

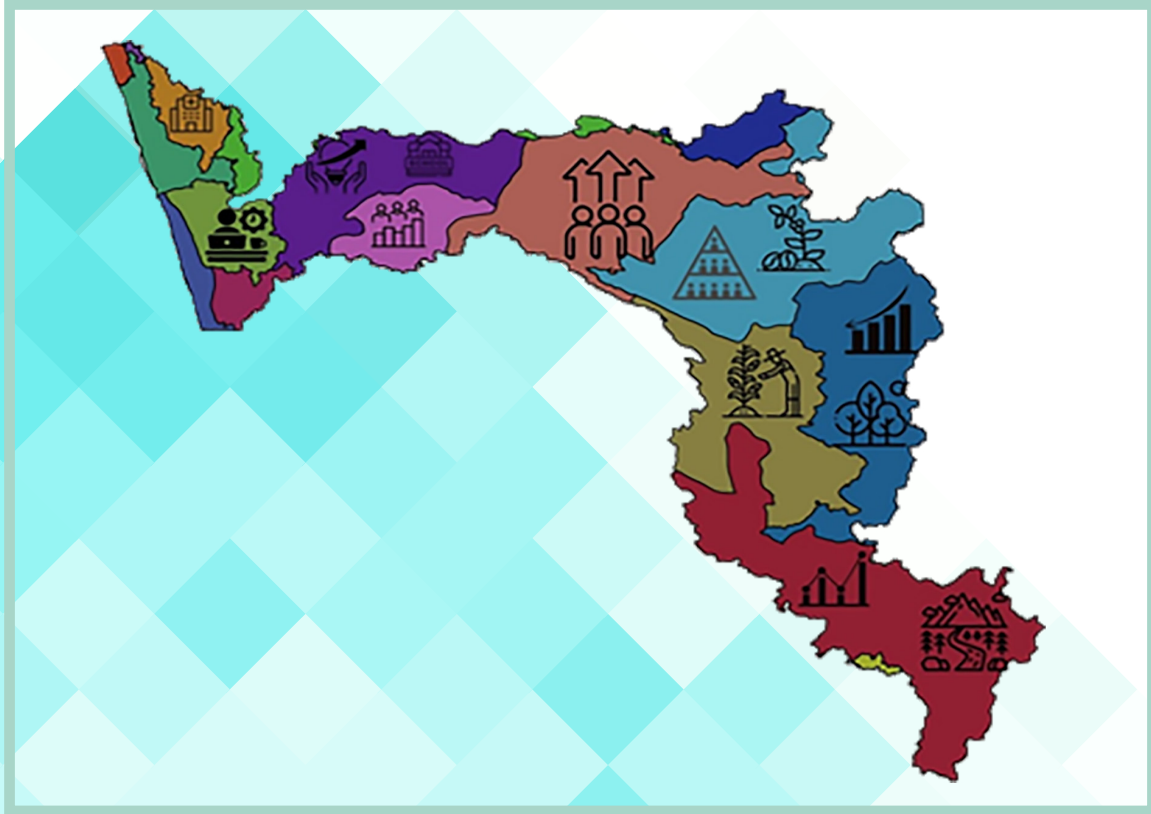


National River Conservation Directorate

Department of Water Resources, River Development & Ganga Rejuvenation

Ministry of Jal Shakti

Government of India



DEMOGRAPHY OF PERIYAR RIVER BASIN

SEPTEMBER 2024



Centres for Periyar River Basin Management Studies
(cPeriyar)



Centre for Ganga River Basin Management and Studies
(cGanga)

© cPeriyar, cGanga and NRCD, 2024

DEMOGRAPHY OF PERIYAR RIVER BASIN

SEPTEMBER 2024



© cPeriyar, cGanga and NRCD, 2024



NATIONAL RIVER CONSERVATION DIRECTORATE (NRCD)

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

www.nrcd.nic.in

CENTRES FOR PERIYAR RIVER BASIN MANAGEMENT STUDIES (cPERIYAR)

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

www.cperiyar.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 IIT Palakkad (Lead Institute) and NIT Calicut (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.

SUGGESTED CITATION

cPeriyar and cGanga (2024), Demography of Periyar River Basin, NRCD, DoWR, RD & GR, Ministry of Jal Shakti, Government of India.

TEAM

Athira P, cPeriyar, IIT Palakkad
Praveena G, cPeriyar, IIT Palakkad
Deepak Jaiswal, cPeriyar, IIT Palakkad
Subhasis Mitra, cPeriyar, IIT Palakkad
Sarmishta Singh, cPeriyar, IIT Palakkad
Vinod Tare, cGanga, IIT Kanpur
Rahul Ramachandran, cGanga, IIT Kanpur

Rajith K, cGanga, IIT Kanpur
Santhosh G Thampi, cPeriyar, NIT Calicut
Pramada S K, cPeriyar, NIT Calicut
N R Chithra, cPeriyar, NIT Calicut
Satheesh Kumar D, cPeriyar, NIT Calicut
Aswathy E V, cPeriyar, NIT Calicut
Ganaraj K, cPeriyar, NIT Calicut



जल शक्ति मंत्री
भारत सरकार

Minister for Jal Shakti
Government of India

संदेश

मानव सभ्यता का विकास नदियों के किनारे हुआ है, और इसे सुरक्षित रखने के लिए नदियों का संरक्षण अत्यंत आवश्यक है। भारत की नदियों के स्वास्थ्य और सुरक्षा के लिए 2019 में संसद के संयुक्त सत्र में राष्ट्रपति ने गंगा नदी के उदाहरण पर अन्य प्रमुख नदियों के बेसिन प्रबंधन की आवश्यकता पर बल दिया था। इस उद्देश्य की पूर्ति हेतु छह प्रमुख नदियों के बेसिन प्रबंधन में सी-गंगा के समग्र समन्वय से 12 प्रतिष्ठित शैक्षणिक संस्थाओं को शामिल करने का निर्णय लिया गया। राष्ट्रीय नदी संरक्षण निदेशालय द्वारा संचालित कंडीशन एसेसमेंट एंड मैनेजमेंट प्लान (कैप) प्रोजेक्ट नदियों के समग्र बेसिन प्रबंधन को साकार करने का प्रयास है।

नदियों के संरक्षण और उनके प्रबंधन के लिए इस तरह की पहल से न केवल हमारे प्राकृतिक संसाधनों का बचाव होगा, बल्कि स्थानीय समुदायों के जीवन और संस्कृति को भी संरक्षित किया जा सकेगा। यह अत्यंत हर्ष का भविष्य है कि इस प्रोजेक्ट के तहत तैयार की गई 'रिवर एट ए ग्लान्स' रिपोर्ट का लोकार्पण होने जा रहा है। जैसे किसी व्यक्ति के बाह्य स्वरूप से उसकी पुरी पहचान नहीं होती, वैसे ही नदी के व्यवहार और चुनौतियों को सिर्फ मुख्यधारा से नहीं समझा जा सकता। इसके लिए नदी के इतिहास, उसके किनारे बसे नगरों और गांवों की संस्कृति, सहायक नदियों और उस क्षेत्र के भूगोल को भी समझाना पड़ता है। इसी रिपोर्ट के जरिए नदी की पूरी प्रकृति, उसकी चुनौतियाँ, सहायक नदियाँ और आसपास के क्षेत्रों की सांस्कृतिक-भौगोलिक स्थिति को समझने के जो कोशिश की गई है, वह बहुत महत्वपूर्ण है।

हमें विश्वास है कि यह रिपोर्ट नदी, जल और पर्यावरण के क्षेत्र में काम करने वाले व्यक्तियों, संस्थाओं और हितकारकों के लिए अत्यधिक उपयोगी साबित होगी। रिपोर्ट के प्रकाशन और लोकार्पण के इस विशेष अवसर पर बधाई।


सीआर पाटील





जल शक्ति राज्य मंत्री
भारत सरकार, नई दिल्ली

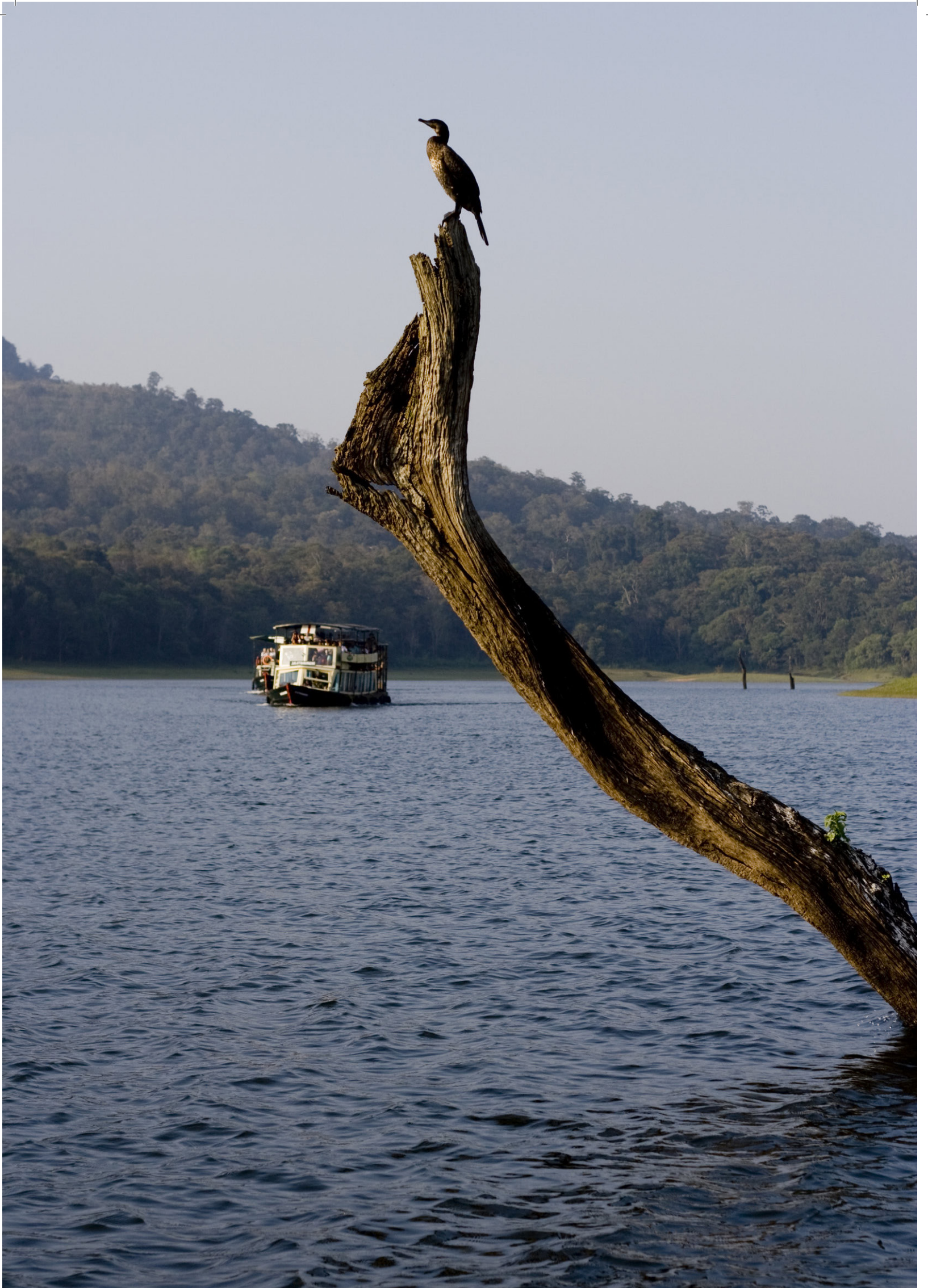
Minister of State for Jal Shakti
Government of India, New Delhi

संदेश

नदियां हमारे जीवन के लिए अत्यावश्यक संसाधन हैं और उनका पर्यावरणीय, सामाजिक, और आर्थिक महत्व भी बहुत अधिक है। नदियों का संरक्षण भविष्य की पीढ़ियों के लिए जीवन की गुणवत्ता सुनिश्चित करने की दिशा में एक महत्वपूर्ण कदम है। देश की छह प्रमुख नदियों के बेसिन प्रबंधन के लिए शीर्ष तकनीकी शिक्षण संस्थाओं के सहयोग से राष्ट्रीय नदी संरक्षण निदेशालय का कैप (कंडीशन एसेसमेंट एंड मैनेजमेंट प्लान) प्रोजेक्ट संरक्षण के लिए वर्तमान सरकार की प्रतिबद्धता दर्शाता है। भारत सरकार के नमामि गंगे मिशन के अंतर्गत किये प्रयासों से आज गंगा नदी के पुनर्जीवन को वैश्व मान्यता मिल चुकी है। उम्मीद है की ऐसी ही सफलता हमें कैप प्रोजेक्ट में भी मिलेगी।

रिवर बेसिन जनसांख्यिकी (डेमोग्राफिक) रिपोर्ट को देखकर हार्दिक प्रसन्नता हुई। कम समय में विस्तृत रिपोर्ट तैयार करने के लिए सभी सदस्यों को बधाई। जनसांख्यिकी रिपोर्ट न केवल हमें वर्तमान के बारे में अवगत कराता है, बल्कि इस रिपोर्ट को देखकर भविष्य की चुनौतियों और अपेक्षाओं का भी अनुमान लगाया जा सकता है। यह रिपोर्ट शासन, प्रशासन शिक्षण के लिए एक अहम दस्तावेज है।


डा. राज भूषण चौधरी



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.

cPeriyar and cGanga

CONTENT

Preface	9
List of Appendices	12
1. Introduction	14
1.1 Basin Overview	
1.2 Source of Data	
2. Administrative delineation at various levels within the Periyar River Basin	16
2.1. State Boundaries	
2.2. District Boundaries	
2.3. Sub-District Boundaries	
2.4. Block Boundaries	
2.5. Village Boundaries	
2.6. Map showing Urban Local Bodies (ULBs)	
3. Distribution of Population	26
3.1. Total Population	
3.1.1. Gender Distribution in the Periyar Basin	
3.2. Population Distribution Urban & Rural	
3.3. Population Growth Trends	
3.3.1. Population Growth Analysis for Ernakulam District	
3.3.2. Population Growth Analysis for Idukki District	
4. Demographic Characteristics	35
4.1. Age Structure	
4.2. Sex Ratio	
4.3. Household Composition	
4.4. Population Density	

5. Socio-Economic Characteristics	44
5.1. Educational levels	
5.2. Population Health	
5.2.1. Birth Rate	
5.2.2. Death Rate	
5.2.3. Life Expectancy	
5.2.4. Infant Mortality Rate (IMR)	
5.2.5. Maternal Mortality Ratio (MMR)	
5.3. Total Working Population	
5.3.1. Importance of the Working Population	
5.4. Total work force Participation Ratio	
5.5. Occupational Patterns in the Periyar Basin	
5.6. Income Levels	
6. Class I – VI Towns	62
7. Population Projection	64
7.1. Cohort Component Method for Population Projection	
7.2. Methodology for the Cohort Component Method	
7.3. Population Projection in Periyar River Basin	
8. Findings and Summary	70
9. Role of Demographic Data in Periyar River Basin Management	72
10. References	75

LIST OF ABBREVIATIONS

NDVA	Net District Value Added
NSDP	Net State Domestic Product
GSDP	Gross domestic product
ESRI	Environmental Systems Research Institute, Inc.
CIAL	Cochin International Airport Limited
BDO	Block Development Officer
ULB	Urban Local Bodies
IMR	Infant Mortality Rate
MMR	Maternal Mortality Ratio



1. Introduction

Basin demography studies provide detailed information about the population characteristics of the river basins. The study is crucial for several reasons, particularly in understanding the relationship between human populations and the environmental resources of the river basins. In this study, we gather data on population density, urbanization patterns, demographic shifts over time, age distribution, and sex ratio. This information is compiled into a report that is essential for assessing the socio-economic effects on the basin's environment and resources (UNESCO).

