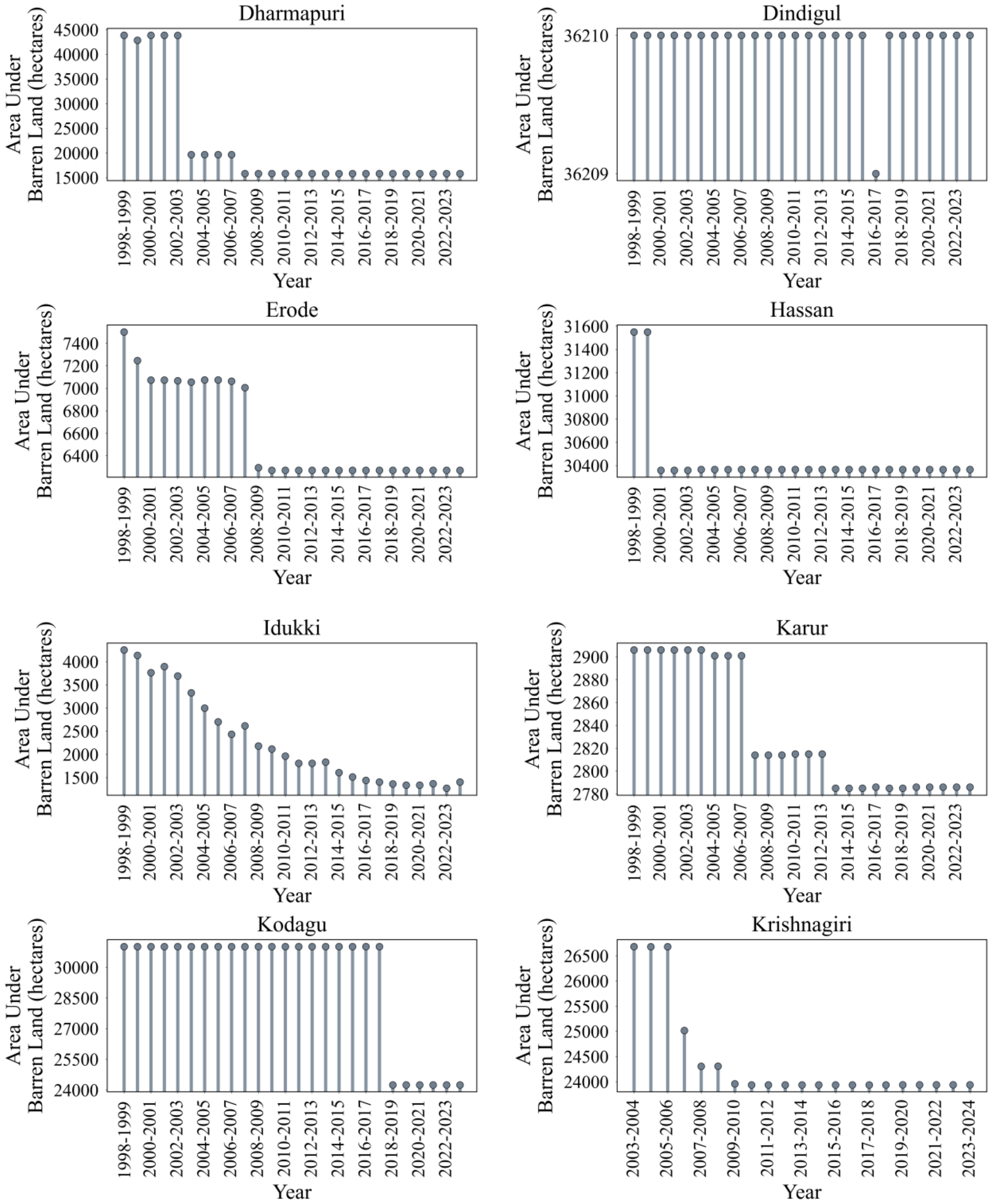


Fig. 51. Time-series plots of barren land (ha) for Dharmapuri, Dindigul, Erode, Hassan, Idukki, Karur, Kodagu, and Krishnagiri districts

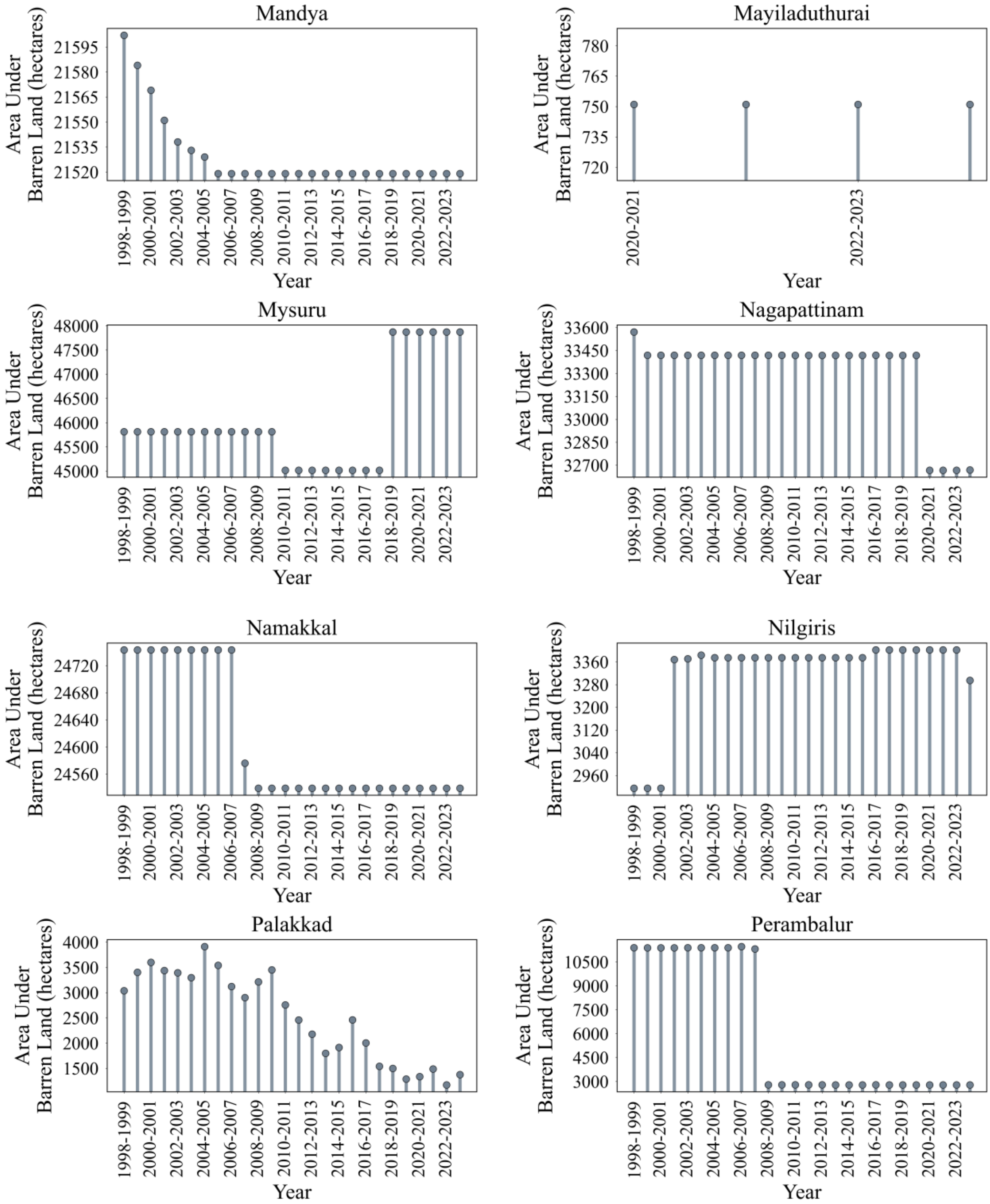


Fig. 52. Time-series plots of barren land (ha) for Mandya, Mayiladuthurai, Mysuru, Nagapattinam, Namakkal, Nilgiris, Palakkad and Perambalur districts

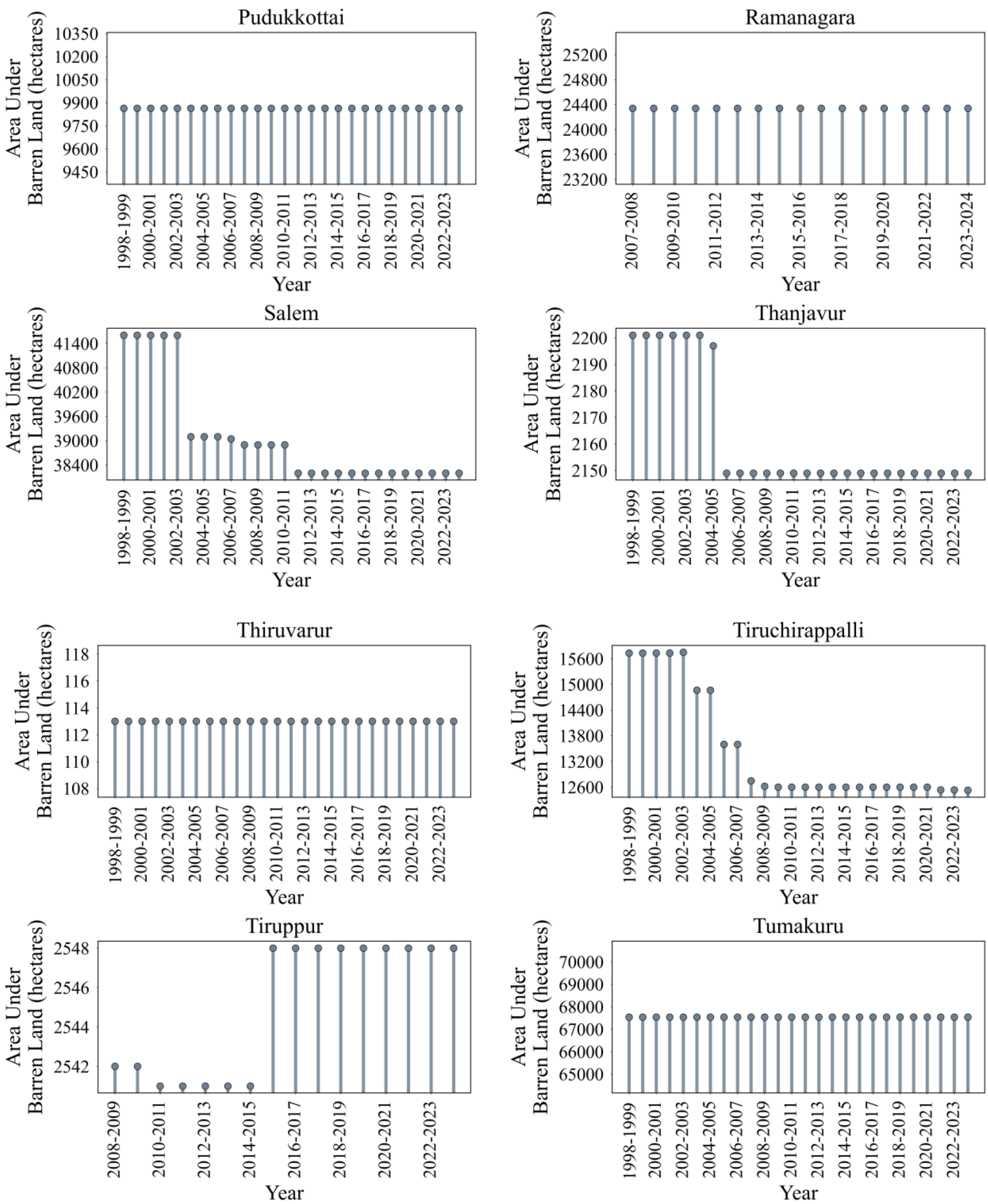


Fig. 53. Time-series plots of barren land (ha) for Pudukkottai, Ramanagara, Salem, Thanjavur, Thiruvarur, Tiruchirappalli, Tiruppur, and Tumakuru districts

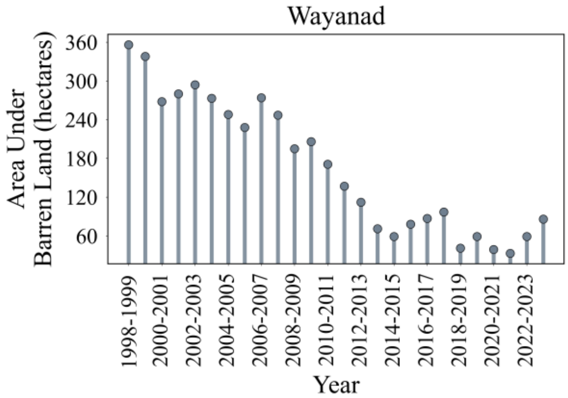


Fig. 54. Time-series plot of barren land (ha) for Wayanad district

3. Productions of Different Crops

3.1. Area Under Cash Crop

For districts of Karnataka that lie within the CRB, the major cash crops are sugarcane and cotton (Department of Agriculture, Government of Karnataka). Similarly, in Tamil Nadu, districts within the CRB predominantly cultivate banana, coconut, sugarcane, cotton, maize, and groundnut as cash crops (Department of Agriculture & Farmers Welfare, Government of Tamil Nadu). Table 1 presents the district-wise temporal variation in area (ha) under sugarcane cultivation across Karnataka districts within the CRB during 2011-12 to 2023-24. Sugarcane, being a water-intensive cash crop, exhibits pronounced spatial and temporal variability across the basin, reflecting differences in irrigation infrastructure, agro-climatic suitability, and market-driven cropping decisions.