Demographic reports provide data on population size, density, age structure, gender distribution, employment patterns, and socio-economic status. This information is essential for planning and resource allocation, as it helps governments and organizations understand population trends and their impact on services like healthcare, education, and infrastructure, also helps in managing water resources effectively ([UNPF](#)). For instance, in the Ganga basin, the high population density impacts water quality and availability, necessitating targeted management strategies to address pollution and resource allocation (NMCG). The report tracks urbanization trends, which are vital for urban planning and infrastructure development. Many reports, highlight the need for sustainable development policies that can accommodate this growth while protecting the environment. They assess how population growth affects local ecosystems, such as forest cover and biodiversity. For example, in the Cauvery Basin, increased human populations contribute to forestland loss, which in turn affects local climate and agricultural practices (Cauvery Basin Report, 2014).

Demographic reports also delve into socio-economic conditions by providing insights into the characteristics of the population, including literacy rates and employment trends. This information is critical for developing targeted programs to improve education and economic opportunities in the basin. They also provide information about the population relying on various livelihoods including agriculture and the implications of shifting population dynamics on local economies and ecosystems. Policymakers use these reports to formulate strategies that address the challenges posed by population dynamics, such as pollution control, sustainable land use, and climate change adaptation. Understanding demographic trends allows for more effective governance and resource allocation within the basin. The comprehensive data presented in these reports can facilitate dialogue among stakeholders, including government agencies, local communities, and environmental organizations. This engagement is crucial for collaborative policy formulation that reflects the needs and priorities of all parties involved.

1.1 Basin Overview

Periyar ('Peri' – Big, 'Aar' – River), is the longest river in Kerala, extending for 244 km. It is also the state's second-largest river basin, covering an area of 5,245 km². Most of the river's catchment area—about 5,131 km²—lies within Kerala, with the remaining 114 km² located in

the Anamalai Hills of Tamil Nadu. The Periyar River has the highest discharge capacity among all rivers in Kerala and serves as one of the region's few perennial water sources, providing a critical supply of drinking water to numerous communities. It discharges into the Arabian Sea at Cochin, playing a crucial role in the state's economy. The river supports Kerala's energy needs through the Idukki Dam, and its waters are vital for domestic use, irrigation, tourism, industry, resource collection, and fisheries.

The Periyar River Basin encompasses six districts – Idukki (3025.6 sq. km), Ernakulam (1735.3 sq. km), Thrissur (358.1 sq. km), Pathanamthitta (14.5 sq. km) and Kottayam (0.14 sq. km), in Kerala, and Coimbatore (114 sq. km) in Tamil Nadu. The basin has 87 villages, 67 towns, 17 taluk and 25 blocks. The sole Municipal Corporation in the basin is Kochi, located in the Ernakulam district. The total population of the basin is 3.76 million. The Periyar river basin spans majorly Idukki with 57.6%, followed by Ernakulam (33.1%), Thrissur (6.8%) of the total area with minor parts in Coimbatore (2.2%), Pathanamthitta (0.3%) and Kottayam (0.08%). Major part of the basin lies in the Idukki, Ernakulam, and Thrissur district of Kerala. Thus, these three districts are considered in the demographic analysis done at the district level.

The Periyar River basin is home to several indigenous tribal communities, including the Mannans, Palians, Uralis, Mala-arayas, and Malampandarams. They rely on shifting agriculture, fishing, honey, and nontimber forest produce for survival. Farmers in the midland belt grow paddy, coconut, and plantain, while those in the foothills cultivate rubber, coconut, and pepper. Riverside villages harvest high-value fin fish and shellfish.

1.2 Source of Data

The analysis of basin demography incorporates diverse data types to offer a thorough understanding of population dynamics and their impact on the river basin. The data and statistics analyzed in this study are derived from secondary sources, as listed in Table 1.

Table 1. Source and Type of Data

Sl. No.	Type of Data	Source
1	Administrative Boundaries	Survey of India, 2015
2	Population Data and Statistics	Census, Govt. of India, 2011
3	Education and Health Data	Department of Economics & Statistics, Govt. of Kerala 2011
4	Population Projections	Environmental Systems Research Institute, Inc. (ESRI)

2. Administrative delineation at various levels within the Periyar River Basin

Administrative delineations refer to the hierarchical divisions of governance and management within a region, designed to facilitate the organization of public services and the implementation of policies. In this report, we focus specifically on the administrative boundaries at the state, district, sub-district (taluk), Block, and Village levels. These divisions are critical for demographic studies as they allow for a structured analysis of population distribution, resource allocation, and socio-economic planning. A comprehensive understanding of the demographic patterns within the region can be understood by studying the variations within the administrative units. Figure 1 shows the boundary of the Periyar River Basin. The basin has an inverted 'L' shape, with its widest point at the intersection. About 77% of the basin is covered by vegetation, including evergreen forests, deciduous forests, degraded forests, and scrubs.

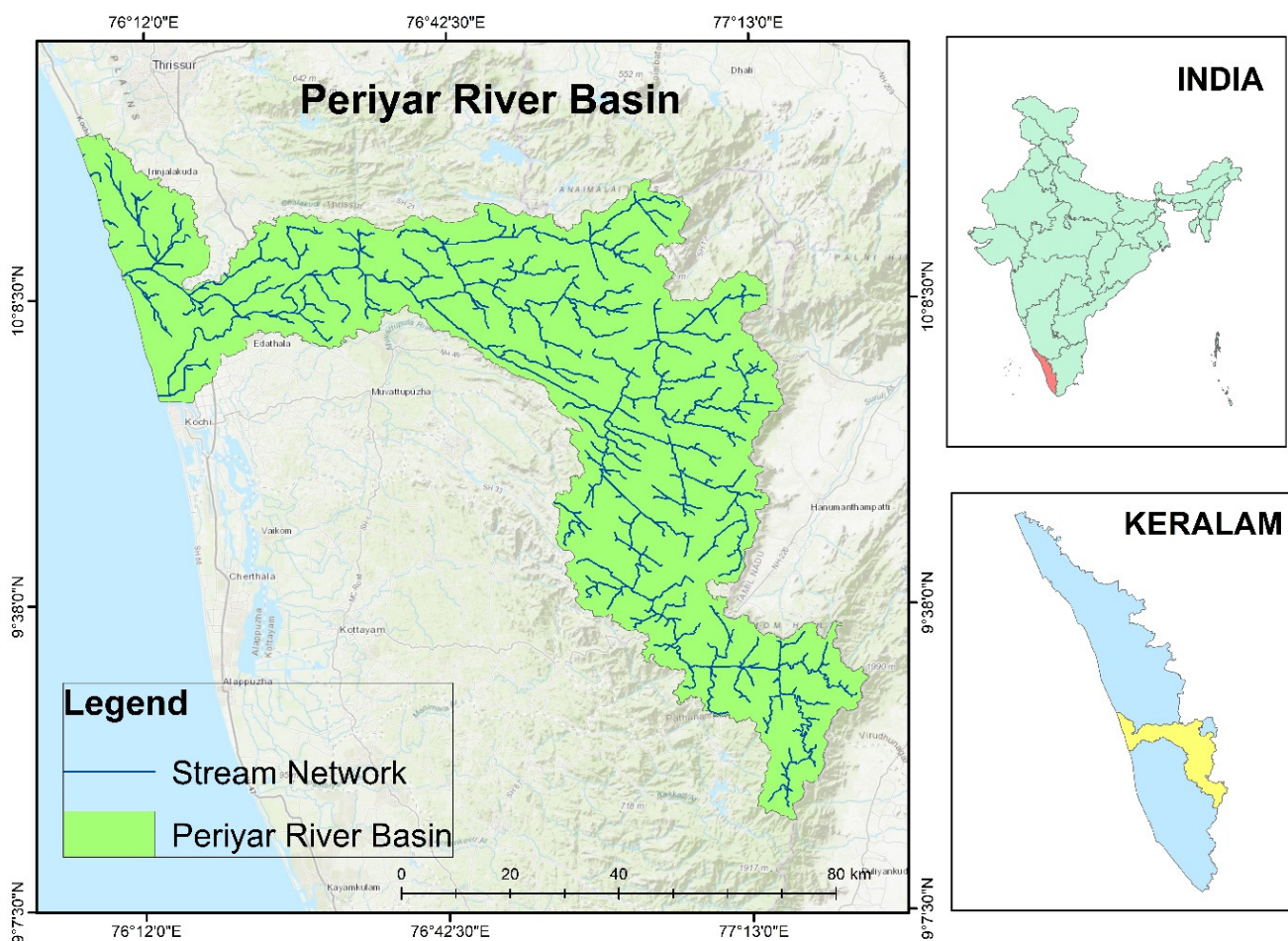


Figure 1. Boundary of the Periyar River Basin

2.1 State Boundaries

The Periyar River primarily flows through Kerala, with its tributaries extending into Valparai in Tamil Nadu. The river's basin covers 5,131 km² in Kerala (98%) and 114 km² in Tamil Nadu (2%). Of the 14 districts in Kerala, only 5 are included in our study area, with 2 of these districts covering less than 1% of the total area. In Tamil Nadu, only one out of the 38 districts fall

within the study area, accounting for merely 2% of the total coverage. Most dams in the Periyar Basin are located in Kerala, with none in the Tamil Nadu portion of the basin. Sandy clay loam soils dominate approximately 80% of the basin, primarily in Kerala. The remaining 20% of the basin, consisting of clay loam soils, is found mostly in Tamil Nadu and some areas of Kerala. The land use in the basin is predominantly diverse in Kerala, whereas Tamil Nadu is characterized by primarily vegetative cover due to the protected status of these areas. Key elements of the basin, including industrial zones, ecologically sensitive regions, dams, irrigation systems, major agricultural areas, high population density, culturally significant sites, and a rich diversity of flora and fauna, are concentrated mainly within the Kerala region. Figure 2 depicts the state boundaries of Kerala and Tamil Nadu within the basin

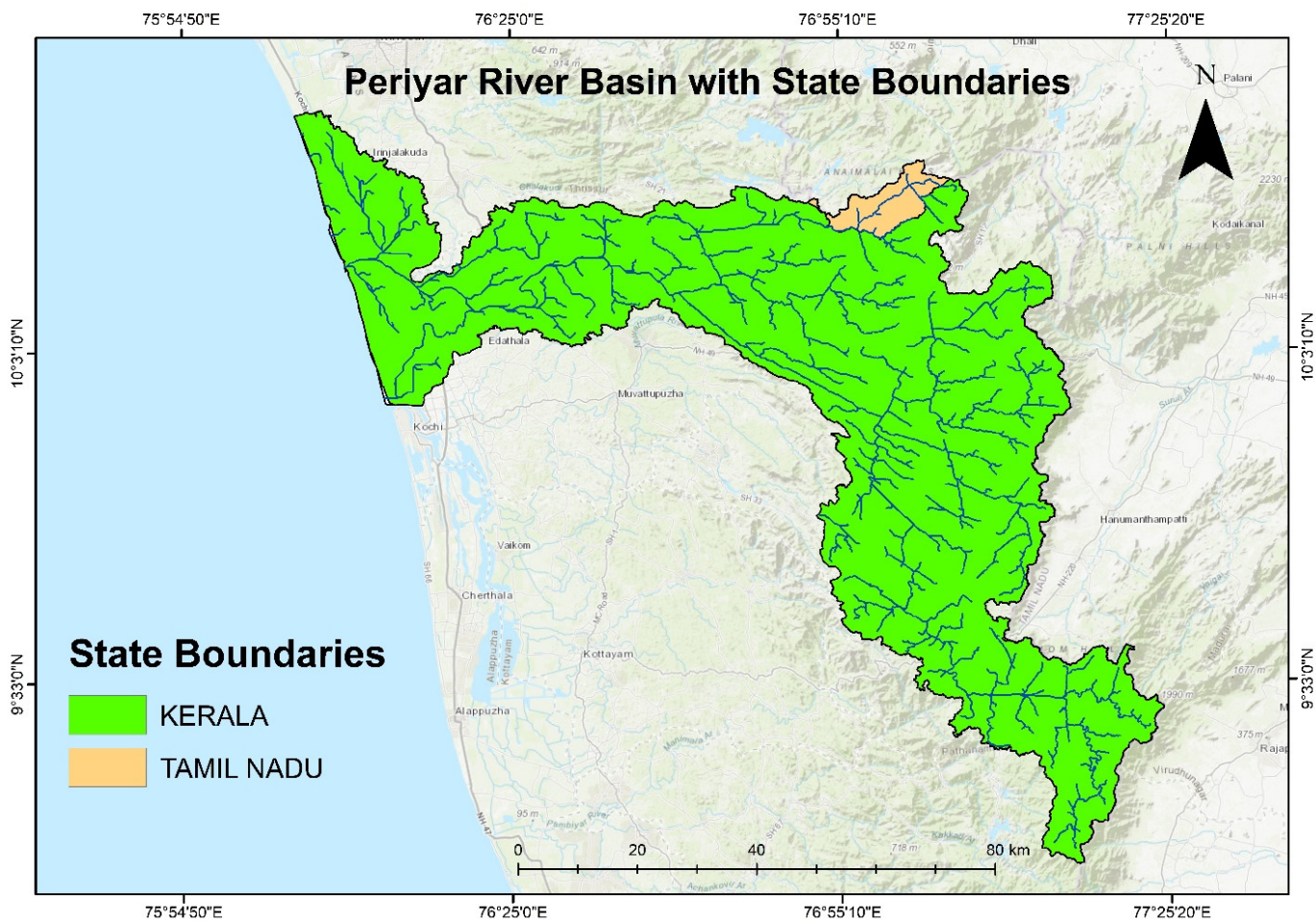


Figure 2. Periyar River Basin with State Boundaries

2.2 District Boundaries

District, an administrative unit or division, often used in the context of local government. It serves as a key region for governance, law enforcement, and administration. The study area, include 5 districts of Kerala, with 2 of them accounting for less than 1% of the total area. In the state of Tamil Nadu, one out of 38 districts come within the basin boundary, accounting for only 2% of the area. Table 2 presents the districts that comprise the Periyar River Basin, along with their respective areas in square kilometres and their percentage contribution to

the basin. The majority of industries, and consequently pollution sources, are concentrated in Ernakulam, where all urban local bodies are situated.

Table 2. Periyar Basin District Boundaries

Districts	Area (sq km)	Percentage Composition
Idukki	3025.6	57.6
Ernakulam	1735.3	33.1
Thrissur	358.1	6.8
Coimbatore	114	2.2
Pathanamthitta	14.5	0.3

Figure 3, the district boundaries of Idukki, Ernakulam, Pathanamthitta, Thrissur, and Coimbatore, which encompass the Periyar River Basin, are shown.

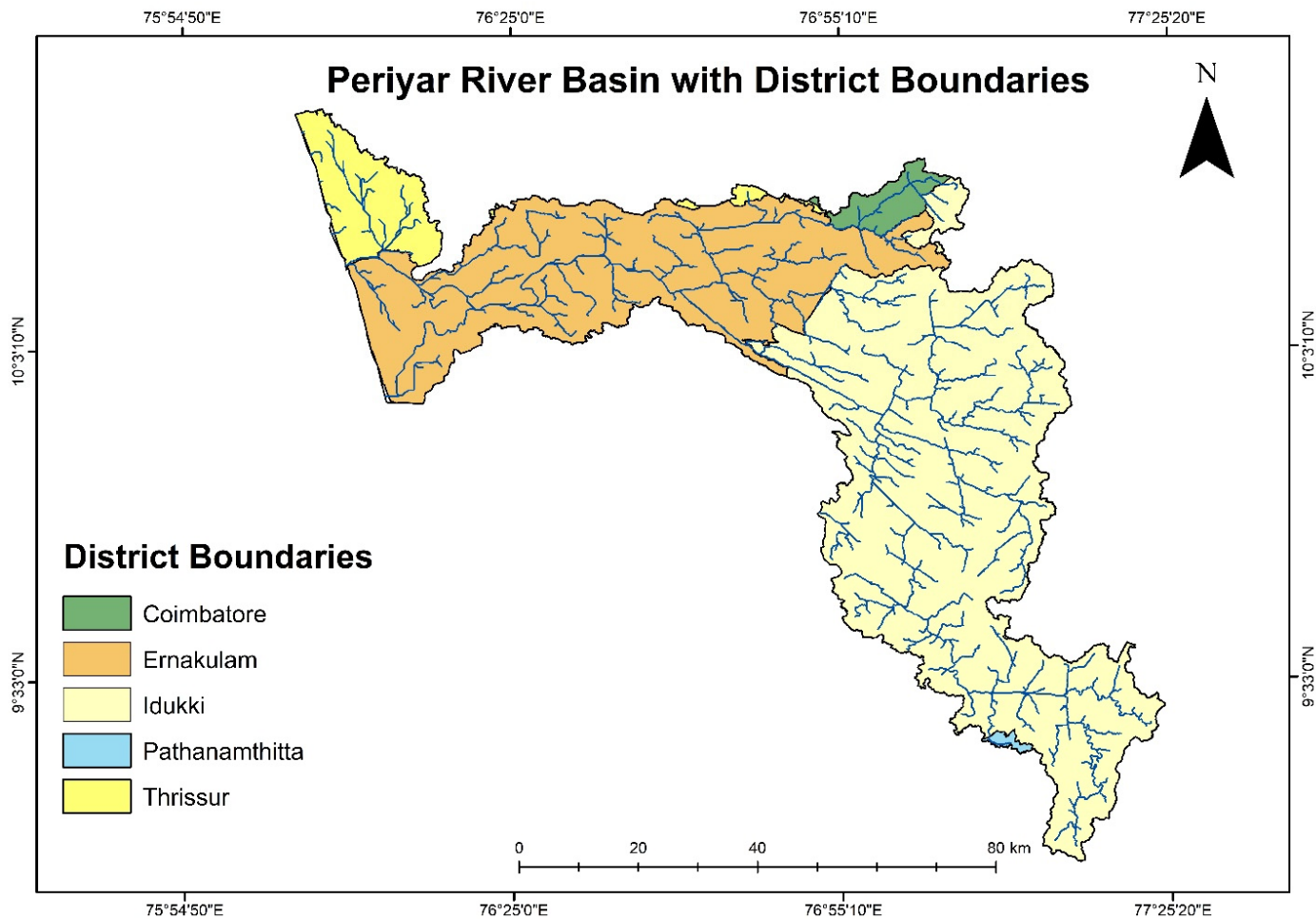


Figure 3. Periyar Basin District Boundaries

Idukki and Valparai holds considerable social and ecological significance, being home to most of the region's tribal communities. Economically, Ernakulam is vital, housing the CIAL and harbours. The Cochin International Airport, Chendamangalam and Munambam Fish Harbour are locations of economic importance. These locations come in the downstream side of the basin. Cochin International Airport, owned and operated by Cochin International Airport Limited (CIAL), is the first airport in India built under Public Private Partnership. It ranks as the third busiest for international passengers and seventh largest overall in India. As of 2022, Cochin Airport handles 61.8% of Kerala's total air passenger movement. The diverse investor base has played a crucial role in nurturing the airport, a significant undertaking materialized by the State Government, which remains the largest investor with a stake of approximately 34%. Idukki leads in agriculture, producing 90% of Kerala's cardamom, while Ernakulam and Thrissur contribute notably to paddy, tapioca, coconut, and banana production.

2.3 Sub-District Boundaries

A subdistrict is an administrative division that is smaller than a district and functions as a subdivision within a larger district. In our country, it is often referred to as a tehsil or taluk. The Periyar Basin encompasses 17 sub-districts, spanning across Idukki, Ernakulam, Thrissur, Pathanamthitta, and Kottayam in Kerala, as well as Coimbatore in Tamil Nadu. Table 3 details the sub-districts or taluks within the basin and their corresponding districts, along with their respective areas.

Table 3. Periyar Basin Subdistrict Boundaries

Sl. No.	Sub District	District	Area (sq. km.)
1	Aluva	Ernakulam	464.2
2	Chalakkudy	Thrissur	74.7
3	Chavakkad	Thrissur	20.4
4	Devikulam	Idukki	753.5
5	Idukki	Idukki	599.9
6	Kanayannur	Ernakulam	77.7
7	Kochi	Ernakulam	72.3
8	Kodungallur	Thrissur	141.7
9	Konni	Pathanamthitta	14.0
10	Kothamangalam	Ernakulam	723.0
11	Kunnathunad	Ernakulam	213.1
12	Mukundapuram	Thrissur	117.1
13	Paravur	Ernakulam	183.3
14	Peerumade	Idukki	1008.9
15	Thrissur	Thrissur	5.7
16	Udumbanchola	Idukki	663.4
17	Valparai	Coimbatore	114.0

Among these, the Peerumade taluk contributes the largest area of 1008.9 km², which is 19% of the total basin area, while Thrissur taluk contributes the smallest area of 5.7 km². Figure 4 offers a detailed map of the sub-district or taluk boundaries within the basin, covering 17 sub-districts.

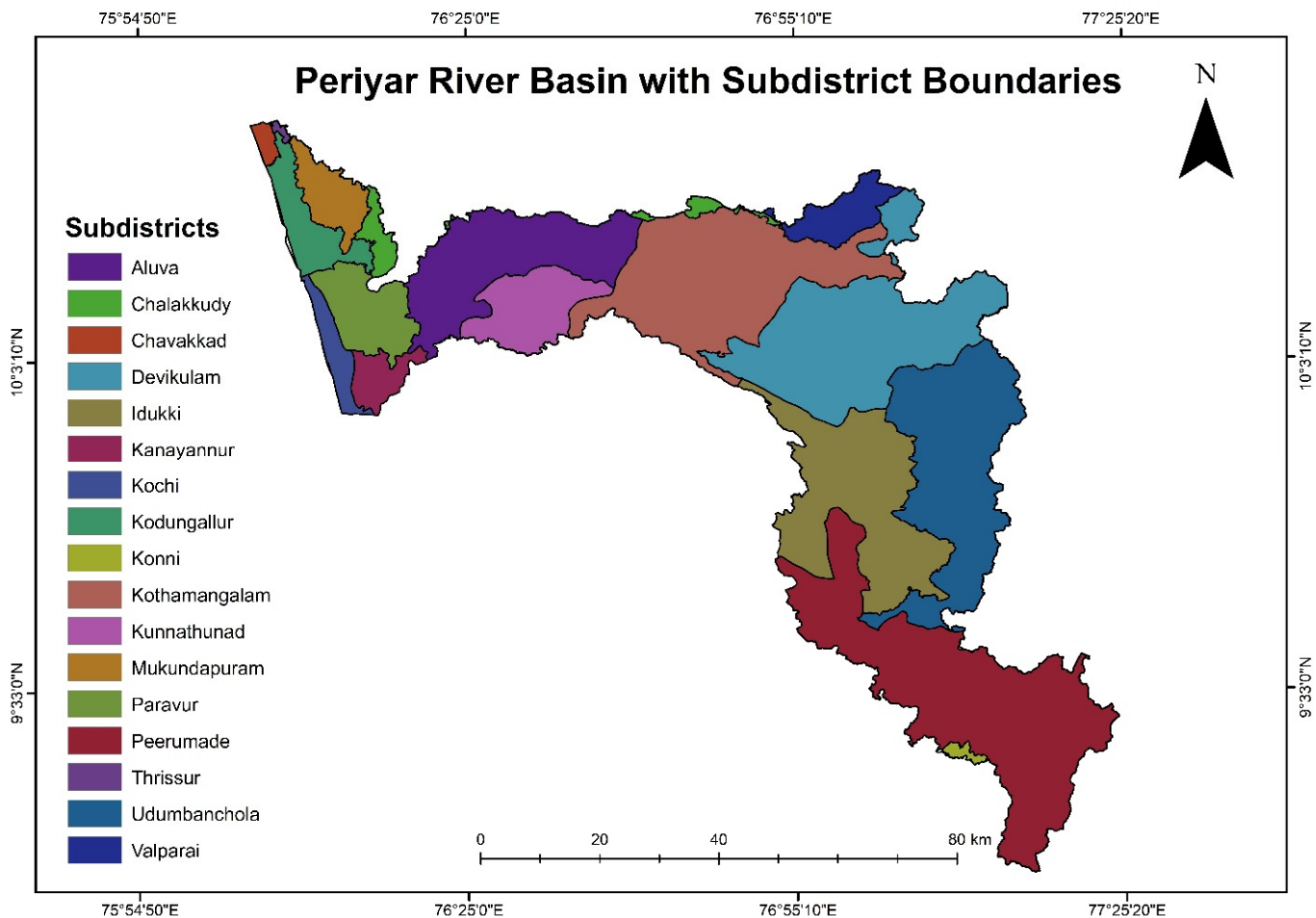


Figure 4. Periyar Basin Subdistrict Boundaries

Peerumade served as a summer retreat for the British during the colonial period, and it continues to attract tourists with its serene landscapes and charming hill stations. The area is also rich in biodiversity, with dense forests and a variety of flora and fauna and its economy is primarily driven by agriculture (Idukki -Govt. of Kerala). Konni taluk contributes more to the basin than Thrissur taluk.

2.4 Block Boundaries

A "Block" (also known as a "Development Block" or "Community Development Block") is an administrative division within a district. Blocks are part of the rural administrative framework in India and are designed to facilitate local governance and development planning at the grassroots level. Each block is typically made up of a group of villages and is headed by a Block Development Officer (BDO), who oversees various government schemes, development programs, and local administration. Table 4 focuses on the blocks within the basin, and their corresponding districts, along with their respective areas. Figure 5 highlights the block boundaries within the basin, comprising 25 blocks.

Table 4. Periyar Basin Block Boundaries

Sl. No.	Blocks	Districts	Area (km ²)
1	Alangad	Ernakulam	75.4
2	Angamaly	Ernakulam	359.9
3	Idappally	Ernakulam	18.3
4	Koovappady	Ernakulam	165.7
5	Kothamangalam	Ernakulam	720.0
6	Parakkadavu	Ernakulam	99.4
7	Paravoor	Ernakulam	62.7
8	Vazhakkulam	Ernakulam	60.6
9	Vypin	Ernakulam	82.3
10	Adimali	Idukki	412.8
11	Azutha	Idukki	898.9
12	Devikulam	Idukki	604.7
13	Elamdesom	Idukki	91.1
14	Idukki	Idukki	335.7
15	Kattappana	Idukki	329.9
16	Nedumkandam	Idukki	346.0
17	Ranni	Pathanamthitta	14.4
18	Anthikkad	Thrissur	5.5
19	Chalakudi	Thrissur	27.4
20	Irinjalakkuda	Thrissur	14.4
21	Kodungalloor	Thrissur	34.4
22	Mala	Thrissur	73.8
23	Mathilakam	Thrissur	72.7
24	Thalikulam	Thrissur	19.6
25	Vellangallur	Thrissur	100.1

Among these, the Azutha block in Idukki is the largest contributor to the Periyar basin, covering 898.9 km², followed by the Kothamangalam block in Ernakulam, which spans 720 km². Azhutha is known for its hilly terrain, agricultural activities like tea, coffee, and spice cultivation, and its rich natural resources and scenic beauty, making it significant for both agriculture and tourism. Kothamangalam is historically significant and renowned for its agricultural production of rubber, coconut, and spices, and it also serves as a gateway to the Thattekad Bird Sanctuary, attracting bird watchers and nature enthusiasts. (LSGD). Despite having fewer blocks, the Idukki district contributes a larger area to the basin compared to other districts.

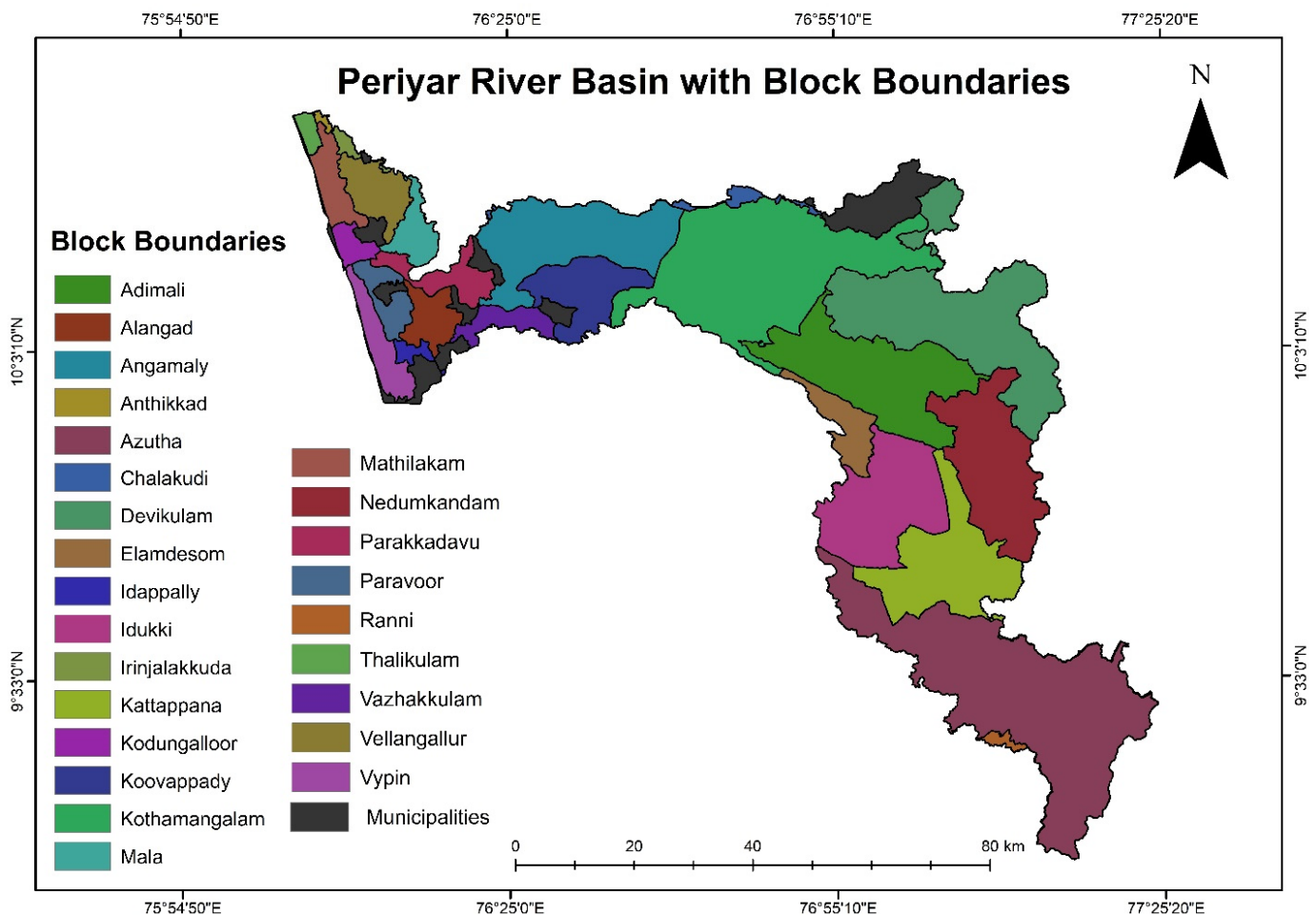


Figure 5. Periyar Basin Block Boundaries

2.5 Village Boundaries

A village is the smallest unit of rural governance, often governed by a Gram Panchayat, which is an elected body responsible for local administration. Villages serve as the primary level for implementing government schemes and programs at the grassroots level. They are crucial in the decentralized governance structure, enabling direct interaction with the rural population. The Periyar Basin encompasses a total of 87 villages, with 26 in Ernakulam, 40 in Idukki, 20 in Thrissur, and one in Pathanamthitta. Table 5 lists the villages situated within the basin boundaries, and their corresponding districts. The Kuttampuzha village in Ernakulam covers the largest area within the basin at 646.5 km², followed by Mlappara village in Idukki district, which spans 474.3 km². Kuttampuzha is known for its tranquil environment and agricultural activities. It is situated amidst lush greenery and contributes to the local economy with its diverse crops. (Ernakulam-Govt. of Kerala). Mlappara is recognized for its scenic beauty and agricultural prominence. The village is surrounded by hills and forests, making it a picturesque location with a strong focus on farming and natural resource utilisation. (Idukki-Govt. of Kerala). The majority of Idukki district's villages are within the Periyar Basin, contributing not only the highest number of villages but also a significant portion of the basin's area. Figure 6 illustrates the village boundaries, encompassing 87 villages.