Mandya district consistently dominates sugarcane cultivation throughout the study period, maintaining the largest area under the crop. Although interannual fluctuations are evident, Chamarajanagar emerges as another major sugarcane-growing district, exhibiting substantial variability over time. After a decline during the mid-2010s, sugarcane area expanded sharply post-2017-18, reaching a maximum of 16,589 ha in 2022-23, followed by a moderate decline in 2023-24. Mysuru also shows a significant presence of sugarcane cultivation, with area expanding notably after 2017-18 and peaking at 23,109 ha in 2021-22, before declining in recent years.

Hassan displays moderate but fluctuating sugarcane area, with notable increases during 2018-20, followed by a gradual decline thereafter. In contrast, Chikkamagaluru records a steady long-term reduction, declining from over 3,000 ha in the early 2010s to less than 200 ha by

2023-24, indicating a possible shift away from sugarcane towards less water-intensive crops or plantation systems.

Districts such as Ramanagara, Tumakuru, and Chikkaballapura maintain relatively smaller extents under sugarcane, characterised by high year-to-year variability and an overall declining trend, suggesting limited suitability or increasing irrigation constraints. Bengaluru Rural and Bengaluru Urban exhibit negligible sugarcane cultivation throughout the period, reflecting rapid urbanisation, declining agricultural land availability, and competition for water resources.

Kodagu shows virtually no sugarcane cultivation, consistent with its plantation-dominated cropping system and agro-ecological conditions that are unfavourable for sugarcane. Overall, the spatial pattern indicates a strong concentration of sugarcane cultivation in canal-irrigated districts of southern Karnataka, while peripheral and urbanising districts show marginal or declining participation.

Table 1. Area under sugarcane cultivation (ha) in Karnataka districts within the CRB

Crop	District	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
Sugarcane	Bengaluru Rural	4	6	11	6	60	39	45	9	149	114	138	192	167
	Bengaluru Urban	7	20	5	3	3	7	2	43	68	41	33	30	20
	Chamarajanagar	15951	11215	7300	7913	5598	4585	6788	11443	11200	10483	13231	16589	10896
	Chikkaballapura	202	212	73	58	101	96	205	189	108	95	232	172	112
	Chikkamagaluru	2426	3089	2937	2504	2181	1810	1662	643	500	332	292	259	138
	Hassan	5352	4149	4587	2600	1526	2042	2191	4055	4574	3285	4471	4087	2688
	Kodagu	-	-	-	-	-	-	-	-	1	-	1	-	-
	Mandya	43349	40879	33519	37124	36678	22874	20941	56474	61327	59040	59477	56228	51878
	Mysuru	15709	15621	12909	10232	9404	5596	4150	13469	16764	17031	23109	21100	14967
	Ramanagara	1199	1069	768	1032	751	214	221	448	441	320	408	372	191
	Tumakuru	2546	2653	2126	2175	324	862	1146	879	581	574	512	409	326

Table 2 presents the district-wise temporal variation in area (ha) under cotton cultivation across Karnataka districts within the CRB for the period 2011-12 to 2023-24. Cotton cultivation is highly unevenly distributed across the basin, with a strong concentration in a limited number of interior districts. Chamarajanagar consistently records the largest area under cotton cultivation throughout the study period. Following a steady expansion during the early 2010s, cotton area peaked at 15,062 ha in 2014-15, followed by a gradual contraction, declining to 5,755 ha by 2023-24.

Mandya also emerges as a major cotton-growing district, maintaining relatively high cultivated area during the early part of the study period. However, a pronounced decline is observed after 2017-18, with area reducing from 14,465 ha to 5,046 ha by 2023-24, indicating a significant shift away from cotton cultivation, possibly linked to water constraints, pest pressures, or changing crop economics.

Kodagu exhibits substantial but highly variable cotton area, with pronounced peaks in 2017-18 and 2022-23, followed by sharp declines. Mysuru shows moderate but fluctuating cotton cultivation, with a notable expansion during 2019-20, before contracting in subsequent years. Chikkamagaluru shows a sharp rise to 3,824 ha in 2022-23, followed by a decline in 2023-24.

On the other hand, Hassan and Ramanagara maintain comparatively smaller cotton areas and exhibit an overall declining trend, indicating limited long-term suitability or economic viability of cotton in these districts. Chikkaballapura and Tumakuru consistently record low cotton cultivation, marked by high interannual variability but negligible long-term change. Bengaluru Rural and Bengaluru Urban show negligible cotton cultivation throughout the study period. Overall, cotton cultivation within the CRB is spatially concentrated in a few interior districts and demonstrates a general contraction in recent years.

Table 2. Area under cotton cultivation (ha) in Karnataka districts within the CRB

Crop	District	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
Cotton	Bengaluru Rural	-	-	2	-	2	-	-	3	3	2	1	2	-
	Bengaluru Urban	-	-	-	-	-	-	-	14	3	-	-	2	2
	Chamarajanagar	6582	7374	10166	15062	13584	8975	10014	7097	10091	9370	7496	8823	5755
	Chikkaballapura	196	155	160	67	107	109	40	118	223	145	217	508	621
	Chikkamagaluru	1026	1159	1299	1843	1364	1570	1883	1688	1068	1015	1783	3824	1956
	Hassan	1434	558	348	439	470	466	458	713	461	366	346	563	321
	Kodagu	5784	5067	8614	6978	7210	5587	10971	5907	5785	4200	4835	6122	3611
	Mandya	11028	13662	12486	11681	10866	11824	14465	9230	8027	3957	5304	5985	5046
	Mysuru	2799	2155	2096	5014	4835	5064	5133	5273	8069	3944	4309	5409	3630
	Ramanagara	848	696	568	1095	796	688	755	988	1162	717	1144	1581	748
	Tumakuru	88	64	281	400	354	97	125	48	353	435	677	1591	661

Table 3 presents the district-wise temporal variation in area (ha) under banana cultivation across Tamil Nadu districts lying within the CRB for the period 2011-12 to 2023-24. Erode records the largest area under banana cultivation throughout the study period. The cultivated area increases steadily from 5,246 ha in 2011-12 to 22,053 ha in 2023-24. Coimbatore also maintains a substantial banana area, with moderate fluctuations during the mid-2010s followed by a marked expansion after 2019-20, reaching 9,784 ha by 2023-24.

Several districts display moderate but relatively stable banana cultivation. Tiruchirappalli shows a gradual decline after 2012-13, decreasing from 8,870 ha to 5,918 ha by 2023-24. Dindigul and Thanjavur show comparatively stable trends with mild interannual variability, indicating sustained banana cultivation. Cuddalore exhibits a gradual increase over time, rising from 4,133 ha to 5,620 ha.

Notable expansions in banana area are observed in Salem, where cultivation increases from 2,374 ha in 2011-12 to 3,729 ha in 2023-24, and in Tiruppur, which shows a steady post-2017 expansion, reaching 3,464 ha by 2023-24. Namakkal also records a gradual increase after mid-decade, reflecting growing horticultural diversification.

In contrast, Karur exhibit long-term decline in banana area, suggesting shifts toward alternative crops or constraints related to water availability. Dharmapuri shows a marked reduction during the early part of the study period, followed by a gradual recovery after 2018-19, indicating partial revival of banana cultivation. Nagapattinam records very low banana area throughout the study period, with a sharp decline after 2019-20.

Nilgiris and Thiruvarur maintain low but stable banana areas, indicating niche or localised cultivation.

Table 3. Area under banana cultivation (ha) in Tamil Nadu districts within the CRB

Crop	District	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
Banana	Ariyalur	144	154	131	156	178	167	157	160	165	176	185	179	172
	Coimbatore	8634	8351	7412	8115	8199	7935	6288	5741	7071	7012	7731	9123	9784
	Cuddalore	4133	3982	4251	4348	4481	4665	4649	5095	4945	5182	5422	5437	5620
	Dharmapuri	838	735	619	416	526	709	663	295	318	329	593	1165	1392
	Dindigul	5307	5198	4037	3584	3545	3312	2870	3074	3475	3785	4045	4345	4440
	Erode	5246	12098	10426	11150	12335	11628	10613	12950	14116	15272	17608	20075	22053
	Karur	4812	4036	2666	2909	3222	3350	2239	2420	2420	2593	2390	2598	2665

	Krishnagiri	1768	1455	920	878	713	718	599	590	376	513	644	772	748
	Mayiladuthurai	-	-	-	-	-	-	-	-	-	579	563	544	524
	Nagapattinam	645	636	575	549	566	595	539	548	634	69	74	106	74
	Namakkal	2928	1774	1716	1299	1784	1792	1374	1914	2592	2424	2555	2665	2743
	Perambalur	188	234	182	169	178	203	176	219	231	236	165	266	286
	Pudukkottai	3123	2505	2303	2255	2209	1704	1662	2439	2550	2208	2127	2019	1888
	Salem	2374	2409	1658	1525	1572	1263	988	1322	1711	2324	2847	3175	3729
	Thanjavur	3212	3087	3176	3318	3434	3335	3217	3919	4282	3989	3811	3516	3934
	Nilgiris	883	694	622	939	862	732	618	572	621	597	709	638	740
	Thiruvarur	422	392	359	355	396	418	413	377	372	385	375	391	449
	Tiruchirappalli	8767	8870	7144	6914	7002	6777	5692	6649	6335	6113	5724	5991	5918
	Tiruppur	3057	2464	1815	1497	1710	1560	1140	1412	1980	1903	2430	3093	3464

Table 4 presents the district-wise temporal variation in area (ha) under coconut cultivation across Tamil Nadu districts lying within the CRB for the period 2011-12 to 2023-24. Coconut cultivation shows strong spatial concentration and relatively stable long-term trends across most districts.

Coimbatore consistently records the largest area under coconut cultivation throughout the study period, maintaining a high and steadily increasing extent from 82,704 ha in 2011-12 to 93,226 ha in 2023-24. Tiruppur also emerges as a major coconut-growing district, exhibiting continuous expansion from 51,478 ha to 78,663 ha over the study period, indicating rapid growth of plantation-based agriculture. Thanjavur records a stable but gradually increasing coconut area, rising from 33,742 ha to 42,502 ha, reflecting sustained cultivation supported by irrigation infrastructure.

Dindigul and Erode maintain substantial coconut areas with moderate long-term growth. Dindigul shows a steady increase from 29,478 ha to 30,997 ha, while Erode exhibits a more pronounced expansion from 11,368 ha to 19,331 ha, particularly after 2018-19. Karur and Namakkal also show gradual increases.