Table 5. Periyar Basin Village Boundaries

Ernakulam							
1	Arakapady	2	Asamannoor	3	Ayyampuzha	4	Edavanakkad
5	Ezhikkara	6	Karukutty	7	Keerampara	8	Kodanad
9	Kombanad	10	Kottappady	11	Kunnukara	12	Kuttampuzha
13	Kuzhuppilly	14	Malayattoor	15	Manjapra	16	Mookkannoor
17	Nayarambalam	18	Neriamangalam	19	Pallippuram	20	Parakkadavu
21	Pindimana	22	Rayamangalam	23	Thrikkariyoor	24	Thuravoor
25	Vengoor	26	Vengoor West				
Idukki							
27	Kannan Devan Hills	28	Mannamkandam	29	Mankulam	30	Pallivasal
31	Vellathuval	32	Anaviratty	33	Kunjithanny	34	Idukki
35	Ayyappancoil	36	Kattappana	37	Konnathady	38	Kanjikuzhi
39	Thankamony	40	Vathikudy	41	Upputhode	42	Mlappara
43	Kumily	44	Upputhara	45	Periyar	46	Elappara
47	Vagamon	48	Manjumala	49	Peerumade	50	Chinnakanal
51	Parathodu	52	Kalkoonthal	53	Karunapuram	54	Baisonvally
55	Poopara	56	Rajakumari	57	Udumbanchola	58	Pampadumpara
59	Santhanpara	60	Anakkara	61	Anavilasam	62	Chathurangapara
63	Kanthippara	64	Rajakkad	65	Vandanmedu	66	Chakkupallam
Pathanamthitta							
67	Chittar						
Thrissur							
68	Alathur	69	Annallur	70	Azhikode	71	Eriyad
72	Kaduppassery	73	Kakkulissery	74	Karumathra	75	Kizhakkummuri
76	Koolimuttam	77	Kottanellur	78	Kuruvilassery	79	Nattika
80	P. Vemballur	81	Pariyaram	82	Puthenchira	83	Thazhekkad
84	Thirumukkulam	85	Vadakkumbhagom	86	Valappad	87	Vallivattom

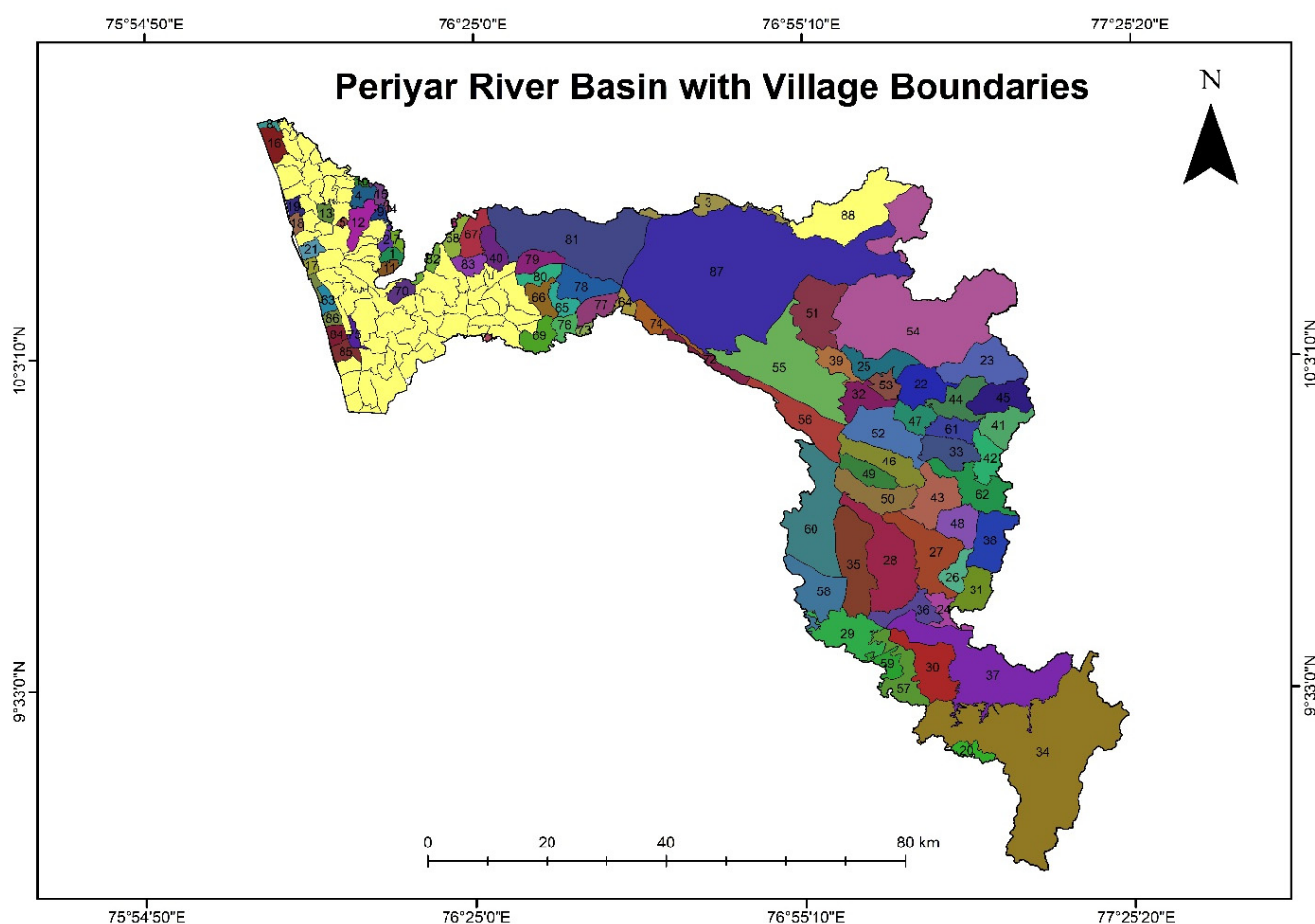


Figure 6 Periyar Basin Village Boundaries

2.6 Urban Local Bodies (ULBs)

Urban Local Bodies (ULBs) are the key institutions of local self-governance which is responsible for delivering essential services to urban citizens, including public health, education, sanitation, waste management, transportation, and housing development. Urban local bodies include Municipal Corporations and Municipalities which vary in size and function based on the population and administrative needs of the area. Municipal Corporation are the largest urban local bodies which governs cities with significant populations. They are responsible for major infrastructure development, public services, sanitation and urban planning. Municipalities govern smaller cities and towns by managing the local administration of the area. Figure 7 represents the administrative boundaries of various urban local bodies in the Periyar River Basin. It consists of a total of 1 Municipal Corporation namely Kochi Corporation and 10 Municipalities, including Thrikkakkara Municipality, Perumbavoor Municipality, North Paravur Municipality, Kalamassery Municipality, Irinjalakkuda Municipality, Eloor Municipality, Angamaly Municipality, Aluva Municipality, Kodungallur Municipality and Valparai Municipality.

Kochi Corporation is a premier urban local body in Kerala. As the commercial capital of the state, Kochi plays a significant role in its economic and social development. As per the census of 2011, the population of Kochi Corporation is 6,02,046. As a key metropolitan city, it plays

a crucial role in both regional and national trade, offering modern amenities, higher educational institutions, advanced infrastructure, major transportation hubs like Kochi International Airport and seaports.

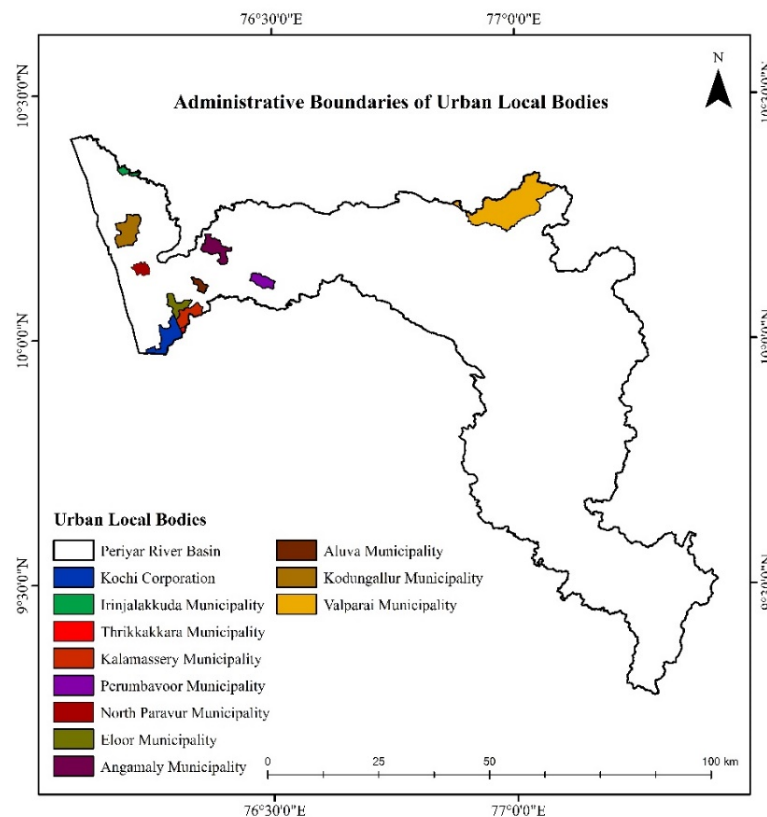


Figure 7. Administrative boundaries of urban local bodies in the Periyar River basin

Figure 8. represents demographic distribution of various municipalities based on their population figures. Among the 10 municipalities, 9 are located in Kerala, while Valparai Municipality is located in Tami Nadu.

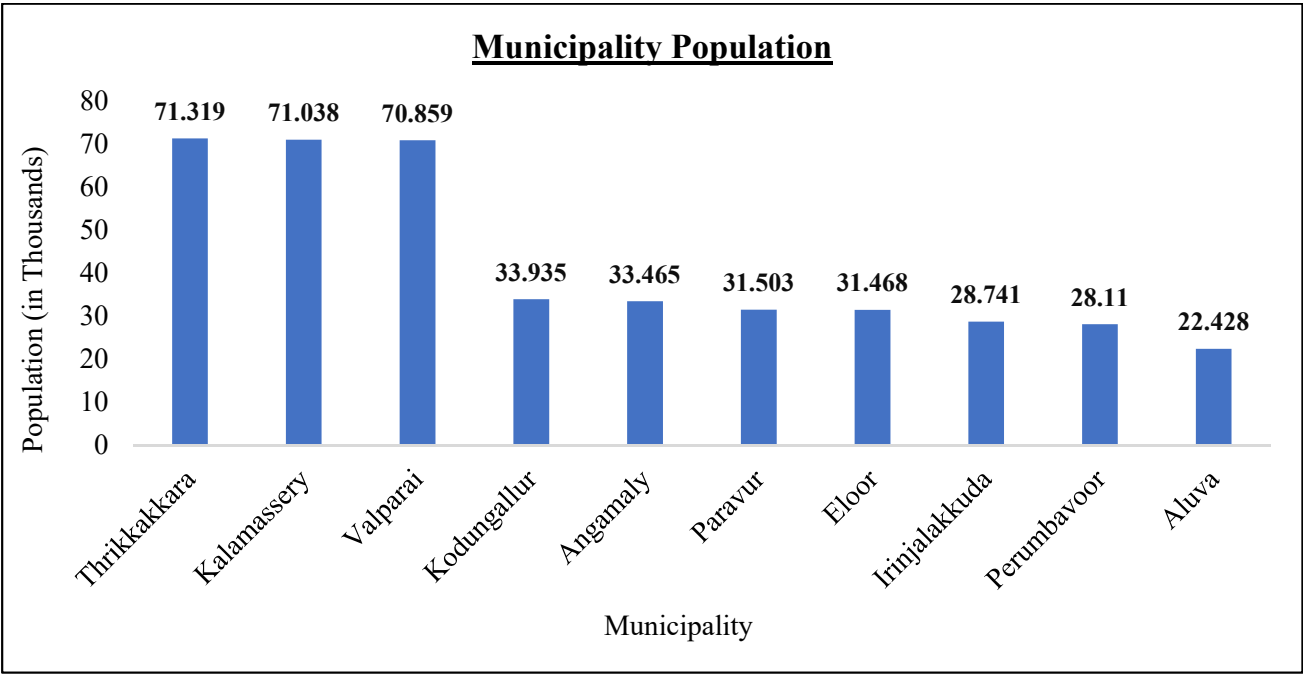


Figure 8. Population distribution in Municipalities

The analysis aims to understand the differences in population across the municipalities in the Periyar River basin. Among these, Thrikkakkara, Kalamassery, and Valparai have the highest populations, each approaching 70,000. This indicates that these areas are more urbanized, likely due to factors such as better infrastructure, employment opportunities, and greater access to resources. On the other hand, Eloor, Irinjalakkuda, and Perumbavoor have populations ranging from 30,000 to 40,000, suggesting a more balanced urban-rural characteristic. Urbanization in these areas may be present but on a smaller scale compared to the top municipalities. Aluva, with just 22,428 residents, has the smallest population among the Municipalities. This could indicate a less urbanized region or slower population growth compared to others.

3. Distribution of Population

Distribution of Population refers to the way in which people are spread out across a specific area, whether it be a country, region, city, or other geographic unit. Studying the distribution of population in a river basin involves examining how people are spread throughout the geographical area of the Periyar basin. It involves understanding where and how densely populations are concentrated in different parts of the basin, including urban, rural, and isolated areas. This distribution is influenced by factors like the availability of water resources, land use patterns, economic activities, and environmental conditions within the river basin. It helps in planning and managing resources, infrastructure, and services to meet the needs of the population living in the basin.

3.1 Total Population

The total population of an area refers to the entire number of people living within a defined geographic region, such as a city, town, state, country, or any specified area. This count includes all residents, regardless of age, gender, nationality, or legal status, and it serves as a fundamental demographic indicator used in various statistical analyses, planning, and resource allocation. Population data is typically collected through censuses, surveys, or estimations by government and research organizations. To obtain an accurate population estimate of the basin, data from the 2011 Census was used at the village level. The population figures for each village were aggregated to their respective sub-districts, ensuring that only the population within the basin is represented, rather than the entire sub-district. This method avoids overestimations and inaccuracies, especially since only two districts are predominantly within the basin while others contribute minimally. A district-wide population approach would have led to substantial errors in the analysis.

According to the 2011 Census, the Periyar Basin hosts a population of 3.76 million, representing less than 1% of the total population of India. For a more detailed understanding of the population distribution within the basin, our study focuses on the subdistrict (taluk) level rather than the district level. Figure 9 illustrates the population distribution across the

17 subdistricts within the basin—16 from Kerala and 1 from Tamil Nadu, with populations expressed in lakhs.