Salem sustains a largely stable coconut area with minor variations, while Tiruchirappalli experiences a modest long-term decline followed by partial stabilization in recent years. Krishnagiri shows a slight but consistent decline over the study period.

On the other hand, Dharmapuri demonstrates pronounced variability, with a sharp contraction in coconut area during the mid-2010s and a partial recovery after 2017-18, though levels remain below those of the early years. Cuddalore displays a steady downward trend in coconut area, and Nagapattinam records a sustained reduction, indicating a continuing decline in coconut cultivation.

The Nilgiris consistently records negligible coconut area throughout the study period. Newly formed districts such as Mayiladuthurai show stable coconut areas from the onset of their reporting period.

Table 4. Area under coconut cultivation (ha) in Tamil Nadu districts within the CRB

Crop	District	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
Coconut	Ariyalur	323	341	331	331	310	303	310	325	320	322	326	324	327
	Coimbatore	82704	83341	84531	83789	85448	85832	87413	87702	87749	88467	89927	91809	93226
	Cuddalore	2343	1990	1881	1772	1732	1640	1626	1609	1648	1655	1667	1749	1743
	Dharmapuri	7836	7085	5472	6774	8392	7974	7751	9170	7619	6080	5424	5206	5579
	Dindigul	29478	29932	32069	30515	30762	30538	29233	28829	28657	28784	29347	30270	30997
	Erode	11368	12623	13056	12808	13234	14301	14026	14315	14686	15260	16297	17626	19331
	Karur	6155	6312	6641	6557	6564	6640	6747	6793	6735	6749	7310	7648	7853
	Krishnagiri	15550	15834	15781	15526	15558	15611	15525	15167	14767	15005	14598	14644	14613
	Mayiladuthurai	-	-	-	-	-	-	-	-	-	794	769	758	765
	Nagapattinam	4026	3665	3854	3919	3898	3823	3761	3760	3088	2633	2698	2689	2587
	Namakkal	7466	7460	7793	8237	8059	8270	8616	8609	9064	9474	10126	11140	11803
	Perambalur	560	568	715	675	701	693	669	675	663	608	623	635	673
	Pudukkottai	8639	8716	9200	9426	9584	9456	9513	10218	10021	10902	12044	12461	13286
	Salem	14590	14476	14457	13929	13749	13636	13092	12917	12659	12633	12985	13082	12858
	Thanjavur	33742	34747	35237	35726	37210	36136	37346	38116	38777	39962	40977	41414	42502
	Nilgiris	66	64	55	83	94	56	59	56	51	53	53	51	53
	Thiruvarur	4916	4805	4787	4773	4710	4718	4675	4728	5737	5957	5851	5911	6384
	Tiruchirappalli	6648	6574	6487	6241	6249	6070	5704	5493	5123	4865	4975	5048	5119
	Tiruppur	51478	53661	56484	56808	58374	60148	60333	61250	61890	63012	68277	73311	78663

Table 5 presents the district-wise temporal variation in area (ha) under sugarcane cultivation across Tamil Nadu districts lying within the CRB for the period 2011-12 to 2023-24. Erode and Cuddalore consistently emerge as the dominant sugarcane-growing districts throughout the study period. Erode records the highest area in the early years, with 31,541 ha in 2011-12, followed by a sharp decline up to 2017-18. However, the district shows a notable recovery after 2020-21, reaching 20,106 ha in 2023-24, indicating partial revival of sugarcane cultivation. Cuddalore also maintains a large sugarcane area but displays a steady and continuous decline from 31,064 ha in 2011-12 to 14,957 ha in 2023-24, reflecting sustained contraction.

Namakkal represents a relatively stable sugarcane-growing district compared to others. Although the area declines from 19,733 ha in 2011-12, it stabilizes around 10,000-11,000 ha in the later years, suggesting continued suitability for sugarcane production. Salem records a gradual decline from 12,218 ha to 6,427 ha, with minor recovery after 2020-21. Perambalur and Tiruppur also show declining trends, though Tiruppur exhibits a partial rebound in recent years.

Thanjavur, traditionally an important sugarcane district, demonstrates a sharp long-term decline from 10,665 ha in 2011-12 to 2,608 ha in 2023-24, indicating significant withdrawal from sugarcane cultivation. Tiruchirappalli follows a similar pattern, with a reduction from 5,232 ha to 1,694 ha over the study period.

Districts such as Dharmapuri, Dindigul, Karur, Krishnagiri and Tiruchirappalli show pronounced contractions in sugarcane area, losing a substantial share of cultivation after the mid-2010s. Although marginal increases are observed in a few districts after 2020-21, the overall levels remain far below those recorded in the early years.

In contrast, Nagapattinam and the Nilgiris record negligible or near-cessation of sugarcane cultivation in recent years. Overall, the temporal pattern indicates a state-wide decline and spatial concentration of sugarcane cultivation, driven by factors such as water scarcity, high input requirements, and shifts towards alternative crops, with only a few districts demonstrating resilience or partial recovery in recent years.

Table 5. Area under sugarcane cultivation (ha) in Tamil Nadu districts within the CRB

Crop	District	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
Sugarcane	Ariyalur	7967	7804	9875	7493	6147	5824	5108	4541	4318	4214	4417	4403	3397
	Coimbatore	1484	1404	1170	1128	926	792	401	440	462	392	436	381	429
	Cuddalore	31064	30638	30304	27531	24443	21628	18747	17138	15248	14809	15406	15918	14957
	Dharmapuri	20305	16102	8433	5854	7905	8204	8114	4893	1062	1762	2665	4217	4347
	Dindigul	5739	5378	3838	1824	2504	2373	1661	1827	1788	1618	1991	1904	1679
	Erode	31541	31227	23539	21198	22332	19370	8742	12214	12785	14211	18124	19644	20106
	Karur	8130	6576	3372	2520	2723	2345	915	1130	1022	837	1236	1540	1375
	Krishnagiri	2199	1135	840	483	581	862	540	555	308	251	438	419	465
	Mayiladuthurai	-	-	-	-	-	-	-	-	-	281	305	422	526
	Nagapattinam	3079	3421	2962	2576	1899	1062	596	386	258	-	-	3	254
	Namakkal	19733	20299	16544	16849	14268	11817	10152	10813	10111	9806	10072	10625	11183
	Perambalur	6729	6500	5241	6039	8112	5253	4452	3754	2905	3061	3454	3728	3475
	Pudukkottai	9243	9124	6826	5062	4417	3473	3388	2850	2333	1150	1875	1948	1923
	Salem	12218	15485	12652	9433	8255	5961	5755	5600	4341	4768	5325	5828	6427
	Thanjavur	10665	11671	8580	9317	7690	5660	4754	4837	4415	3635	3428	3935	2608
	Nilgiris	-	4	3	4	4	4	5	4	1	1	-	-	-
	Thiruvarur	548	593	503	581	375	357	168	75	24	25	76	115	271
	Tiruchirappalli	5232	4899	4034	2999	2699	2384	1749	1784	1608	1670	1798	1872	1694
	Tiruppur	7633	5347	4713	2933	5593	4887	1390	2966	2425	2626	3484	3361	2950

Table 6 presents the district-wise temporal variation in area (ha) under cotton cultivation across Tamil Nadu districts for the period 2011-12 to 2023-24. Cotton cultivation exhibits marked inter-district and inter-annual variability, with a few districts consistently accounting for a major share of the cultivated area. Perambalur, Salem, Tiruchirappalli, Dharmapuri, and Ariyalur emerge as the dominant cotton-growing districts during most of the study period. Perambalur records exceptionally high cotton area in the early years, peaking at 40,048 ha in 2014-15, followed by sharp fluctuations and a pronounced decline after 2017-18, reaching 7,948 ha in 2023-24, indicating substantial contraction. Salem shows a similar pattern, with extensive cultivation in the early years (16,992 ha in 2011-12), followed by a sustained decline, punctuated only by modest recoveries in 2017-18 and 2019-20.

Dharmapuri and Tiruchirappalli also maintain relatively large cotton areas during the early and mid-2010s, but both districts experience a significant reduction after 2017-18, reflecting growing instability in cotton cultivation. Cuddalore exhibits fluctuations, with a peak in 2017-18.

Districts such as Dindigul, Namakkal, Thiruvarur, and Thanjavur display moderate cotton cultivation with notable fluctuations. Thiruvarur stands out for its sharp increase after 2020-21, reaching very high levels during 2021-22 and 2022-23, indicating recent expansion or renewed adoption of cotton in the delta region. Namakkal and Dindigul, while fluctuating, maintain moderate levels throughout the period, reflecting continued but unstable suitability for cotton cultivation.

On the other hand, districts like Karur, Erode, Tiruppur, and Pudukkottai record relatively low cotton area throughout the study period, though some show marginal increases in recent years. Nilgiris consistently records negligible or no cotton cultivation, underscoring its agro-climatic unsuitability for the crop.

Table 6. Area under cotton cultivation (ha) in Tamil Nadu districts within the CRB

Crop	District	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
Cotton	Ariyalur	7811	8634	9118	13377	9189	9780	10892	9334	9413	6697	7416	8441	5996
	Coimbatore	1434	558	348	439	470	466	458	713	461	366	346	563	321
	Cuddalore	5784	5067	8614	6978	7210	5587	10971	5907	5785	4200	4835	6122	3611
	Dharmapuri	11028	13662	12486	11681	10866	11824	14465	9230	8027	3957	5304	5985	5046
	Dindigul	2799	2155	2096	5014	4835	5064	5133	5273	8069	3944	4309	5409	3630
	Erode	848	696	568	1095	796	688	755	988	1162	717	1144	1581	748
	Karur	79	63	93	147	125	133	286	246	351	271	393	796	653
	Krishnagiri	1695	1506	2082	4633	2414	2978	3273	1681	1527	1372	1424	1708	2025
	Mayiladuthurai	-	-	-	-	-	-	-	-	-	3455	5056	6871	5498
	Nagapattinam	317	675	2496	2350	2438	3059	2256	3119	5336	1130	1559	2028	2238
	Namakkal	2898	2735	1908	2365	2162	2495	2226	2431	3133	1852	2672	4403	2799
	Perambalur	26150	24280	31087	40048	20371	21165	32995	13871	20566	9014	10327	13289	7948
	Pudukkottai	42	10	11	50	28	45	20	26	57	48	194	442	262
	Salem	16992	15798	13003	15752	12467	12701	17099	9418	14014	8895	10462	10083	6605
	Thanjavur	969	1015	1788	2092	1689	1740	816	1608	2122	1861	3101	3944	3434
	Nilgiris	5	5	6	5	-	-	-	-	-	-	-	-	-
	Thiruvarur	1254	1320	3676	5157	4799	6998	4199	6689	8049	6683	16427	16401	15845
	Tiruchirappalli	14373	16928	16462	17284	14977	11635	14887	8863	13474	8676	11420	12902	9625
	Tiruppur	653	371	331	860	969	893	908	1152	1206	931	1084	1273	869

Table 7 presents the district-wise temporal variation in area (ha) under maize cultivation across Tamil Nadu districts lying within the CRB for the period 2011-12 to 2023-24. Among the districts, Perambalur consistently emerges as the most dominant maize-growing district throughout the period. The area under maize increases from 40,748 ha in 2011-12 to a peak of 68,581 ha in 2020-21, followed by marginal fluctuations, ultimately reaching 71,654 ha in 2023-24.

Dindigul and Salem also represent major maize-producing districts. Dindigul maintains a high area throughout the period, despite fluctuations, rising from 40,644 ha in 2011-12 to 33,092 ha in 2023-24 after a mid-period decline. Salem shows a gradual upward trend, with maize area increasing from 34,666 ha in 2011-12 to a notable peak of 51,987 ha in 2023-24, indicating a strong shift towards maize cultivation in recent years.

Tiruppur and Cuddalore exhibit moderate but stable maize cultivation. Tiruppur records a decline from 26,639 ha in 2011-12 to around 20,000 ha in later years, yet maintains a relatively consistent area, suggesting resilience despite production constraints. Cuddalore shows a steady increase over time, expanding from 13,347 ha to 26,103 ha by 2023-24, reflecting growing adoption of maize.

Namakkal and Erode display fluctuating trends. Districts such as Ariyalur, Coimbatore, Dharmapuri, Pudukkottai, and Tiruchirappalli show moderate maize cultivation with pronounced year-to-year variability. While some districts like Tiruchirappalli demonstrate a gradual increase after 2019-20, others such as Dharmapuri experience sharp mid-period declines followed by partial recovery in the later years.

Karur, Krishnagiri, and Thanjavur record comparatively lower maize area throughout the study period, reflecting limited adoption. Thanjavur, despite its agricultural importance, shows consistently low maize coverage, indicating dominance of alternative crops. Nagapattinam, Thiruvarur, Mayiladuthurai, and the Nilgiris record negligible or near-absence of maize cultivation, likely due to agro-climatic and cropping pattern constraints.

Overall, the temporal pattern indicates a gradual expansion and spatial concentration of maize cultivation, particularly in western and central districts such as Perambalur, Salem, Dindigul, and Cuddalore.

Table 7. Area under maize cultivation (ha) in Tamil Nadu districts within the CRB

Crop	District	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
Maize	Ariyalur	12135	14743	17768	14825	17246	15343	14997	16139	15374	17564	18130	17822	21443
	Coimbatore	4444	4601	5443	4473	4167	3987	3946	4013	3222	3486	3433	3574	2604
	Cuddalore	13347	15171	20520	23911	22704	20558	18857	21667	22415	23259	23099	24922	26103
	Dharmapuri	3643	2503	13435	14137	10061	5852	6945	6244	2530	4198	4129	4931	6354
	Dindigul	40644	34325	27461	23805	27889	21326	27116	27284	24498	28955	27649	31596	33092
	Erode	12585	13955	18259	19551	20023	14683	18209	14541	15040	16022	15912	15995	13619
	Karur	1354	1239	1804	2327	2389	410	2025	1124	913	1026	842	1000	1022
	Krishnagiri	948	981	3438	4215	3822	2845	3112	3238	992	933	1259	1193	1444
	Mayiladuthurai	-	-	-	-	-	-	-	-	-	33	37	20	49
	Nagapattinam	17	30	22	29	7	5	13	14	37	-	-	-	-
	Namakkal	6655	8451	10029	10926	9382	5898	7490	9157	3870	5926	4895	9908	12677
	Perambalur	40748	45747	47737	36809	54249	48537	39725	61642	57172	68581	67183	66047	71654
	Pudukkottai	4757	4022	8662	5738	5097	3199	3415	3265	2579	1737	1766	2069	2197
	Salem	34666	29542	35650	38005	37134	30362	34410	35226	32341	36890	39917	48293	51987
	Thanjavur	1291	959	1475	1284	630	540	900	1040	1273	910	930	1012	893
	Nilgiris	-	-	-	-	-	-	-	-	1	3	3	4	7
	Thiruvarur	3	-	1	-	-	-	-	10	20	17	21	13	8
	Tiruchirappalli	5836	7716	9857	10003	12686	11011	12269	15628	11561	18654	18339	18456	20964
	Tiruppur	26639	18095	22824	23482	23074	18297	21451	21105	22029	20841	20961	20598	19900

Table 8 presents the district-wise temporal variation in area (ha) under groundnut cultivation across Tamil Nadu districts lying within the CRB for the period 2011-12 to 2023-24. Among the districts, Namakkal, Salem, Erode, and Dharmapuri consistently emerge as the major groundnut-growing districts throughout the study period. Salem records a relatively high and stable area, increasing from 19,773 ha in 2011-12 to a peak of 25,049 ha in 2020-21, followed by a slight decline to 22,219 ha in 2023-24, indicating sustained dominance with minor recent contraction. Erode also maintains a large area under groundnut cultivation, fluctuating around 18,000-20,000 ha for much of the period, before declining to 16,515 ha in 2023-24, suggesting gradual withdrawal in recent years.

Namakkal exhibits a notable expansion in groundnut cultivation, increasing sharply from 26,538 ha in 2011-12 to a peak of 33,539 ha in 2020-21, followed by marginal fluctuations, reaching 29,935 ha in 2023-24. Dharmapuri also shows relatively high and stable cultivation, with the area rising from 17,069 ha in 2011-12 to 15,922 ha in 2023-24 after moderate mid-period fluctuations.

Cuddalore and Ariyalur display moderate but stable groundnut cultivation over the study period. Cuddalore maintains an area between 9,698 and 11,703 ha, indicating consistency despite minor year-to-year variation. Ariyalur shows a gradual increase from 13,027 ha to 13,325 ha, reflecting stability in groundnut adoption.

Districts such as Pudukkottai, Tiruchirappalli, Tiruppur, Thanjavur, Dindigul, Karur, and Krishnagiri exhibit fluctuating but generally declining trends. Pudukkottai records a decline from 17,629 ha in 2011-12 to 10,399 ha in 2023-24, despite intermittent recovery phases. Tiruchirappalli and Tiruppur show gradual reductions in area, indicating a shift towards alternative crops or reduced groundnut preference. Thanjavur, traditionally dominated by paddy cultivation, maintains relatively low groundnut area, with a declining trend from 8,262 ha to 7,181 ha. Dindigul shows a sharp decline from 12,780 ha in 2011-12 to 3,576 ha in 2023-24, reflecting substantial withdrawal from groundnut cultivation. Karur records persistently low and declining area, while Krishnagiri shows a gradual reduction after 2015-16, despite relatively higher values in the early years.

Groundnut cultivation is negligible or absent in Nilgiris, indicating limited agro-climatic suitability or dominance of alternative cropping systems in these districts.

Table 8. Area under groundnut cultivation (ha) in Tamil Nadu districts within the CRB

State	District	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
Groundnut	Ariyalur	13027	9108	10007	8967	8593	8620	9850	9105	8962	11803	12482	12743	13325
	Coimbatore	7077	5434	5055	4588	4877	3318	3581	4650	3320	4001	3768	3292	2101
	Cuddalore	9698	11002	11670	11372	9626	8597	10120	9680	9954	11102	10863	11747	11703
	Dharmapuri	17069	12043	13657	8412	10515	7677	10874	9585	11491	17098	16000	15801	15922
	Dindigul	12780	7263	4242	8022	10436	3641	6347	3471	3180	6656	5591	5064	3576
	Erode	18534	15710	17111	20103	20517	17164	18993	18843	17991	19706	20584	19745	16515
	Karur	7228	3953	2240	4594	4385	1574	3078	1427	1025	2441	3521	3330	2671
	Krishnagiri	15609	16505	13006	12419	12588	13329	10490	11285	8235	14813	14683	13420	12555
	Mayiladuthurai	-	-	-	-	-	-	-	-	-	1188	1075	1018	1080
	Nagapattinam	2595	1730	1812	1601	1740	1686	1737	1942	2623	1479	1467	1481	1347
	Namakkal	26538	28686	25429	28854	31428	27405	27450	32108	31318	33539	32656	30723	29335
	Perambalur	2224	1481	2023	1451	2903	1207	2175	927	2064	2625	1978	2360	1852
	Pudukkottai	17629	12303	8465	5869	7998	8434	10596	10425	10517	15324	11452	11434	10399
	Salem	19773	17548	18837	20716	21818	15765	17748	19988	19852	25049	24394	22633	22219

	Thanjavur	8262	6984	5039	4069	4843	7231	8010	5994	8097	10292	8701	7810	7181
	Nilgiris	-	-	4	1	4	4	7	-	-	-	-	-	-
	Thiruvarur	4093	3334	3394	1659	2122	2546	2975	3283	2784	2522	2052	2593	2505
	Tiruchirappalli	11478	8482	7893	8526	9456	7415	10382	6583	8035	9205	8366	7068	6270
	Tiruppur	8253	5098	7422	7785	8451	5417	8176	7850	6878	7740	8527	7946	7235

3.2. Area Under Non-Cash Crops

In Karnataka's CRB districts, crops classified as non-cash include niger seed, safflower, sanhemp, pulses, total food grain, black pepper, chillies, rice, potato, onion, bajra, gram, arhar (tur), rice, jowar, bajra, ragi, ginger, turmeric, cardamom, betulnet, garlic, coriander, mango, banana, citrus fruits, grapes, pome fruits, papaya, cashewnut, dry fruits, tapioca, sweet potato, castor seed, sesamum, rapeseed and mustard, soyabean, sunflower, tobacco, tea, coffee, rubber, fodder crops, green manure. Table 9 shows that the area under non-cash crop cultivation in Karnataka's CRB districts exhibits considerable spatial and temporal variation from 2011-12 to 2022-23. Districts such as Tumakuru, Hassan, and Mysuru consistently record the largest areas under non-cash crops, indicating the continued dominance of food grains and allied crops in these regions. In contrast, Bengaluru Urban maintains the lowest area, reflecting high urbanisation and limited agricultural land.

Across most districts, the area under non-cash crops remains relatively stable with moderate fluctuations, with a general increase after 2018-19 in districts like Bengaluru rural, Bengaluru urban, Chamarajanagar, Chikballapura, Hassan, Ramanagara, Mysuru, and Kodagu.

Table 9. Area under non-cash crops (ha) in Karnataka districts lying within the CRB

State	District	2011 - 2012	2012 - 2013	2013 - 2014	2014 - 2015	2015 - 2016	2016 - 2017	2017 - 2018	2018 - 2019	2019 - 2020	2020 - 2021	2021 - 2022	2022 - 2023
Non-cash crops	Bengaluru rural	130611	122954	119576	111867	116889	107525	103246	118388	134941	136363	125793	116618
	Bengaluru urban	53584	54154	51057	45373	41204	37167	36273	43926	58119	46381	42748	127355
	Chamarajanagar	199871	213697	171342	168049	175510	137896	176855	166028	214400	182885	198628	181459
	Chikballapura	215086	217706	210243	212846	216688	213192	221641	175450	193418	225808	210606	190634
	Chikkamagaluru	320183	328648	344328	353264	357424	325838	333857	402261	377149	420892	414039	429977
	Hassan	442450	429541	423192	446308	415582	361563	418409	500914	516473	536581	552196	569400
	Kodagu	180098	177603	173615	183641	181578	183700	177634	249083	273291	326867	327925	332329
	Mandya	218147	187824	193479	223398	212154	165445	221253	261148	253197	293906	283306	299232
	Mysuru	517815	461439	507489	471273	476366	357858	477780	462340	477015	507727	542346	546815
	Ramanagara	166950	146257	168508	158491	170550	161420	171348	160821	174588	181183	177696	158045
	Tumakuru	573327	554227	541019	596989	557456	537559	540388	594414	569047	664099	641470	685780

For Tamil Nadu's CRB districts, non-cash crops comprise pulses, total food grain, black pepper, chillies, rice, potato, onion, bajra, gram, arhar (tur), rice, jowar, bajra, ragi, ginger, turmeric, cardamom, betulnet, garlic, coriander, mango, banana, citrus fruits, grapes, pome fruits, papaya, cashewnut, dry fruits, tapioca, sweet potato, castor seed, sesamum, rapeseed and mustard, soyabean, sunflower, indigo, tobacco, tea, coffee, fodder crops, green manure. The area (ha) under non-cash crop cultivation for the period 2011-12 to 2022-23 is summarized in Table 10. Districts such as Cuddalore, Dharmapuri, Dindigul, Erode, Krishnagiri, Nagapattinam, Namakkal, Pudukkottai, Salem, Thanjavur, Thiruvarur, and Tiruchirappalli consistently record higher areas, reflecting the continued importance of food grains, plantation, and horticultural crops in these regions.