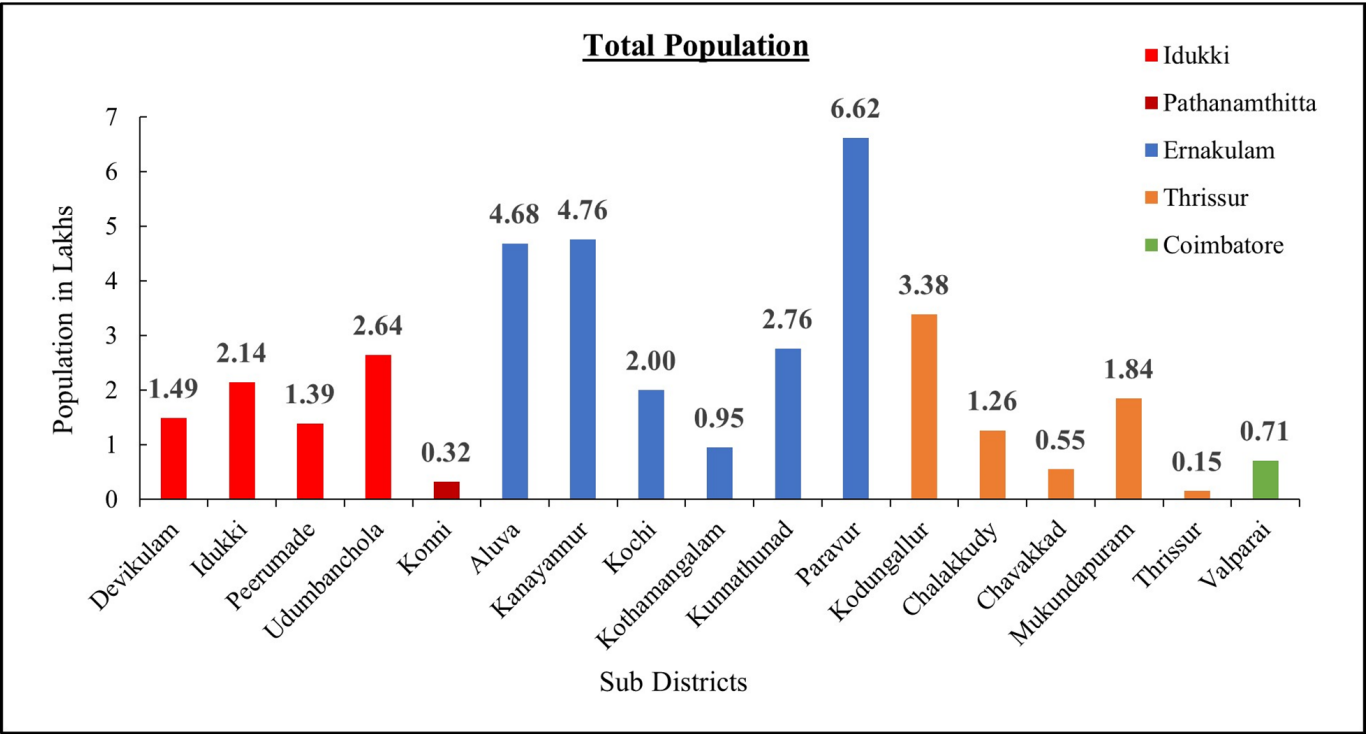


Figure 9. Graph depicting the population distribution across various sub-districts.

The data reveals that Paravur taluk in Ernakulam district has the highest population in the basin, with 6,61,766 people, accounting for 17.5% of the basin’s total population. This high population density is largely due to Paravur’s proximity to urban centres like Kochi, offering enhanced access to employment, education, healthcare, and developed infrastructure that attracts residents. Following Paravur, Kanayannur taluk in Ernakulam has a population of 4,75,808, making up 12.6% of the basin’s population, and Aluva taluk, also in Ernakulam, hosts 4,68,408 people, representing 12.4% of the basin’s population. Conversely, Thrissur taluk in Thrissur district is the least populated subdistrict in the basin, with only 15,018 people, contributing less than 1% due to its limited area within the basin. Similarly, Konni taluk in Pathanamthitta district has 31,969 people, contributing less than 1% of the basin’s population due to its small geographic area.

Figure 10 provides a basin map depicting the population distribution across subdistricts, highlighting both their area coverage and their share of the basin population. The subdistricts were assessed based on their proportionate contribution to the basin’s total population, categorized into ranges: 0-4% and 12-18%, with the latter representing the highest contributors. The map underscores that Ernakulam district, while covering only 33.1% of the basin’s area, contributes the largest share of the population, with 2,176,497 residents, or 57.8% of the basin’s total population.

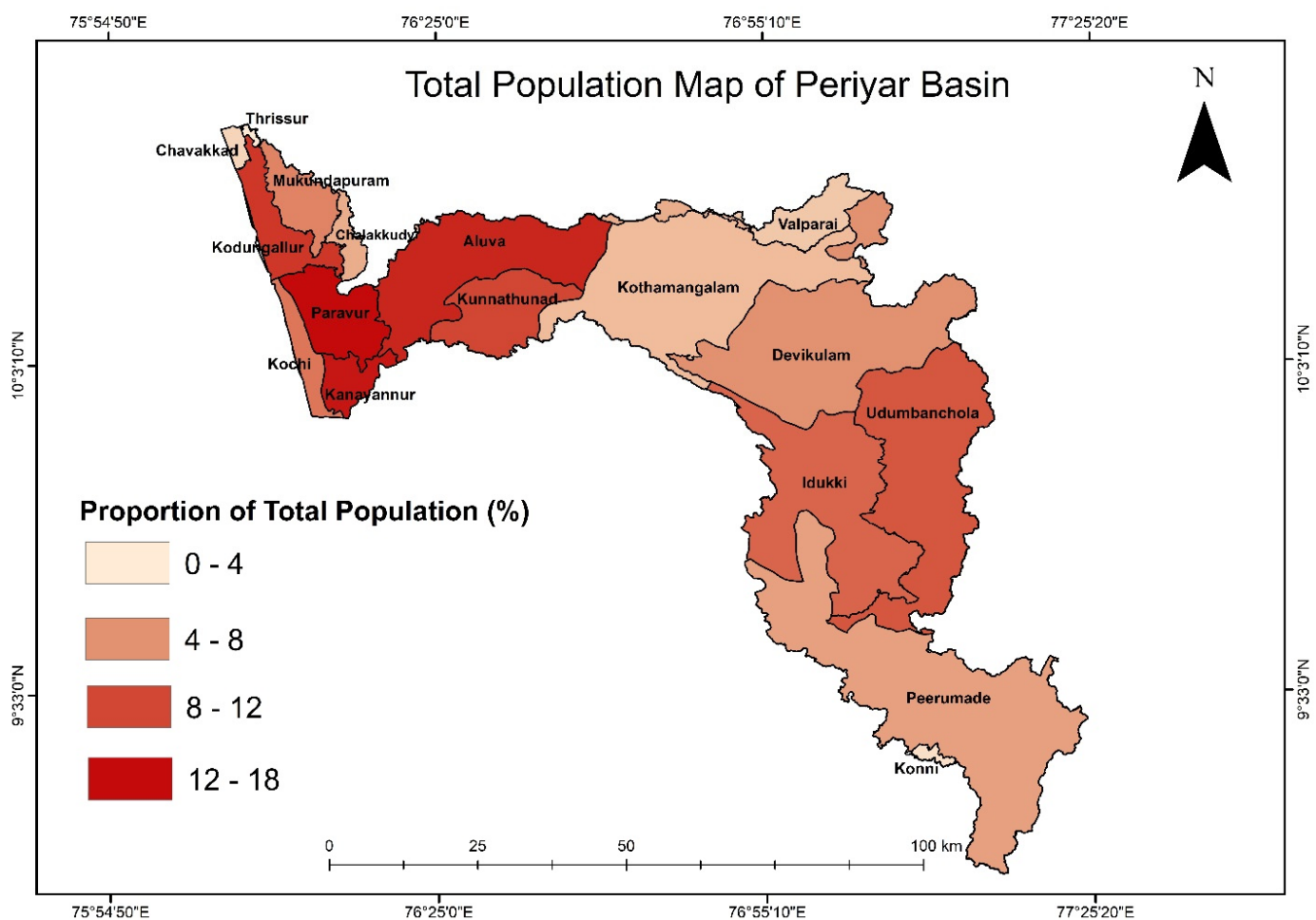


Figure 10. Map illustrating the population distribution across different sub-districts.

Ernakulam's substantial population is attributed to its role as a major urban and commercial hub, including Kochi, which offers extensive opportunities for employment, education, and healthcare, along with advanced infrastructure and connectivity. In contrast, the Idukki district, which spans 57.6% of the basin's area, contributes just 20.3% of the basin's population (7,65,390 people), primarily due to its challenging terrain, dense forests, and wildlife sanctuaries that limit urbanization and large-scale agricultural activities. Thrissur district, occupying only 6.8% of the basin's area, supports 7,18,822 people, or 19% of the basin's population, driven by its cultural significance, strong agricultural base, and vibrant commercial activities.

3.1.1 Gender Distribution in the Periyar Basin

Analyzing the distribution of males and females in the Periyar Basin is crucial for demographic studies. Understanding the distribution of males and females in an area is important for effective planning and resource allocation, as it influences the needs for healthcare, education, and employment opportunities tailored to each gender. It helps identify gender imbalances, which can affect social dynamics, economic development, and the design of targeted policies for gender equality and empowerment. Additionally, analyzing this distribution aids in understanding demographic trends like birth rates, workforce participation, and dependency ratios, crucial for long-term planning.

Figure 11 presents the male and female population distribution across subdistricts. Similar to the overall population trend, Paravur taluk of Ernakulam has the highest male population comprising 17.6% of the basin’s male population, followed by Kanayannur (12.6%) and Aluva (12.5%). The lowest male population is observed in Thrissur taluk. Ernakulam district accounts for 58.1% of the basin’s male population, reinforcing its status as the highest contributor. Figure 12 shows the spatial distribution of the male population, highlighting that Idukki contributes only 20.8% of the basin’s male population, with a population difference of less than 37% between Ernakulam and Idukki.

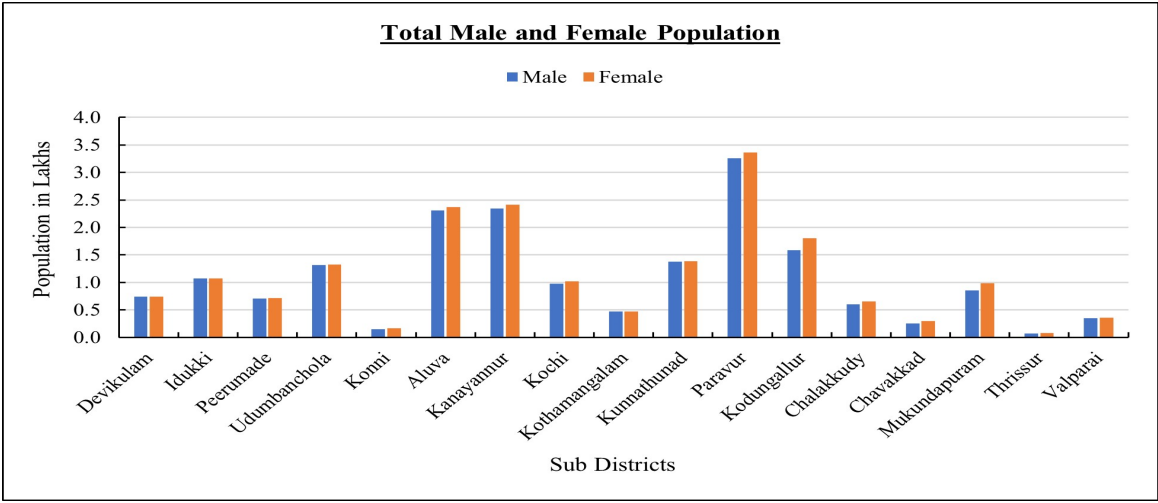


Figure 11. Graph showing the distribution of male & female population in various sub-districts

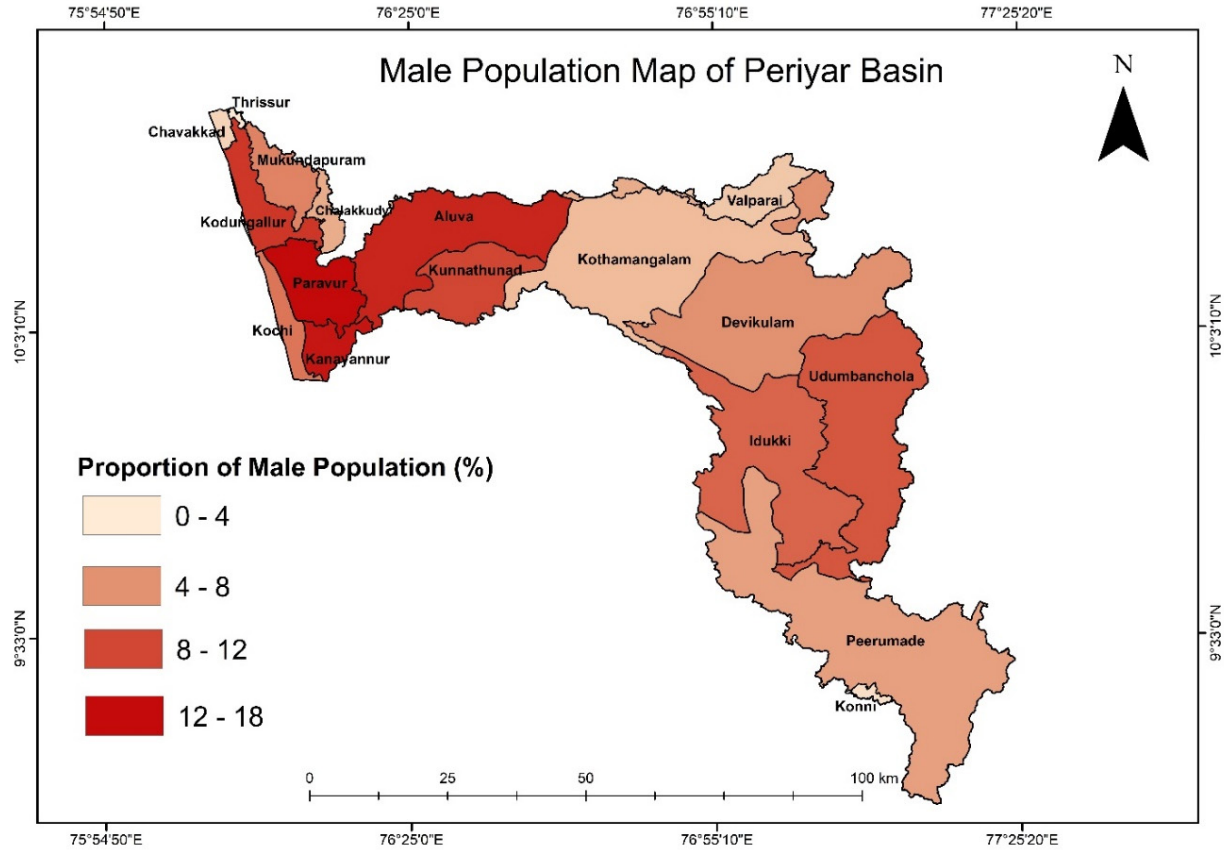


Figure 12. Map showing the male population distribution across different sub-districts.

The female population distribution mirrors the overall and male trends, with the highest population in Paravur and the lowest in Thrissur taluk. There is a 37% difference between the female populations of Ernakulam and Idukki. Figure 13 depicts the female population distribution map, revealing a balanced gender ratio in the basin, with a marginally higher female population—a less than 1% increase over males. Kodungallur taluk in Thrissur district has the most significant gender difference, with 21,731 more females than males, while Devikulam taluk in Idukki is the only subdistrict with a higher male population, having 414 more males than females.

Overall, the basin exhibits a slightly female-dominant population, with Thrissur showing the most pronounced gender imbalance, followed by Ernakulam. Idukki maintains a balanced gender ratio with a slight increase in females. The notable gender disparity in Ernakulam and Thrissur is primarily due to high rates of male migration for employment, particularly to the Middle East, which significantly reduces the local male population ([KSESD](#)). In contrast, Idukki's economy involves balanced gender participation in agriculture and local livelihoods, contributing to a more equal gender distribution.

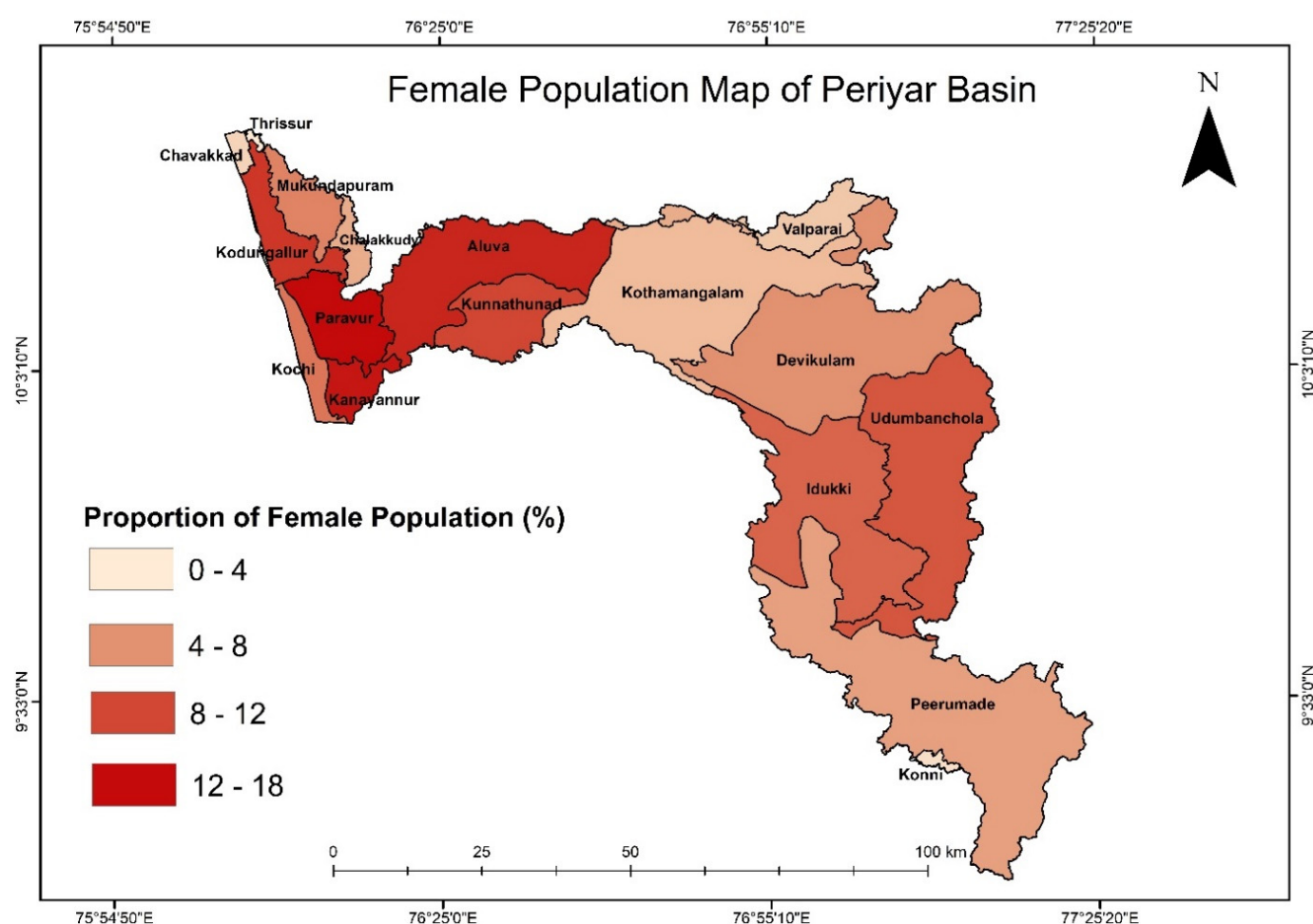


Figure 13. Map showing the female population distribution across different sub-districts.

3.2 Population Distribution Urban & Rural

India is the second most populous country in the world which exhibits complex population distribution patterns marked by significant disparities between urban and rural areas. The distribution of populations between urban and rural areas is a key demographic factor that impacts economic growth, social dynamics, and the allocation of resources. Urban areas often have younger populations due to migration, better healthcare, and higher literacy levels compared to rural regions. In contrast, rural areas may have a more balanced age structure or a higher proportion of older adults, and limited access to services. The population distribution in the Periyar River basin shows that 58% of the population is urban, while 42% resides in rural areas. This highlights substantial urban growth particularly around industrial and port hubs like Kochi in Ernakulam District which influence the economic progress but also posing environmental challenges especially regarding the water quality and ecological parameters. Figure 14 depicts the total population distribution in urban and rural area of the Periyar River basin.

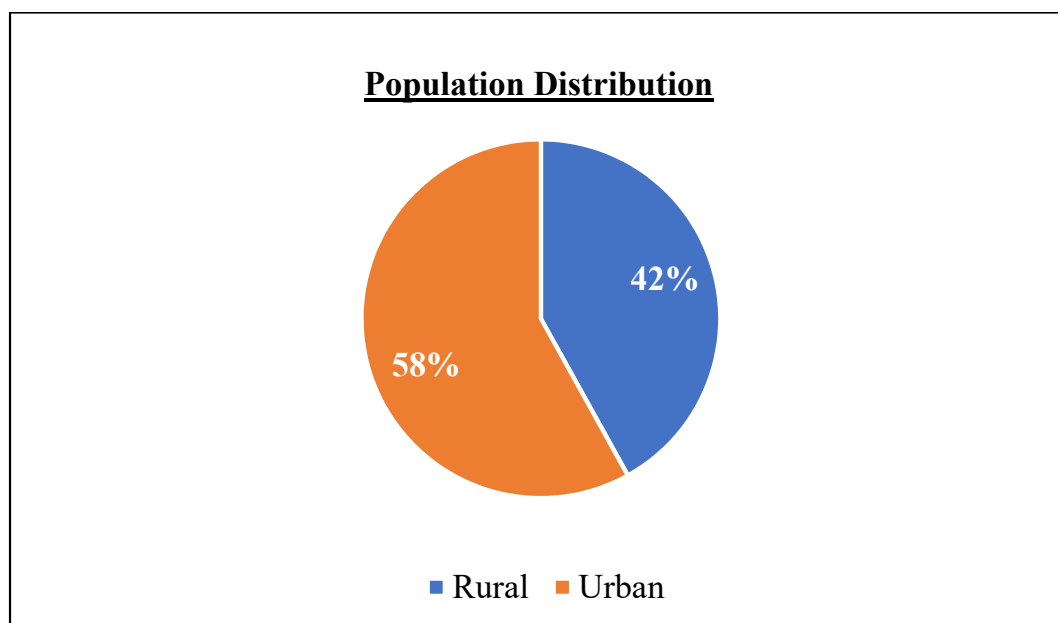


Figure 14. Total population distribution in urban and rural area the Periyar River basin

The concentration of populations in cities accelerates economic growth as urban centres become hubs for industry, trade, and services. Kochi City located in Ernakulam district plays a pivotal role in this process within the Periyar River basin. As a major port city, Kochi has attracted a large urban population with the Kochi Corporation accounting for a total population of 6,02,046 people. This population concentration fuels local economic activities, ranging from commerce to industrial development, making Kochi a critical urban centre in the region. In contrast, Madathumpady Town in Thrissur District, another urban settlement within the basin, has the lowest urban population with just 4,294 residents. This highlights the disparities in urbanization levels across the basin. While Kochi drives economic expansion, smaller towns may experience slower growth, limited access to infrastructure, and fewer opportunities, illustrating the need for balanced development strategies across the region.

In the rural areas of the Periyar River basin population distribution varies significantly, reflecting both geographical and economic factors. Kannan Devan Hills located in the Idukki district stands out with a relatively high rural population of 55,738. This area, known for its tea plantations and natural beauty, supports a large number of residents involved in agriculture, particularly tea cultivation, and related activities. The region's high population is driven by its economic dependence on plantation work, which has historically attracted workers and their families. On the other hand, Mlappara village located in Peerumade Taluk of Idukki district represents a contrast with a much smaller rural population of just 1,129 people. This low population density can be attributed to the village's more remote location, limited economic activities, and perhaps challenging terrain. The disparity between Kannan Devan Hills and Mlappara illustrates the uneven distribution of the rural population across the Periyar River basin, which is influenced by the availability of resources, employment opportunities and accessibility to basic infrastructure. Addressing these imbalances is essential for fostering equitable rural development in the region.

Population distribution is crucial for effective resource allocation and balanced development. Understanding where people live help governments allocate resources like healthcare, education, and infrastructure based on specific needs. It also aids in managing environmental challenges and addressing migration trends.

3.3 Population Growth Trends

Population growth trends refer to the patterns and changes in the population size of a region over a specific period, indicating whether the population is increasing, decreasing, or stabilizing. Decadal population growth trends specifically track these changes over ten-year intervals, providing a long-term perspective on demographic shifts. In India, decadal data from 1901 to 2011 helps assess how factors like birth rates, death rates, migration, and government policies have influenced population dynamics over time. Understanding these trends is crucial for demographic reports as they inform planning and decision-making in areas such as infrastructure development, healthcare, education, and resource allocation. They also help identify the impact of economic, social, and environmental factors on population changes. Analyzing these trends allows policymakers to predict future needs, address challenges related to overpopulation or population decline, and implement targeted interventions. For instance, a consistent increase in population might signal the need for expanded services, while a decline could highlight issues like ageing populations or out-migration.

The Census 2011 data is used to examine decadal population growth trends at the district level. The Periyar basin predominantly lies within the Ernakulam and Idukki districts of Kerala, which together encompass 90.5% of the total basin area. Population changes in these districts have the most significant impact on the Periyar River, making them critical to our analysis. As a result, the focus was placed on these two districts, as their population dynamics have a direct and substantial impact on the Periyar River basin.

3.3.1 Population Growth Analysis for Ernakulam District

The population growth trend of Ernakulam district over the last eleven decades is given in Figure 15. The data indicates a consistent upward trend, with notable spikes in specific decades. Between 1901 and 1951, the district's population increased by approximately 7lakh, despite the overall lower population growth rate in India during this period. A significant surge was observed post-1951, with a 22% rise in population, followed by another substantial increase of 27.4% in the subsequent decade. This rapid growth can be attributed to the district's improved infrastructure, expansion of transportation networks, and enhancement of port facilities, which bolstered economic activities and urban development. Additionally, the rise of educational institutions and healthcare facilities made Ernakulam a preferred destination for those seeking better opportunities. The Cochin International Airport (CIAL) has significantly influenced population growth in Ernakulam district by boosting economic activities and attracting businesses, especially in the tourism, logistics, and service sectors. The airport's development has spurred infrastructure growth, created job opportunities, and drawn migrants seeking employment, contributing to an increase in both the urban and suburban populations in the district.

From 1971 onwards, the district experienced uniform growth, but the pace slowed in the 21st century. This deceleration is mainly due to increased migration of the working-age population, particularly males, to Gulf countries and other international destinations for employment, which tempered local population growth. Other contributing factors include declining birth rates, improved family planning, higher education levels, and increased female workforce participation ([CDS](#)). Urban saturation, rising living costs, and limited space for further expansion in major urban centres like Kochi also deterred large-scale migration, resulting in a slower population increase compared to previous decades. The population of Ernakulam rose from 6.4 lakh in 1901 to 13.9 lakh in 1911, followed by a sharp increase to 28.4 lakh by the end of the 20th century, with only a marginal rise of 1 lakh in the 21st century until 2011. Despite the deceleration, Ernakulam has never exhibited a negative population trend due to its role as an economic hub with continuous urbanization and employment opportunities.

Regarding the district's gender composition, Ernakulam showed slower growth in the female population from 1901 to 1991, as the male population primarily drove the increase due to migration and economic activities. However, from 1991 onwards, the female population began to outpace male growth, albeit by a narrow margin, reflecting a relatively balanced sex ratio. The increase in the female population post-1991 can be attributed to large-scale male migration for overseas employment, leaving a higher proportion of females in the district.

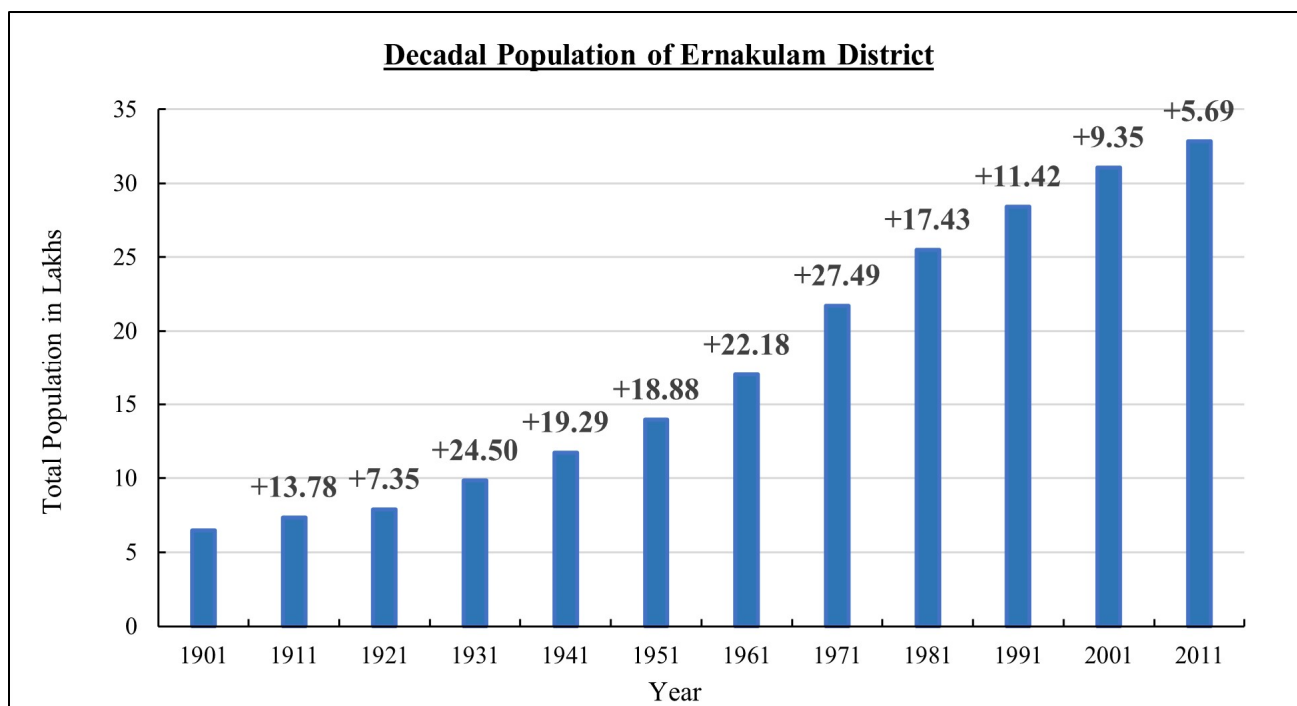


Figure 15. Graph depicting the population growth trends of Ernakulam District

3.3.2 Population Growth Analysis for Idukki District

The population growth trend of the Idukki district over the last eleven decades, characterized by steady growth with some notable fluctuations. The population trend is shown in Figure 16. The Idukki district predominantly comprising tribal populations, experienced a dramatic 108% population surge in 1911, primarily driven by large-scale migration related to the establishment of tea and coffee plantations, which attracted workers from neighbouring areas. In 1931, another significant increase of 72.5% occurred due to the influx of settlers seeking cultivable land, coupled with agricultural expansion and forest clearance for plantations.