Table 10. Area under non-cash crops (ha) in Tamil Nadu districts lying within the CRB

State	District	2011 - 2012	2012 - 2013	2013 - 2014	2014 - 2015	2015 - 2016	2016 - 2017	2017 - 2018	2018 - 2019	2019 - 2020	2020 - 2021	2021 - 2022	2022 - 2023	2023-2024
Non-cash crops	Ariyalur	63722	55691	66413	66728	67176	61662	66979	66587	68570	71689	75631	85647	73425
	Coimbatore	63199	69328	74606	73964	73227	66770	68116	70874	69949	71698	70014	72736	59016
	Cuddalore	233360	207037	248204	256390	262020	250555	251923	251052	249837	255275	256319	281276	249889
	Dharmapuri	183969	122062	204548	163165	180034	119440	150965	161796	210897	214997	214688	248816	212603
	Dindigul	131330	130047	126360	164582	155012	140199	149472	142485	149735	148218	154791	166831	146833
	Erode	142842	86637	103108	113443	105155	59791	79352	95958	99035	88864	88372	124434	73358
	Karur	67429	51728	66846	74556	68558	33008	62487	58325	61199	63951	69042	74265	62203
	Krishnagiri	184280	179512	219639	186619	178074	143718	177478	190529	191880	204872	210571	242607	208311
	Mayiladuthurai										154360	155380	159652	158365
	Nagapattinam	277116	211978	256832	257668	260939	234179	248973	257268	250493	109210	115835	125856	121333
	Namakkal	115597	120459	153789	156366	140637	104355	145538	142018	152680	160357	152681	166932	137086
	Perambalur	31542	23768	19290	27526	35592	21318	25899	18592	22414	25359	26479	31923	21442
	Pudukkottai	115365	104325	96767	90274	94381	93298	103760	92558	108081	112284	129765	126389	115145
	Salem	222738	183877	197595	205794	209760	152204	193222	180050	210046	218102	215481	237057	204597
	Thanjavur	227122	176334	212414	214993	214169	184805	215795	223663	230358	242206	269978	283978	242239
	Nilgiris	74790	74103	74239	73439	74537	74512	72716	71870	71564	74958	75709	82246	74639
	Thiruvarur	268906	185754	288003	314718	316466	267371	281325	275131	254242	260190	271121	292670	275049
	Tiruchirappalli	111978	95570	109772	126643	126161	82091	111571	112617	123041	122581	131588	138865	101570
	Tiruppur	100188	72872	86473	96538	86470	73733	85105	85662	86148	88835	90047	95114	79865

4. Land to People Ratio

Fig. 55 illustrates the per capita forest land (ha per person) across districts for the years 2001 and 2011. Forest land data were sourced from the Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, GoI, while population data were obtained from the Census of India (2001 and 2011). Although forest cover data are available for the period 1998-2024, population data are limited to decadal census years (1991, 2001, and 2011). Accordingly, 2001 and 2011 were selected to ensure temporal correspondence between forest cover and population records, enabling a consistent decadal comparison of per capita forest land across districts.

Forest land per capita across the districts of the CRB shows considerable variation between 2001 and 2011. Districts such as Chamarajanagar, Idukki, and Kodagu consistently exhibit high per capita forest land (≈0.18-0.29 ha/person), reflecting dense forest cover relative to population, whereas urbanised or densely populated districts like Bengaluru Urban, Ariyalur, Thanjavur, and Thiruvarur have very low per capita forest land (≈0.0005-0.002 ha/person). Several districts, including Dharmapuri, Perambalur, and Coimbatore, experienced a decline in forest land per capita over the decade, indicating either forest loss or population growth outpacing forest expansion. Conversely, districts such as Chikkamagaluru, Nilgiris, and Erode show stable or slightly increasing trends, suggesting effective forest management or slower population growth.

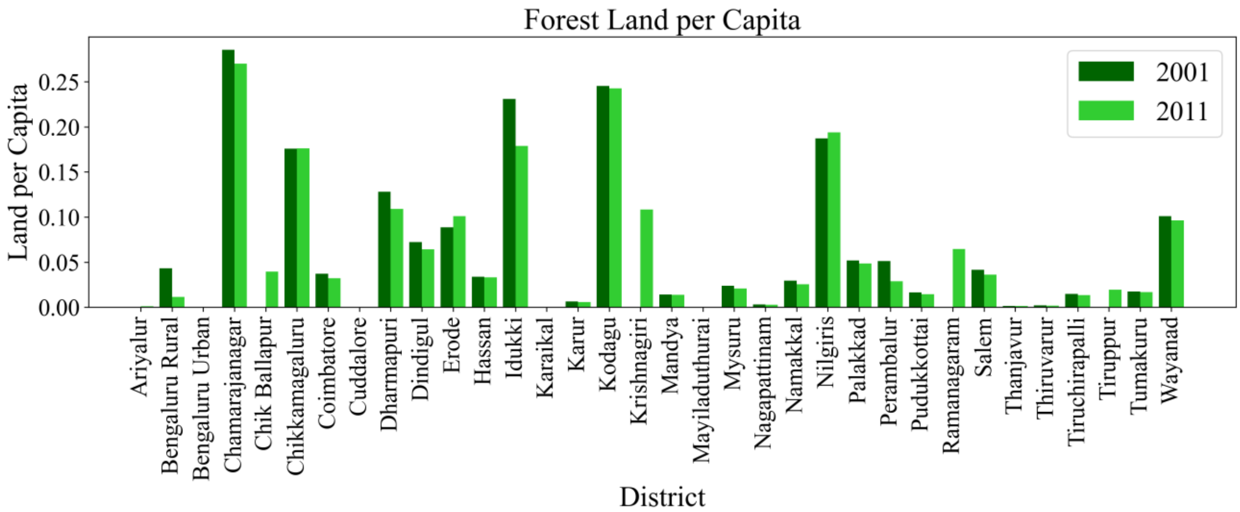


Fig. 55. Forest land per capita (ha per person) across districts of the CRB for the years 2001 and 2011

District-wise agriculture land per capita across the CRB exhibits discernible temporal changes between 2001 and 2011, as illustrated in Fig. 56. In 2001, districts such as Perambalur (≈0.43 ha/person), Kodagu (≈0.27 ha/person), Wayanad (≈0.26 ha/person), Chikkamagaluru (≈0.26 ha/person), and Tumakuru (≈0.24 ha/person) recorded relatively high agricultural land availability per person, reflecting lower population pressure and a predominantly agrarian land-use structure. In contrast, highly urbanised districts such as Bengaluru Urban (≈0.014

ha/person) and industrialised districts like Coimbatore and Tiruchirappalli exhibited very low per capita agricultural land, indicating intense demographic pressure on cultivable land.

By 2011, a general decline in agriculture land per capita is observed across many districts, suggesting that population growth has outpaced the expansion or retention of agricultural land. Pronounced reductions are evident in Perambalur (from ≈0.43 to ≈0.19 ha/person), Namakkal (from ≈0.17 to ≈0.11 ha/person), Coimbatore (from ≈0.077 to ≈0.049 ha/person), Erode, Salem, and Tiruchirappalli. These declines likely reflect a combination of demographic expansion, land fragmentation, and conversion of agricultural land to non-agricultural uses.

Conversely, a few districts exhibit stable or increasing trends in agricultural land per capita over the decade. Kodagu shows a marked increase (from ≈0.27 to ≈0.34 ha/person), while districts such as Chamarajanagar, Chikkamagaluru, Hassan, Idukki, Nagapattinam, and Thiruvarur maintain relatively stable or marginally increasing values. These patterns may be attributed to slower population growth, sustained agricultural land retention, or localized land-use practices favoring agriculture.

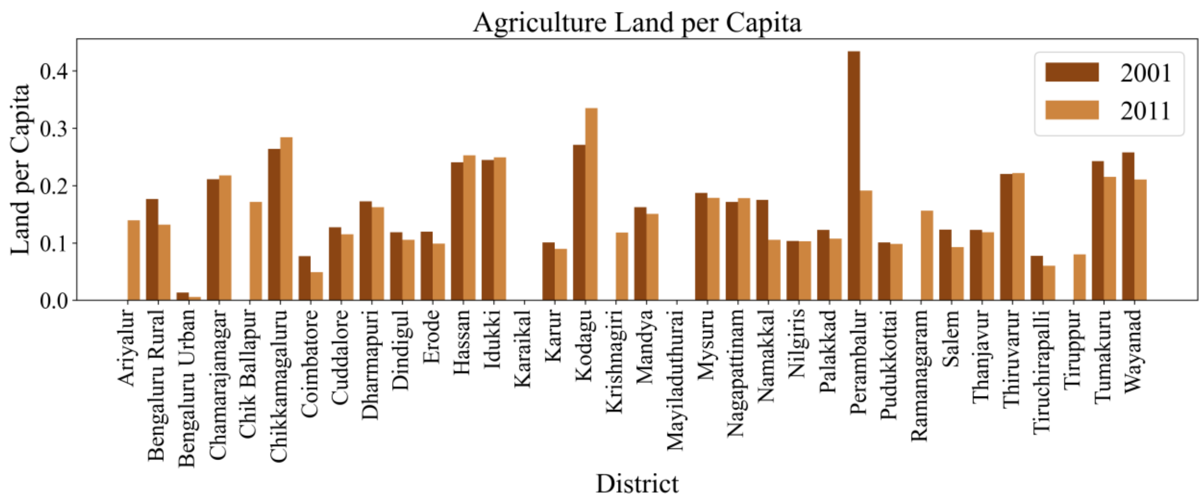


Fig. 56. Agriculture land per capita (ha per person) across districts of the CRB for the years 2001 and 2011

District-wise current fallow land per capita across the CRB exhibits pronounced spatial heterogeneity and contrasting temporal trends between 2001 and 2011 (Fig. 57). In 2001, relatively high per capita current fallow land is observed in districts such as Erode (≈0.060 ha/person), Perambalur (≈0.058 ha/person), Chamarajanagar (≈0.036 ha/person), Coimbatore (≈0.035 ha/person), and Tumakuru (≈0.033 ha/person). These elevated values may reflect seasonal land idling due to rainfall variability, irrigation constraints, or crop rotation practices.

In contrast, districts such as Idukki, Thanjavur, Bengaluru Urban, Wayanad, and Nagapattinam record very low per capita current fallow land (<0.005 ha/person), indicating intensive land utilisation and limited scope for temporary fallowing.

By 2011, several districts show a marked decline in current fallow land per capita, suggesting either increased cropping intensity, conversion of fallow land to non-agricultural uses, or population growth outpacing available fallow land. Pronounced reductions are evident in Perambalur (from ≈0.058 to ≈0.004 ha/person), Coimbatore (≈0.035 to ≈0.008 ha/person), Dharmapuri, Tiruchirappalli, Kodagu, and Chamarajanagar. Such trends may reflect agricultural intensification or reduced land availability for fallowing under growing demographic and economic pressures.

Conversely, several districts exhibit increasing current fallow land per capita between 2001 and 2011. Notable increases are observed in Tumakuru (≈0.033 to ≈0.063 ha/person), Namakkal (≈0.016 to ≈0.033 ha/person), Mysuru, Nilgiris, Karur, and Thanjavur. These increases may indicate emerging water stress, shifts in cropping patterns, soil fertility constraints, or partial land abandonment driven by socio-economic factors.

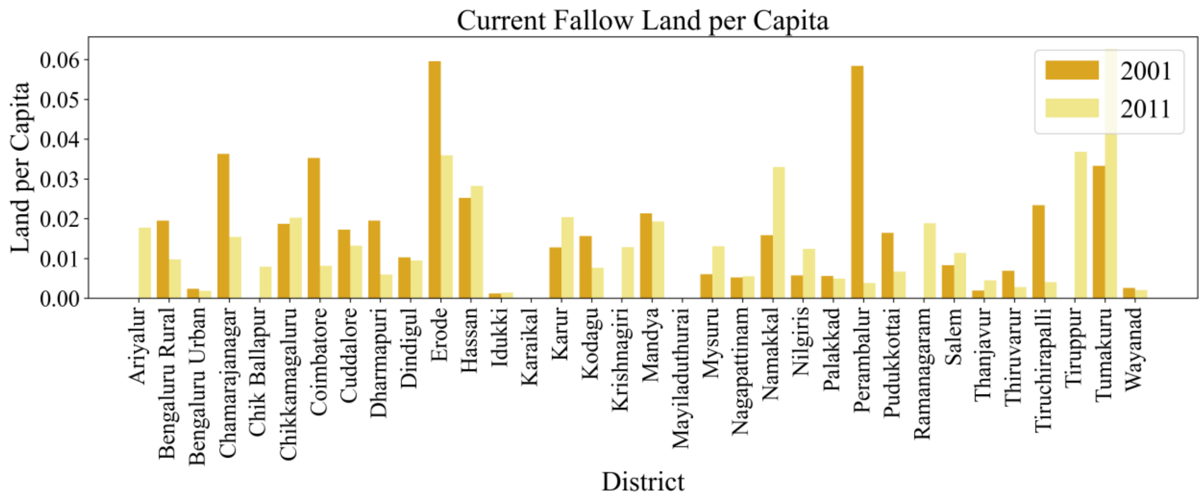


Fig. 57. Current fallow land per capita (ha per person) across districts of the CRB for the years 2001 and 2011

Net sown area per capita across districts of the CRB exhibits marked spatial variability and clear temporal shifts between 2001 and 2011 (Fig. 58). In 2001, districts such as Perambalur (≈0.40 ha/person), Kodagu (≈0.27 ha/person), Chikkamagaluru (≈0.25 ha/person), Tumakuru (≈0.22 ha/person), and Hassan (≈0.22 ha/person) recorded relatively high net sown area per capita, indicating substantial cultivated land availability relative to population. In contrast, highly urbanised districts such as Bengaluru Urban (≈0.013 ha/person) and industrialized districts including Coimbatore and Tiruchirappalli exhibited very low per capita net sown area, highlighting intense pressure on cultivable land.

By 2011, a general decline in net sown area per capita is observed across many districts, suggesting that population growth and land-use change have outpaced the expansion or retention of cultivated land. Pronounced reductions are evident in Perambalur (from ≈0.40 to ≈0.18 ha/person), Mysuru, Namakkal, Erode, Salem, Tumakuru, and Coimbatore. These declines likely reflect a combination of demographic expansion, agricultural land fragmentation, and conversion of cultivated land to non-agricultural uses.

Conversely, a few districts show stable or increasing net sown area per capita over the decade. Kodagu exhibits a notable increase (from ≈0.27 to ≈0.31 ha/person), while Chamarajanagar and Chikkamagaluru show modest gains, suggesting relatively stable population growth or sustained agricultural land management. Districts such as Nilgiris, Nagapattinam, Thiruvarur, and Dindigul display near-stable values, indicating limited change in cultivated land availability per capita.

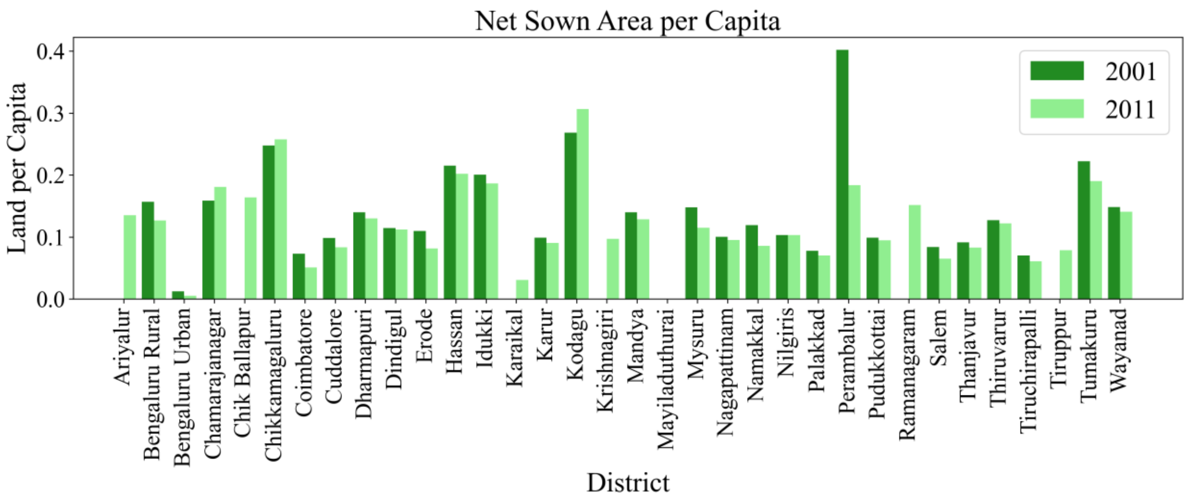


Fig. 58. Net sown area per capita (ha per person) across districts of the CRB for the years 2001 and 2011

Irrigated area per capita across districts of the CRB shows substantial spatial variability and divergent temporal trends between 2001 and 2011 (Fig. 59). In 2001, districts such as Thiruvarur (≈0.16 ha/person), Perambalur (≈0.15 ha/person), Nagapattinam (≈0.11 ha/person), Thanjavur (≈0.10 ha/person), and Cuddalore (≈0.08 ha/person) recorded the highest irrigated area per capita, underscoring the dominance of canal- and tank-fed irrigation systems in the

Cauvery delta. In contrast, hilly or forest-dominated districts such as Nilgiris, Kodagu, Idukki, and Wayanad, along with highly urbanised Bengaluru Urban, exhibited very low irrigated area per capita (<0.01 ha/person), reflecting limited scope for large-scale irrigation.

By 2011, several districts show an increase in irrigated area per capita, indicating expansion or intensification of irrigation relative to population. Notable increases are observed in Thiruvarur, Thanjavur, Mandya, Chamarajanagar, Dharmapuri, Mysuru, Dindigul, and Chikkamagaluru. These trends likely reflect enhanced irrigation infrastructure, greater groundwater development, or improved canal management. Substantial gains in Mandya and Chamarajanagar suggest intensified irrigation supported by both surface water diversions and groundwater abstraction.

Conversely, a decline in irrigated area per capita is evident in several districts, including Perambalur (≈0.15 to ≈0.07 ha/person), Namakkal, Coimbatore, Tiruchirappalli, Salem, Erode, and Bengaluru Rural. These reductions may be attributed to population growth, groundwater stress, reduced canal reliability, or conversion of irrigated land to non-agricultural uses. Declining irrigated area per capita in districts such as Perambalur, despite high initial values, points to increasing pressure on irrigation resources.

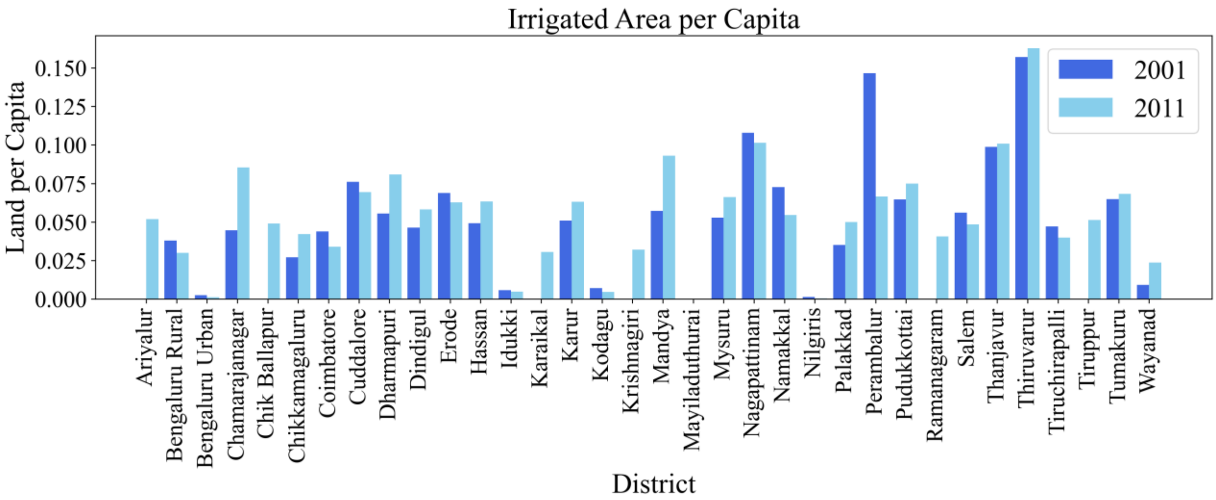


Fig. 59. Irrigated area per capita (ha per person) across districts of the CRB for the years 2001 and 2011

Non-irrigated area per capita across districts of the CRB exhibits pronounced spatial contrasts and notable temporal shifts between 2001 and 2011 (Fig. 60). In 2001, relatively high non-irrigated area per capita is observed in districts such as Kodagu (≈0.26 ha/person), Idukki (≈0.24 ha/person), Wayanad (≈0.25 ha/person), Perambalur (≈0.29 ha/person), Chikkamagaluru (≈0.24 ha/person), and Hassan (≈0.19 ha/person). These districts are characterised by either rainfed-dominated agricultural systems or terrain and land-use conditions that limit large-scale irrigation development. In contrast, deltaic districts such as Thanjavur and Tiruchirappalli, along with highly urbanised Bengaluru Urban, show very low non-irrigated area per capita, indicating a predominance of irrigated agriculture or limited cultivable land.

By 2011, a general decline in non-irrigated area per capita is evident across many districts, suggesting either expansion of irrigation, conversion of rainfed land to non-agricultural uses, or population growth outpacing available rainfed cropland. Substantial reductions are observed in Perambalur (from ≈0.29 to ≈0.12 ha/person), Mandya, Namakkal, Dharmapuri, Dindigul, Tumakuru, Salem, and Coimbatore. These trends likely reflect increased irrigation development and/or intensification of agriculture supported by groundwater abstraction.

Conversely, a few districts exhibit stable or increasing non-irrigated area per capita. Kodagu shows a marked increase (from ≈0.26 to ≈0.33 ha/person), while Idukki, Chikkamagaluru, Nilgiris, and Thiruvarur maintain relatively stable values. In the case of Kodagu and other hilly districts, high and increasing non-irrigated area per capita likely reflects persistent dependence on rainfed plantation agriculture and limited scope for irrigation expansion rather than land-use intensification.

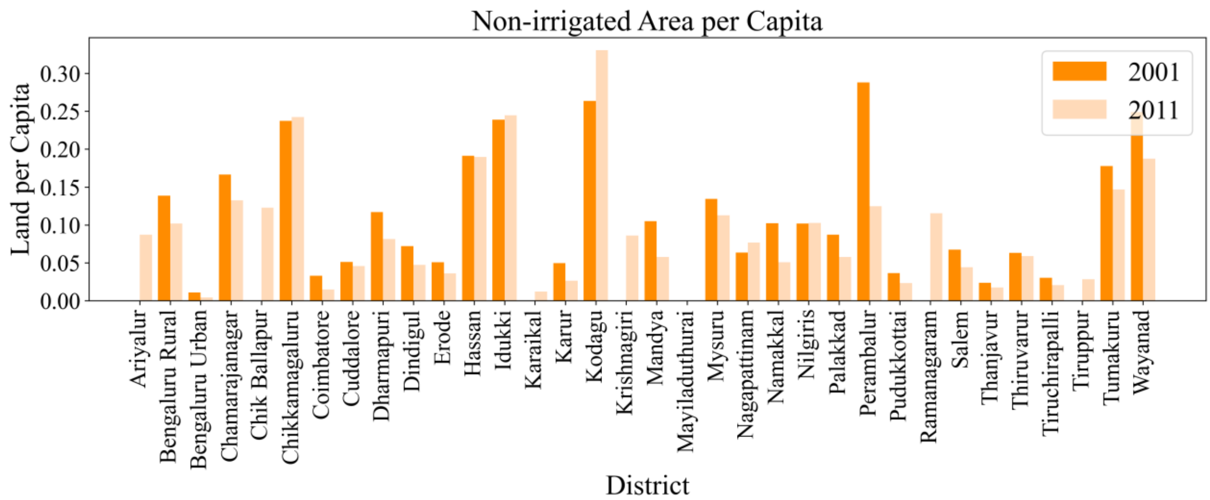


Fig. 60. Non-irrigated area per capita (ha per person) across districts of the CRB for the years 2001 and 2011

Area not available for cultivation per capita across districts of the CRB exhibits moderate spatial variability and relatively subdued temporal changes between 2001 and 2011 (Fig. 61). In 2001, comparatively high per capita values are observed in districts such as Perambalur

(≈0.14 ha/person), Kodagu (≈0.10 ha/person), and Pudukottai (≈0.09 ha/person), indicating substantial proportions of land constrained by physiography, settlement expansion, or non-agricultural land uses. In contrast, densely populated districts such as Bengaluru Urban, Idukki, Nilgiris, Wayanad, and Palakkad record low per capita values (<0.02 ha/person), reflecting limited land availability relative to population.