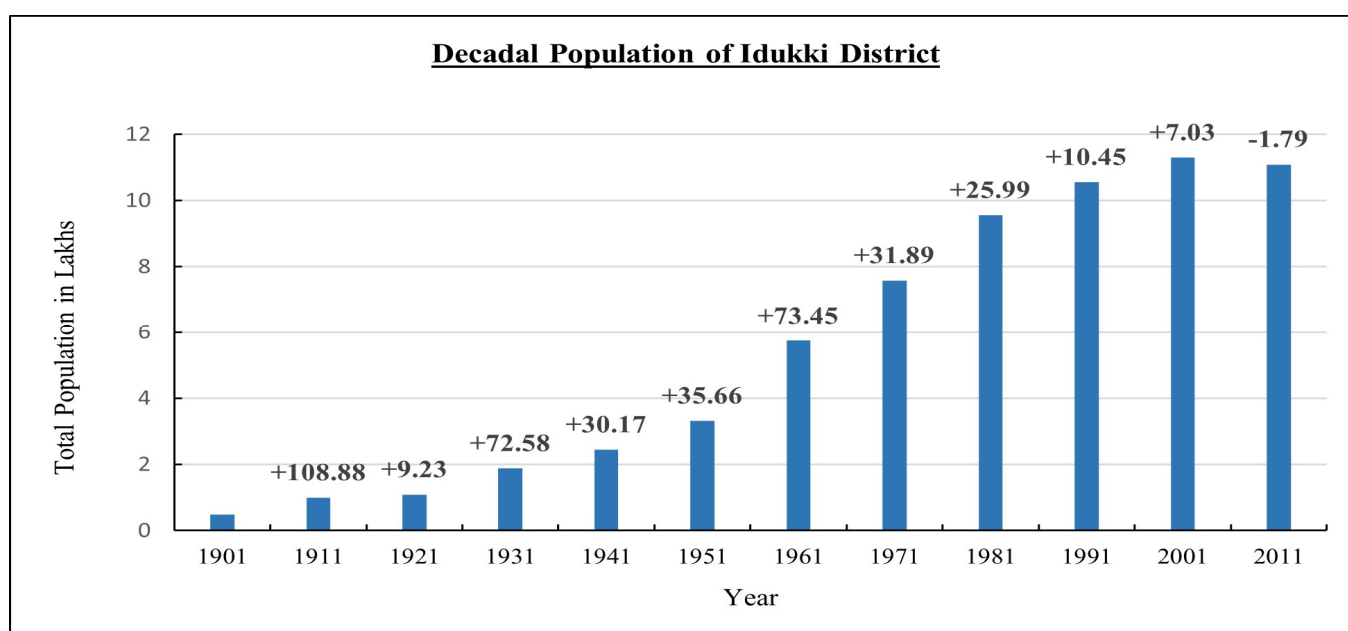


Figure 16. Graph illustrating the population growth trends of the Idukki District

During the pre- and post-independence periods, Idukki continued to see substantial population growth, notably a 73.4% increase post-1947. This growth was fueled by migration due to land distribution policies, the construction of major hydroelectric projects, and the expansion of plantation agriculture, providing ample employment opportunities. However, from 1991 onwards, the district experienced a gradual decline in population growth rates, with only a 10% increase in 1991, decreasing further to 7% in the following decade. By 2011, the district recorded a population decline of 1.79% compared to 2001, attributed to the out-migration of the younger working-age population, declining birth rates, and limited economic growth within the region.

The district's gender composition showed a consistently lower female population compared to males until 1971, largely due to male-dominated migration for plantation and agricultural work, while traditional social norms often restricted female mobility. From 1971 onwards, the female population began to increase gradually, driven by improved educational and healthcare services, reduced male migration rates, and socio-economic changes promoting a better gender balance. Despite the overall decline in population growth, the rising female population highlights changing demographic patterns in the district.

4. Demographic Characteristics

Demographic characteristics encompass the statistical data of a population, including age, sex, education level, employment status, migration patterns, and population density. Understanding these characteristics is essential in demographic studies as they provide insights into population dynamics, social structure, and economic conditions, which are crucial for planning and policy-making. In the context of the Periyar River management, demographic analysis helps identify the population pressure on the river, highlighting areas with high demand for water resources, waste disposal, and other environmental services. This study aids in understanding how different population groups—such as urban versus rural or male versus female—utilize the river, enabling targeted interventions to mitigate environmental impacts. Moreover, demographic data inform the planning of sustainable water management practices by aligning them with the needs of the population, such as ensuring adequate water supply, flood control, and pollution management. Understanding the demographic composition also helps prioritize areas for infrastructure development, public awareness campaigns, and resource allocation for effective river basin management.

4.1 Age Structure

Age structure in a demographic report refers to the distribution of the population across different age groups, such as children, working-age adults, and the elderly. This study is crucial because it reflects the economic, social, and healthcare needs of the population, influencing workforce availability, dependency ratios, and service requirements. In India, the age structure shows a young population with a significant proportion in the working-age group,

indicating a high potential for economic growth but also the need for employment, education, and healthcare services. Understanding the age structure in the Periyar basin can help in river management by identifying the specific needs of different age groups, such as ensuring safe drinking water for children or managing water quality to prevent health issues among the elderly. It can guide targeted community outreach, water conservation education, and resource distribution based on the demographic needs of the basin. Analyzing age structure also aids in forecasting future demands on the river, helping to design sustainable management strategies that cater to a growing and ageing population.

The population structure of the Idukki District, as depicted in Figure 17, highlights a demographic pattern characterized by a declining younger population and an increasing elderly segment. The 0-4 age group consists of 37,443 males and 36,355 females, resulting in a sex ratio of 971. There is a steady decline in the number of individuals in successive younger cohorts, with the 5-9 age group showing 41,740 males and 39,942 females, and the 10-14 age group reflecting 46,763 males and 45,095 females. This downward trend in younger age groups suggests a demographic shift towards an ageing population.

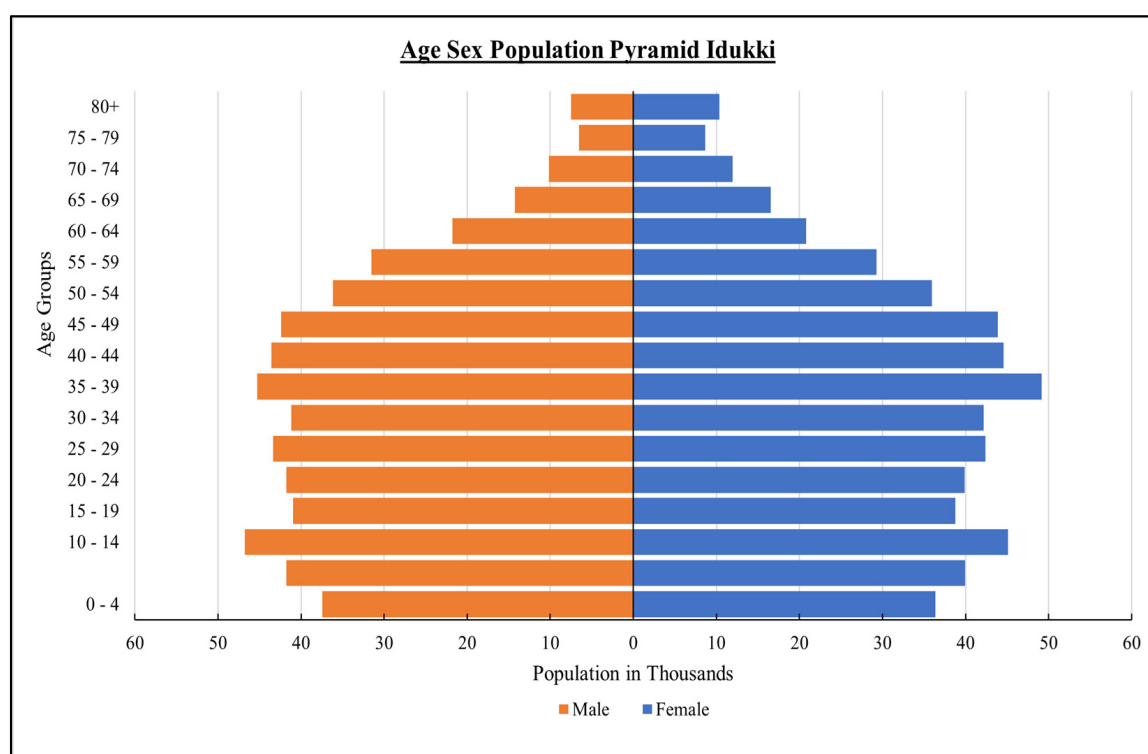


Figure 17. Population pyramid of the Idukki District

The working-age population (15-59 years) maintains relative stability, with the 35-39 age group representing the highest number of individuals at 45,273 males and 49,147 females, yielding a sex ratio of 1,086. The higher female representation in this age bracket may be attributed to improved healthcare and higher longevity among women. The elderly population (60 years and above) exhibits a marked shift, with a notable decrease in the 60-64 age group (21,778 males and 20,822 females) and a significant rise in the 80+ group (7,510 males and 10,362 females), underscoring an ageing demographic that necessitates increased healthcare and social services.

Contrastingly, the population pyramid of Ernakulam District, shown in Figure 18, illustrates a more advanced demographic transition with a robust presence in younger age groups. The 0-4 age group comprises 109,407 males and 105,306 females, resulting in a sex ratio of 963. This pattern continues in subsequent cohorts, with 115,494 males and 110,799 females in the 5-9 age group and 128,742 males and 123,467 females in the 10-14 age group.

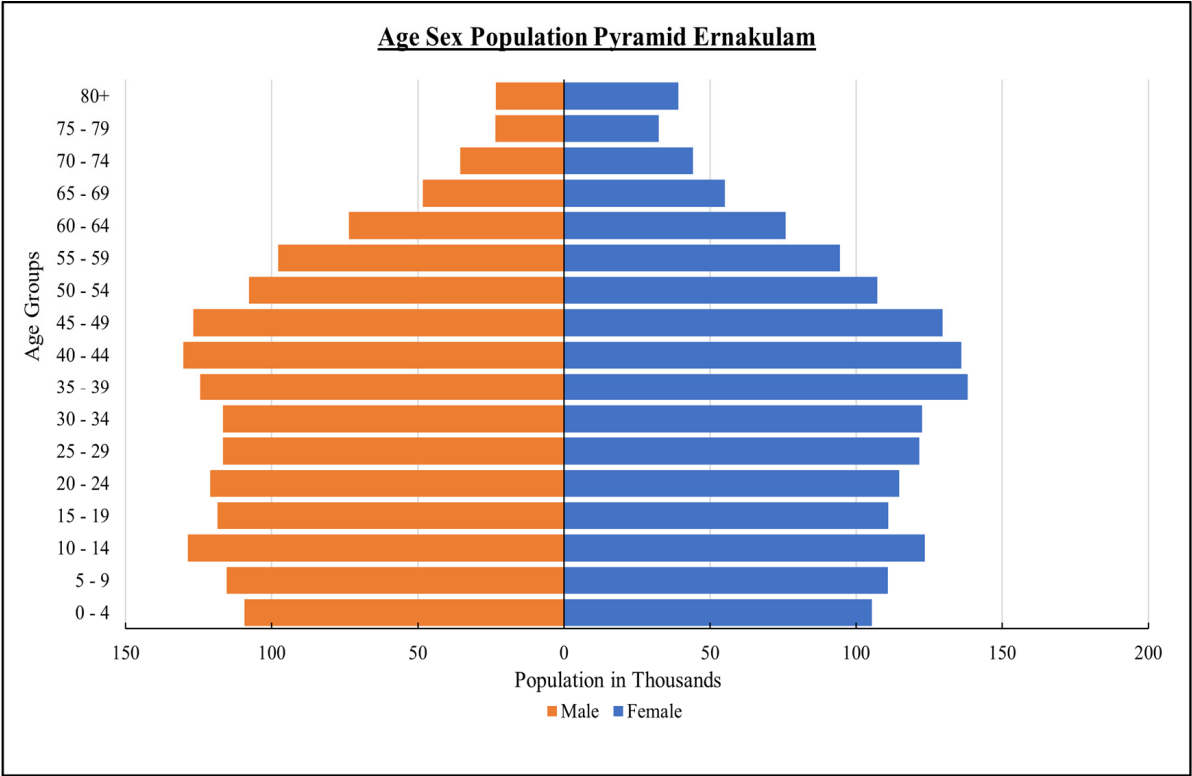


Figure 18. Population pyramid of the Ernakulam District

Ernakulam's working-age population is notably larger than Idukki's, particularly within the 25-29 age group, with 116,775 males and 121,550 females. This reflects the district’s economic opportunities that attract a youthful workforce. The 30-34 age group exhibits a balanced sex ratio of 1,050. However, like Idukki, the elderly segment is expanding, particularly among the 80+ age group, where 23,351 males and 39,105 females result in a high sex ratio of 1,675, highlighting the need for enhanced healthcare services catering to an ageing population.

When comparing the two districts, distinct demographic contrasts emerge. Idukki's age structure, with a higher proportion of young individuals, indicates a slower demographic transition than Ernakulam, which has a more balanced age distribution and a significant working-age population. The sex ratios reveal critical trends; Idukki shows a more balanced ratio among older age groups, while Ernakulam's younger population reveals a declining trend, particularly within the 20-24 cohort. The demographic patterns have critical implications for policy and planning. Idukki's declining birth rates and growing elderly population will require investments in healthcare and social services tailored to an ageing demographic. Conversely, Ernakulam's large working-age population offers economic potential but necessitates sufficient job creation and infrastructure to harness this demographic dividend. The population pyramids of Idukki and Ernakulam provide crucial

insights into the demographic dynamics within the Periyar River basin. Effective planning and resource allocation hinge on understanding age structure and sex ratios, enabling targeted policy interventions. As each district faces unique demographic challenges and opportunities, tailored strategies must address the specific needs of their populations, fostering sustainable development and enhancing quality of life. Continuous demographic monitoring will be essential to inform health, education, and economic strategies moving forward.

The age structures of Idukki and Ernakulam have been shaped by several factors, including socio-economic development, urbanization, family planning initiatives, and migration patterns. Improvements in healthcare, education, and living conditions have contributed to declining birth rates and increased life expectancy. Urban growth in Ernakulam attracts younger individuals, resulting in a larger working-age demographic. Family planning measures have narrowed the base of the population pyramid, and migration trends, particularly among the working-age group, have further influenced demographic compositions. The shifting age structures in Idukki and Ernakulam present both challenges and opportunities. An expanding working-age population can drive economic growth if accompanied by adequate employment opportunities, highlighting the potential demographic dividend. However, the increasing elderly population necessitates robust social security and healthcare systems. A declining younger population may challenge long-term workforce sustainability, necessitating policies that address demographic-specific needs and promote balanced economic and social development.

4.2 Sex Ratio

The sex ratio is a demographic measure that indicates the number of males per 1,000 females in a population, providing insights into gender balance and societal dynamics. It is a critical aspect of demographic studies as it influences social structures, labour markets, and population growth trends. In India, the sex ratio has been historically skewed due to factors such as gender preference, healthcare access disparities, and migration patterns. A skewed sex ratio can impact the demand for resources differently, with implications for family structures, community support systems, and economic participation. This information is vital for river management as it helps design gender-inclusive policies, ensuring that both men and women have equal access to water resources and related services. Addressing the gender dimensions of water management, including providing safe access points for women and addressing occupational exposures for men, can lead to more equitable and effective management of the river.

The sex ratio of the Periyar River Basin, derived from the 2011 Census data, provides a critical understanding of the gender composition across sub-districts within the basin. Figure 19 illustrates the sex ratio across sub-districts, highlighting significant variations among districts. The highest sex ratio is observed in Thrissur taluk of Thrissur district, with a value of 1206, indicating 1,206 females per 1,000 males (female to male population: 8,209 to 6,809). This disparity, with 206 additional females for every 1,000 males, can be attributed to high levels

of male out-migration, particularly to Gulf countries, reducing the local male population. Additionally, better healthcare facilities and improved living conditions contribute to higher female longevity.