Between 2001 and 2011, most districts exhibit only marginal changes in area not available for cultivation per capita, suggesting that population growth and land-use transitions have not substantially altered the proportional extent of non-arable land. Notable declines are observed in Perambalur (from ≈0.14 to ≈0.06 ha/person) and Pudukottai, which may reflect reclassification of land, conversion to cultivable categories, or population growth reducing per capita availability. Conversely, modest increases are evident in Dharmapuri, Idukki, and Cuddalore, potentially associated with gradual urban expansion, infrastructure development, or land degradation.

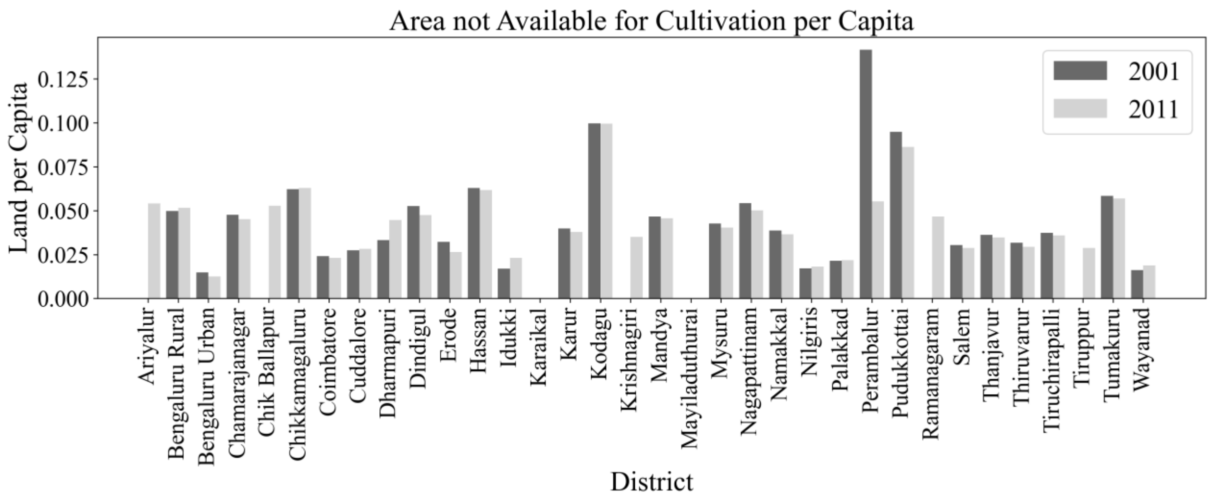


Fig. 61. Non-cultivable area per capita (ha per person) across districts of the CRB for the years 2001 and 2011

Area under barren land per capita across districts of the CRB is generally low and exhibits limited temporal variation between 2001 and 2011 (Fig. 62). In 2001, comparatively higher per capita barren land is observed in districts such as Kodagu (≈0.057 ha/person), Tumakuru (≈0.026 ha/person), Perambalur (≈0.023 ha/person), Nagapattinam (≈0.022 ha/person), and Chamarajanagar (≈0.022 ha/person). These values likely reflect local physiographic constraints, rocky terrain, lateritic soils, or land degradation processes. In contrast, densely populated or deltaic districts such as Thiruvarur, Thanjavur, Bengaluru Urban, Wayanad, and

Palakkad exhibit extremely low per capita barren land (<0.001 ha/person), indicating minimal extent of permanently uncultivable land.

Between 2001 and 2011, most districts show either marginal declines or near-stable barren land per capita, suggesting limited expansion of barren land across the basin. Notable reductions are observed in Perambalur (from ≈0.023 to ≈0.005 ha/person), Dharmapuri, Bengaluru Rural, Salem, and Tiruchirappalli, potentially reflecting land reclamation, conversion to agricultural or non-agricultural uses, or population growth reducing per capita values. Conversely, Kodagu and Tumakuru maintain persistently high barren land per capita with minimal change, indicating structural land constraints rather than recent degradation.

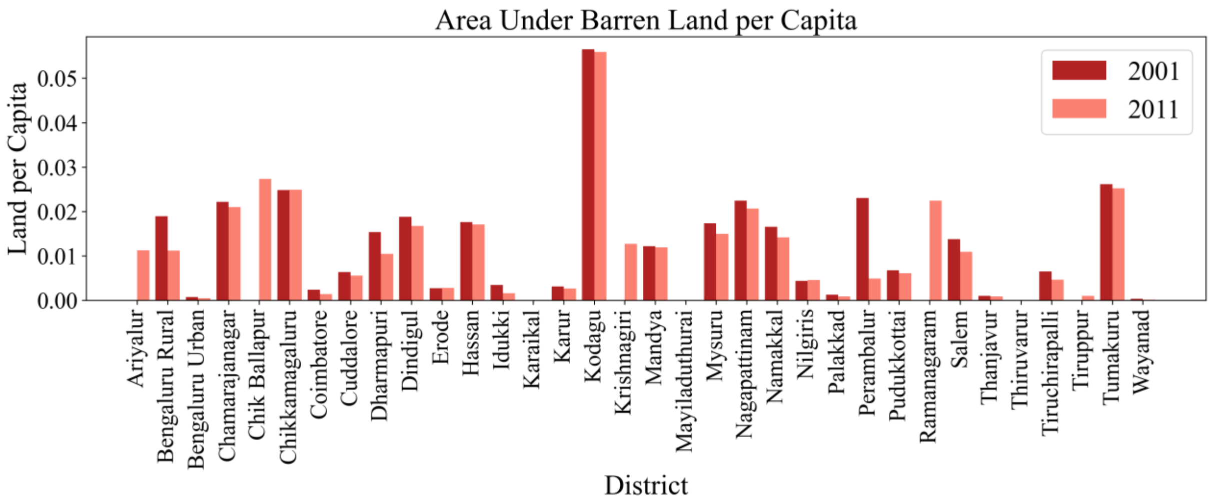


Fig. 62. Barren land area per capita (ha per person) across districts of the CRB for the years 2001 and 2011

5. Vulnerable Areas in Terms of Environmental Degradation

The assessment of environmental vulnerability within the CRB is based on observed long-term spatio-temporal changes in land-use and land-cover categories across districts. Vulnerability is inferred from declines in forest cover and agricultural land, expansion of fallow and non-cultivable land, contraction of irrigated areas, and rapid growth of built-up land.

5.1. Over-Exploited Areas

Districts exhibiting persistent loss of productive land or strong expansion of non-agricultural land uses emerge as environmentally vulnerable within the CRB. The most pronounced vulnerability is observed in Bengaluru Urban and Bengaluru Rural, where the results show sharp declines in agricultural and net sown areas accompanied by a substantial increase in non-cultivable and built-up land. Bengaluru Urban records the largest net increase in areas not available for cultivation and the highest growth in built-up land across the basin, indicating extensive land transformation over the study period.

Several agriculturally significant districts, including Dharmapuri, Coimbatore, Erode, Nagapattinam, and Tumakuru, also display signs of over-exploitation. These districts register large long-term reductions in agricultural land and net-snow area. Dharmapuri and Coimbatore experience some of the steepest contractions in agriculture area, while Erode and Nagapattinam show substantial declines in irrigated area in later years. Tumakuru, despite large absolute agriculture areas, exhibits a marked increase in current fallow land, indicating growing withdrawal of land from active cultivation.

In addition, districts such as Mysuru, Namakkal, Chamarajanagar, Karur, Thanjavur, Krishnagiri, and Salem show significant increases in current fallow land, highlighting areas where cultivated land has become intermittently or persistently unutilised. These trends, taken together, identify zones within the CRB where land resources have undergone sustained stress and transformation during the study period.

5.2. Potential Areas for Sustainable Management

In contrast, several districts demonstrate relative stability or improvement in key land-use indicators, suggesting potential for sustainable land management and conservation. Hassan, Kodagu, and Chikkamagaluru exhibit stable or increasing forest cover over the study period, with increase in agricultural land. These districts show comparatively lower expansion of non-cultivable land and built-up area.

Districts such as Mandya and Chikkamagaluru districts also indicated increase in agricultural areas, indicating scope for continued productive land use. The near-stability of waterbody area across the basin, further supports the possibility of strengthening land and water management strategies in districts where other land-use categories have remained relatively unchanged.

Overall, the results indicate that while certain districts within the CRB are clearly vulnerable due to extensive land-use change and decline in cultivated areas, others retain comparatively stable land-use structures. These stable districts represent areas of possibility for reinforcing sustainable agricultural practices, conserving forested landscapes, and maintaining long-term land productivity within the basin.

6. Development and Sustainable Land-use Strategies

The observed land-use dynamics across the CRB reflect the combined influence of urban expansion, agricultural transformation, irrigation development, and administrative reclassification. These changes have significant implications for long-term sustainability, resource efficiency, and livelihood security within the basin. The heterogeneity in land-use trajectories across districts highlights the need for context-specific and basin-integrated development strategies that balance economic growth with ecological conservation and agricultural resilience.

6.1. Forest Conservation and Ecological Stability

Forest land within the CRB has experienced both marginal gains and losses across districts, largely driven by administrative reclassification, infrastructure development, and plantation expansion. Districts exhibiting notable forest decline require targeted conservation interventions, including strengthened protection of reserved forests, afforestation using native species, and restoration of degraded forest patches. In forest-dominated districts, maintaining ecological integrity is critical to regulating hydrological flows, preventing soil erosion, and preserving biodiversity. Sustainable land-use planning must therefore prioritise the prevention of forest fragmentation and promote landscape connectivity, particularly in ecologically sensitive regions of the basin.

6.2. Sustainable Agricultural Land Management

Agricultural land continues to occupy a dominant share of land use in the CRB, yet its spatial extent shows contrasting trends across districts. Rapidly urbanising districts have witnessed a contraction of agricultural land, underscoring the growing competition between urban development and farming. Protecting high-quality agricultural land through zoning regulations and controlled urban expansion is essential to sustain food security and rural livelihoods.

In contrast, districts with stable or expanding agricultural areas present opportunities for sustainable intensification. Adoption of improved agronomic practices, soil health management, and diversification toward less water-intensive and climate-resilient crops can enhance productivity while reducing environmental stress. Strengthening extension services and access to technology will be critical in supporting such transitions.

6.3. Addressing Expansion of Fallow Lands

The increase in current and other fallow lands in several CRB districts signals underlying stress in agricultural systems, often linked to water scarcity, labour shortages, and economic constraints. Bringing fallow land back into productive use requires targeted interventions, including improved irrigation reliability, promotion of crop diversification, and financial support mechanisms for small and marginal farmers. In districts where fallow land has declined due to intensive cultivation, careful monitoring is necessary to avoid long-term land degradation and declining soil fertility.

6.4. Irrigation Efficiency and Water-Smart Agriculture

Irrigation development has played a central role in shaping land-use patterns within the CRB. While expansion of irrigated areas has supported agricultural growth in some districts, declines in others highlight increasing water stress and the limits of further irrigation expansion. Sustainable strategies should therefore prioritise irrigation efficiency over area expansion, emphasizing micro-irrigation technologies, canal modernisation, and conjunctive use of surface and groundwater resources.

Simultaneously, strengthening rainfed agriculture through watershed development, soil moisture conservation, and climate-adaptive farming practices is essential, particularly in districts with limited irrigation potential. Aligning cropping patterns with local water availability will be critical to reducing pressure on basin water resources.

6.5. Managing Urban Growth and Built-up Expansion

The steady expansion of built-up areas across the CRB, particularly in and around major urban centres, has significantly altered land-use patterns. Unplanned urban growth has often occurred at the expense of agricultural and fallow lands, increasing surface runoff, reducing groundwater recharge, and exacerbating flood risks. Sustainable urban development strategies should promote compact and vertical growth, protection of peri-urban agricultural zones, and integration of green infrastructure such as open spaces, wetlands, and urban forests to maintain hydrological balance.

6.6. Reclamation and Productive Use of Non-cultivable Land

Changes in barren and non-cultivable land categories indicate both opportunities and constraints for land reclamation. Where feasible, reclamation of suitable barren lands for afforestation, agroforestry, or pasture development can contribute to ecological restoration and livelihood diversification. However, irreversible conversions to non-agricultural uses necessitate careful planning to ensure long-term environmental and economic sustainability.

6.7. Basin-Integrated Land-use Governance

Overall, the diverse land-use transitions observed across the CRB demonstrate that uniform policy approaches are inadequate. Sustainable development requires basin-scale coordination combined with district-level planning, integrating land, water, agriculture, and urban development policies. Strengthening land-use monitoring systems, harmonising administrative classifications, and incorporating climate resilience into development planning will be essential for achieving sustainable and equitable land-use outcomes across the CRB.

7. Challenges in Revenue Mapping

Revenue mapping across the CRB provides critical insights into land-use dynamics and agricultural patterns. However, the analysis reveals several methodological, institutional, and data-related challenges that constrain the accuracy, comparability, and interpretability of revenue maps over space and time.

7.1. Shortcomings

One of the primary challenges in revenue mapping is the non-availability of consistent spatio-temporal data at the basin scale. Consequently, complete administrative district-level data was used in this analysis. As many districts extend beyond the CRB boundary, the reported land-use statistics may include areas that are hydrologically disconnected from the basin, potentially leading to spatial overestimation and misrepresentation of basin-specific land-use trends.

A second limitation relates to temporal inconsistencies in land-use classification. Several districts exhibit abrupt, stepwise changes in forest area, agricultural land, fallow land, and irrigated area, which are unlikely to reflect real land-cover transitions. These discontinuities are largely attributable to administrative reorganization (district bifurcation), reclassification of land categories, and revisions in reporting practices, complicating the interpretation of long-term trends.

The analysis also highlights data gaps and uneven availability, particularly for newly formed districts. Notably, forest data are also unavailable even for long-established districts such as Karaikal. These limitations hinder continuous temporal analysis and reduce comparability across districts.

Finally, rapid urban expansion and land conversion, particularly in districts such as Bengaluru Urban and Bengaluru Rural, introduce additional complexity. The pace of built-up land growth often outstrips the update frequency of revenue records, resulting in time lags between actual land transformation and official reporting.

7.2. Proposed Solutions

To address these limitations, future revenue mapping exercises should prioritize spatial analysis, wherein district-level statistics are spatially masked to the CRB boundary using Geographic Information System (GIS) techniques. This would ensure hydrological relevance and improve basin-scale assessments.

Standardization of land-use classification protocols across time and states is essential to minimize artificial discontinuities. Establishing clear documentation of administrative changes, reclassification events, and methodological revisions would further enhance transparency and interpretability.

Integrating remote sensing based LULC datasets with revenue records can significantly improve temporal consistency and spatial accuracy. Satellite-derived products can serve as an independent validation layer, particularly for detecting rapid changes in agriculture, fallow land, waterbodies, and built-up areas.

Improved data continuity for newly formed districts can be achieved through retrospective reconstruction of historical statistics using parent-district records and spatial apportionment methods.

Finally, expanding revenue mapping beyond area statistics to include irrigation intensity, crop water demand, and economic indicators would strengthen its utility for basin planning. Such integration would enable revenue maps to better inform water allocation decisions, climate resilience planning, and sustainable land-use management across the CRB.

8. Conclusion and Recommendations

The present revenue mapping assessment of the CRB provides a comprehensive, long-term evaluation of land-use dynamics across administrative districts spanning multiple states. By integrating multi-decadal revenue statistics with LULC information, the analysis offers critical insights into how agricultural, forest, fallow, irrigated, non-irrigated, built-up, and barren lands have evolved over time. The findings underscore the complex interplay between urbanisation, irrigation development, administrative restructuring, and climatic variability in shaping land-use patterns across the basin.

8.1. Summary of the Key Findings

The analysis reveals pronounced spatial heterogeneity and temporal variability in land-use categories across CRB districts. Forest cover changes are largely characterised by stepwise increases or declines, often associated with administrative reclassification, district bifurcation, and revised forest accounting practices, rather than widespread continuous deforestation. While a few districts record moderate forest gains, substantial losses are confined to select regions and are not uniform across the basin.

Agricultural land-use trends reveal a divergent trajectory between urbanising and agriculturally dominant districts. Rapid urban expansion in districts such as Bengaluru Urban and Bengaluru Rural has resulted in a consistent reduction in agricultural land, whereas districts like Hassan, Kodagu, Mandya, Chikkamagaluru, Thanjavur, and Thiruvarur retain substantial agriculture areas supported by irrigation infrastructure.

Analysis of the land-to-people ratio indicates a steady decline across most CRB districts, driven by population growth coupled with stagnation or reduction in cultivable land. The decline is particularly pronounced in urban and peri-urban districts, reflecting increasing pressure on land resources. Even in predominantly agricultural districts, the shrinking land-to-people ratio underscores rising constraints on agricultural livelihoods and growing competition among agriculture, urban expansion, and other land uses.

Fallow land dynamics further reinforce these pressures. Several core agricultural districts exhibit a marked increase in current fallow land, suggesting short-term withdrawal from cultivation due to water scarcity, climatic variability, labour constraints, or declining profitability. This trend is especially concerning in districts where irrigation expansion has not kept pace with demand.

Irrigated area trends show selective expansion, notably in districts such as Tumakuru, Chikkamagaluru, Mandya, Thanjavur, and Thiruvarur, while others, including Coimbatore, Erode, and Nagapattinam, experience contraction, reflecting spatially uneven water availability and management challenges. Correspondingly, non-irrigated land remains dominant in several districts, indicating continued reliance on rainfall-dependent agriculture.

The analysis of cropping patterns reveals a clear distinction between cash and non-cash crops across states. In Karnataka's CRB districts, cash crops are dominated by sugarcane and cotton, reflecting irrigation-intensive and market-oriented agriculture.

In Tamil Nadu's CRB districts, cash crops include banana, coconut, sugarcane, cotton, maize, and groundnut, indicating a more diversified cash-crop portfolio with varying water requirements.

Non-cash crops, comprising cereals, pulses, millets, oilseeds, spices, plantation crops, fodder, and green manure, continue to occupy a substantial share of cultivated area in both states, underscoring their importance for food security despite increasing commercialisation.

Built-up land and land not available for cultivation show a consistent and accelerating increase, particularly after 2000, highlighting the growing impact of urbanisation on land and water resources. In contrast, barren land generally declines or remains stable, suggesting gradual reclamation or reclassification.

Overall, the findings indicate that land-use change in the CRB is increasingly shaped by demographic pressure, urban growth, irrigation development, and crop commercialisation, rather than uniform environmental degradation. The declining land-to-people ratio and expanding cash-crop cultivation emphasize the need for integrated, basin-scale planning that balances agricultural sustainability, water availability, and urban development.

8.2. Significance of Revenue Map Report

The CRB represents one of the most socio-economically and ecologically significant river systems in peninsular India. Sustaining millions of people across Karnataka, Tamil Nadu, Kerala, and the Union Territory of Puducherry, the basin supports intensive agriculture, hydropower generation, industrial development, expanding urban centers, and ecologically sensitive landscapes including the Western Ghats and the Cauvery delta. In such a multi-functional and politically sensitive basin, understanding land-use dynamics is fundamental for sustainable water resource management, agricultural planning, climate resilience, and inter-state policy coordination.

This report is significant because it provides a comprehensive revenue-based assessment of land-use patterns across complete administrative districts falling within the CRB boundary. While numerous studies rely primarily on satellite-derived LULC datasets, revenue records offer a distinct and policy-relevant perspective. Revenue classifications reflect how land is officially recorded, governed, taxed, and managed by state institutions. Consequently, they directly influence irrigation planning, agricultural statistics, land allocation, infrastructure expansion, compensation frameworks, and development policies. By analyzing revenue data, this report bridges the gap between physical land transformations and administrative land governance.

Another important contribution of this report lies in its district-level focus within a basin-scale framework. River basins transcend administrative boundaries, yet policy implementation occurs largely at the district and state levels. By examining complete districts within the CRB, the study aligns hydrological boundaries with administrative realities, thereby enhancing the operational relevance of its findings. This approach enables the identification of spatial heterogeneity across upland forested regions, rainfed interiors, canal-irrigated command areas, and deltaic agricultural zones.

The report also gains importance in the context of rapid socio-economic and environmental change. The Cauvery Basin has experienced increasing pressures from population growth, agricultural intensification, groundwater extraction, infrastructure expansion, and urbanization. Simultaneously, climate variability and extreme events, such as recurrent droughts and intense rainfall episodes, have amplified uncertainties in water availability and land productivity. Revenue-based land-use trends help reveal structural shifts such as agricultural expansion or decline, changes in fallow land patterns, forest area recording, and growth of non-agricultural categories, which have direct implications for water demand, food security, and ecosystem sustainability.

Furthermore, official land records often reflect not only physical changes on the ground but also administrative reclassification, boundary modifications, and policy-driven adjustments.

By systematically examining these trends, the report supports a nuanced interpretation of land-use transitions, distinguishing between real landscape transformation and institutional redefinition. Such clarity is essential in a basin where land and water allocation are closely linked to inter-state negotiations and legal frameworks.

From a planning and governance perspective, the findings of this report can inform sustainable land and water resource management strategies, climate adaptation planning, irrigation modernization programs, and district-level development policies. The integration of basin geography with revenue-based land classification enhances the evidence base required for long-term resource security in the CRB.

In summary, this report is significant because it situates district-level administrative land data within a basin-scale hydrological context, offering policy-relevant insights into land-use dynamics in one of India’s most critical and contested river basins. It provides a foundational reference for researchers, planners, and decision-makers engaged in sustainable development and integrated river basin management.

References

Altshuler, A.A. and Gomez-Ibanez, J.A., 2000. Regulation for revenue: The political economy of land use exactions. Bloomsbury Publishing USA.

Foley, J.A., DeFries, R., Asner, G.P., Barford, C., Bonan, G., Carpenter, S.R., Chapin, F.S., Coe, M.T., Daily, G.C., Gibbs, H.K. and Helkowski, J.H., 2005. Global consequences of land use. Science, 309(5734), pp.570-574.

Lambin, E.F., Geist, H.J. and Lepers, E., 2003. Dynamics of land-use and land-cover change in tropical regions. Annual review of environment and resources, 28(1), pp.205-241.

Satheesh, K. and Joseph, C., 2025. Spatial Planning in India: A Preliminary Classification of Existing Models (Doctoral dissertation, Politecnico di Torino).

Seto, K.C., Güneralp, B. and Hutyra, L.R., 2012. Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. Proceedings of the National Academy of Sciences, 109(40), pp.16083-16088.

Turner, B.L., Lambin, E.F. and Reenberg, A., 2007. The emergence of land change science for global environmental change and sustainability. Proceedings of the National Academy of Sciences, 104(52), pp.20666-20671.

Department of Agriculture (KSDA), Government of Karnataka. Retrieved September 12, 2025, from https://raitamitra.karnataka.gov.in/60/commercial-crop/en#:~:text=2022%2D23%20Implementation%20of%20Action%20Plan,Crop%20%2D%20Cotton%20and%20Sugarcane&text=Content%20Owned%20and%20maintained%20by%3A,%C2%A9%202025%2C%20All%20Rights%20Reserved

Department of Agriculture & Farmers Welfare, Government of Tamil Nadu. Retrieved November 04, 2025, from https://tnagriculture.in/common_portal/Press

Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India. Retrieved October 19, 2025, from https://data.desagri.gov.in/weblus/lus-source-irrigated-area-report-web