Chavakkad taluk follows with a sex ratio of 1,187 (male to female ratio: 24,980 to 29,663), and Mukundapuram taluk records a ratio of 1,155 (male to female ratio: 85,531 to 98,831), indicating that these regions have significantly higher female populations compared to males. On the other hand, Devikulam taluk of Idukki district exhibits the lowest sex ratio in the basin, at 994 (male to female ratio: 74,488 to 74,074), where the male population slightly exceeds the female population. This is followed by Udumbanchola and Idukki taluks, both with a sex ratio of 1,004. The predominance of male workers in labour-intensive industries such as plantations, combined with harsh living conditions, often deters female residents, leading to a skewed sex ratio in these areas.

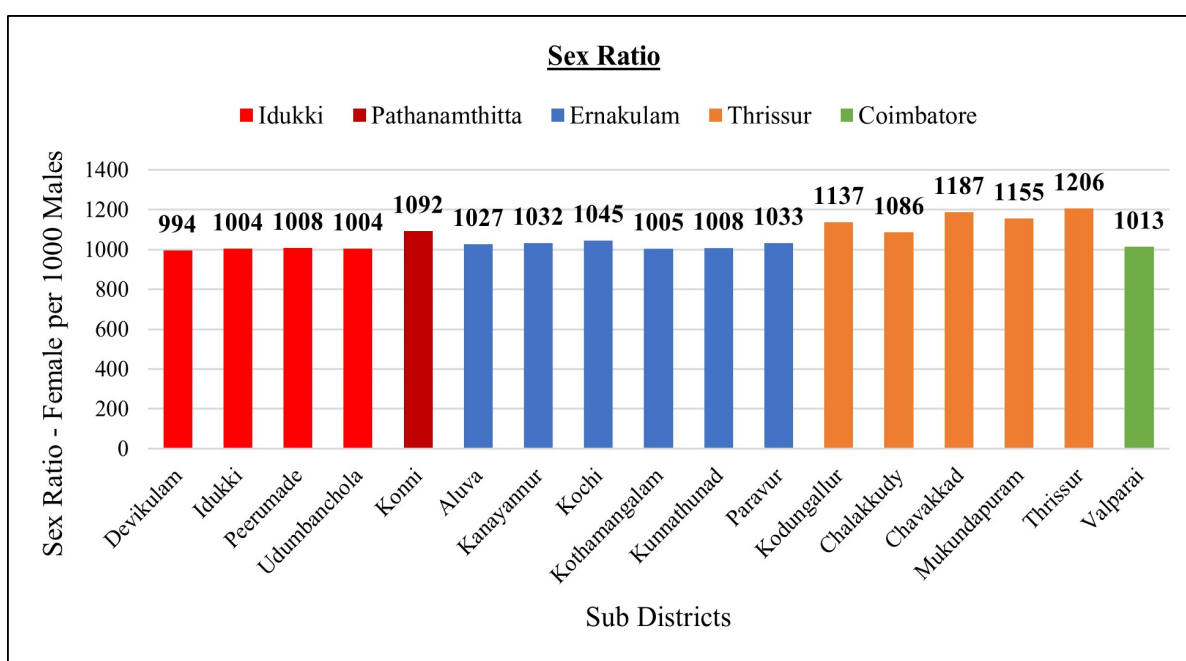


Figure 19. Graph illustrating the sex ratio across different sub-districts

While Paravur taluk of Ernakulam district has the highest male and female populations within the basin, it maintains a balanced sex ratio, indicating minimal gender imbalance. A balanced sex ratio reflects equal representation of both genders without significant domination by one, which contrasts with areas where migration or employment patterns disrupt this balance. District-wise, Idukki records the lowest sex ratio, followed by Ernakulam, while Thrissur shows the highest, reflecting a predominantly female population. Thrissur's higher female population results from extensive male migration for overseas employment and the presence of industries that attract female workers, supported by favourable social and cultural environments that enhance female survival rates.

Overall, the basin demonstrates a largely balanced sex ratio, with variations influenced by socio-economic factors such as employment opportunities, migration patterns, and living conditions. Thrissur exhibits the most notable gender imbalance, followed by Ernakulam.

Ernakulam's balanced sex ratio is attributed to its urban landscape, better access to healthcare, and diverse job market that equally attracts both genders. Conversely, Idukki's low sex ratio stems from high male migration and challenging terrain that limits female settlement. The basin's demographic profile reveals a predominantly female population with nuanced regional variations.

Advantages and Disadvantages of Sex Ratio Extremes:

High Sex Ratio (More Females):

Advantages: Promotes gender balance, enhances family cohesion, and supports social stability.

Disadvantages: A high female population can strain healthcare and social services, particularly when male out-migration is high, affecting household dynamics.

Low Sex Ratio (More Males):

Advantages: Boosts labour-intensive industries with a robust male workforce, enhancing economic productivity.

Disadvantages: Can create social challenges, such as gender imbalance, lower birth rates, and neglect of women's needs in social and policy planning.

This analysis of the sex ratio within the Periyar Basin provides vital insights into demographic dynamics that are crucial for effective river basin management, as gender composition influences labour availability, healthcare needs, and social infrastructure planning.

4.3 Household Composition

Households in India are undergoing significant changes due to economic liberalization, social shifts, and structural transformations, which are also impacting the demographic characteristics. The rise of new economic opportunities for both men and women have increased independence among the younger generation, leading to delayed marriages, lower fertility rates, and smaller family sizes. Urbanization, higher education, and mass media exposure have influenced attitudes toward family and living arrangements, prompting the emergence of new family structures. In India, changes in household composition, such as the shift from joint to nuclear families, smaller household sizes, and the emergence of new family forms, directly impact demographic characteristics.

Household types are often shaped by kinship rules, demographic factors, and socioeconomic conditions within a society. Shifts in the economy and demographic factors, such as migration, sex ratios, birth, and death rates, can also influence household structures. Industrialization and urbanization, driven by economic changes, are recognized as key factors impacting the type and size of households in societies experiencing economic transformation. Figure 20 represents the distribution of total number of households in the various sub-districts of the Periyar River Basin.

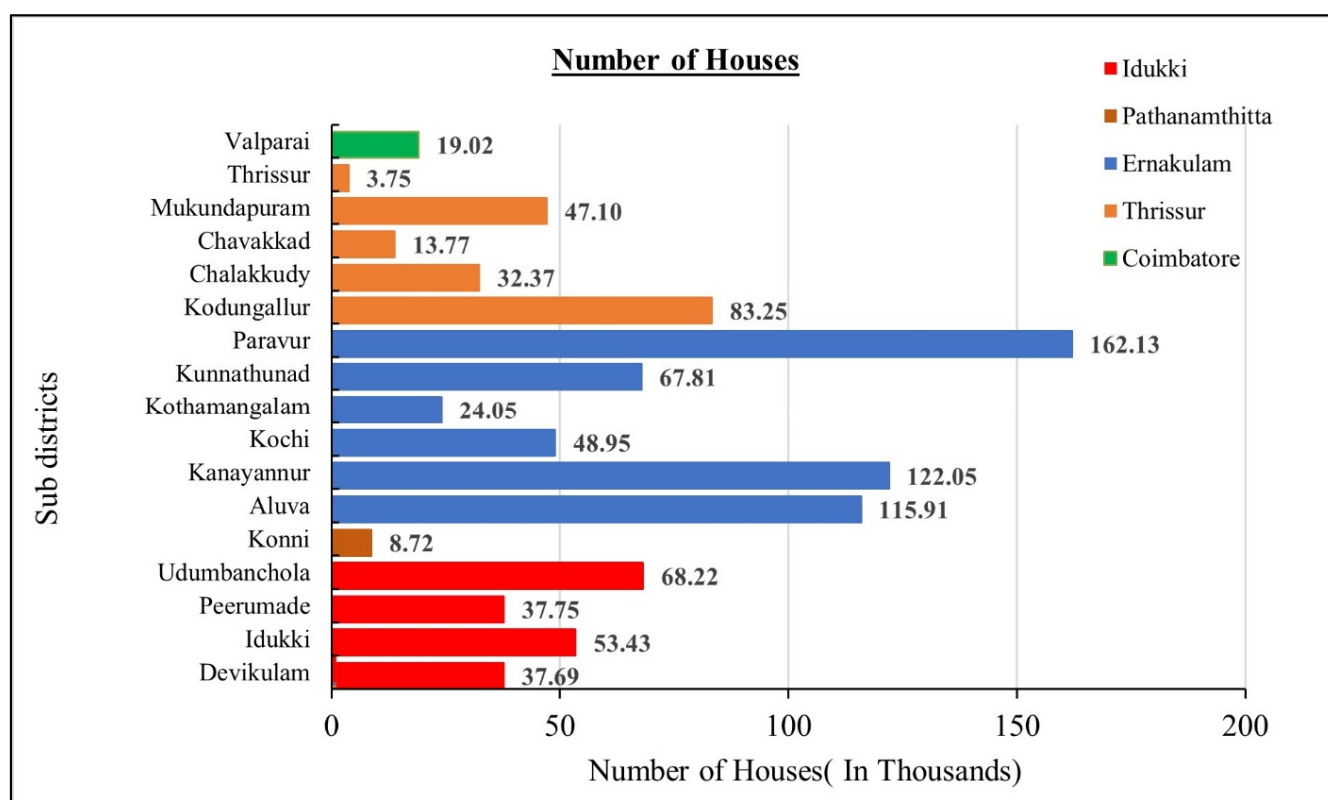


Figure 20. Total number of households in the Periyar River Basin

The bar chart displays the number of houses across various sub-districts in several regions of Kerala and Tamil Nadu, including Idukki, Ernakulam, Thrissur, Pathanamthitta and Coimbatore. Ernakulam District has the largest number of households, with Paravur leading at 1,62,127 houses, followed by Kanayannur (1,22,047) and Aluva (1,15,905). Thrissur District shows a moderate number of households, with Kodungallur having 83,253 households while Thrissur itself has a significantly lower count at 3,748. In Idukki District, household distribution is more even, with Udumbanchola leading at 68,219 and Idukki at 53,426. Pathanamthitta District shows a balanced distribution, with Chalakkudy and Mukundapuram having 32,369 and 47,097 households, respectively. Coimbatore District, represented by Valparai, has the smallest number of households, at 19,017.

The high concentration of households indicates greater urbanization, which drives urban development, employment opportunities, and infrastructure growth, attracting migration from rural areas. In contrast, lower household numbers in districts like Thrissur and Idukki suggest these areas remain largely rural or semi-urban, with agricultural dominance, lesser infrastructure, and slower economic growth. Regions with higher household numbers, such as Paravur and Kanayannur are likely to attract businesses, educational institutions and promotes nuclear family structures. On the other hand, districts with fewer households, such as Valparai, may reflect traditional family structures, lower educational access, and fewer economic opportunities, indicating less industrialization and urbanization. The distribution of average household size across various districts in the Periyar River Basin is shown in Figure 21.

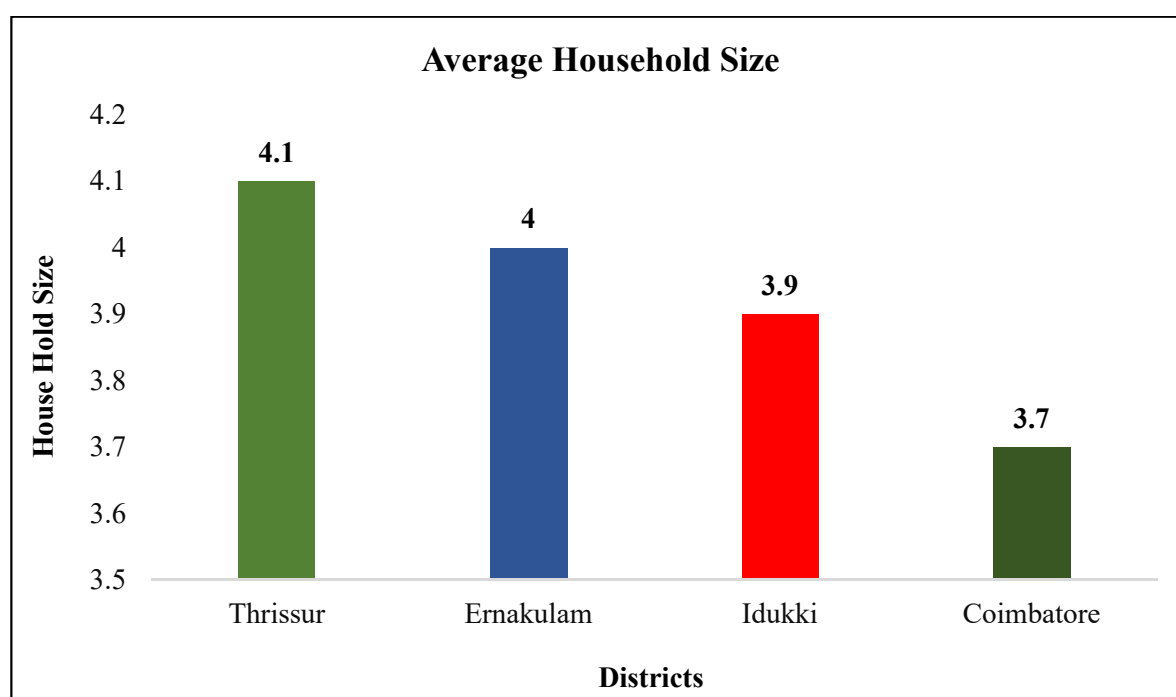


Figure 21. Distribution of average household size across various districts

The average household size refers to the typical number of individuals living in a single housing unit. It represents the average number of people who share living space, forming a household. They often share resources, such as income and wealth, to manage collective expenses and consumption of essential goods and services. This includes shared expenses for housing, utilities, and food. Household members contribute to and benefit from a common standard of living, making the household an essential social and economic unit for understanding population structure and resource distribution. The size of a household can vary depending on social, cultural, and economic factors, with larger households often found in more traditional or rural settings, and smaller, nuclear households more common in urbanized areas.

The bar graph analyses the average household size of the districts. Thrissur has the highest average household size at 4.1, followed closely by Ernakulam with 4 and Idukki at 3.9. Pathanamthitta and Coimbatore have similar average household sizes of 3.7. The average household size plays a crucial role in urban and regional planning. It influences housing demand, infrastructure needs, and public services such as education, healthcare, and transportation. Understanding household size helps planners allocate resources efficiently and develop sustainable communities that meet the needs of their residents.

4.4 Population Density

Population density refers to the number of people living within a specific area, typically expressed as individuals per square kilometre. It provides a clear measure of how crowded or sparsely populated a place is, offering insights into urbanization, resource allocation, and living conditions. Areas with high population density often face challenges related to housing, transportation, and infrastructure due to the concentration of people. On the other hand,

regions with low population density may experience challenges related to access to services and economic opportunities. Understanding population density is crucial for urban planning, environmental management, and ensuring sustainable growth in both densely and sparsely populated regions.

The population density of India in 2011 was 382 per sq.km and with a decadal growth of 17.72 percent. This marked an increase from the previous census in 2001 which recorded a density of 325 persons per square kilometre. The rise in population density reflects India's growing population and the increasing pressure on land and resources, especially in urban areas. The Periyar River basin is primarily distributed across the districts of Idukki (57.6%), Ernakulam (33.1%), and Thrissur (6.8%) in Kerala, with smaller portions extending into Coimbatore (2.2%) in Tamil Nadu, and Pathanamthitta (0.3%) and Kottayam (0.08%) in Kerala. Figure 22 represents the distribution of population density across the districts in the Periyar River basin.

Ernakulam shows the highest population density among the districts at 1072 individuals per square kilometre. High-density areas may require more schools, hospitals, and transportation facilities. It is the commercial and cultural hub of Kerala, attracting a large population. It is a rapidly urbanizing district with a significant industrial base. Idukki has the lowest population density at 255 individuals per square kilometre. It is primarily a hilly district with a focus on agriculture, especially tea and rubber plantations. In sparsely populated regions such as Idukki, the lower density can lead to less strain on infrastructure and a more tranquil environment. However, these areas might struggle with limited economic opportunities, lower access to services, and challenges in maintaining connectivity.

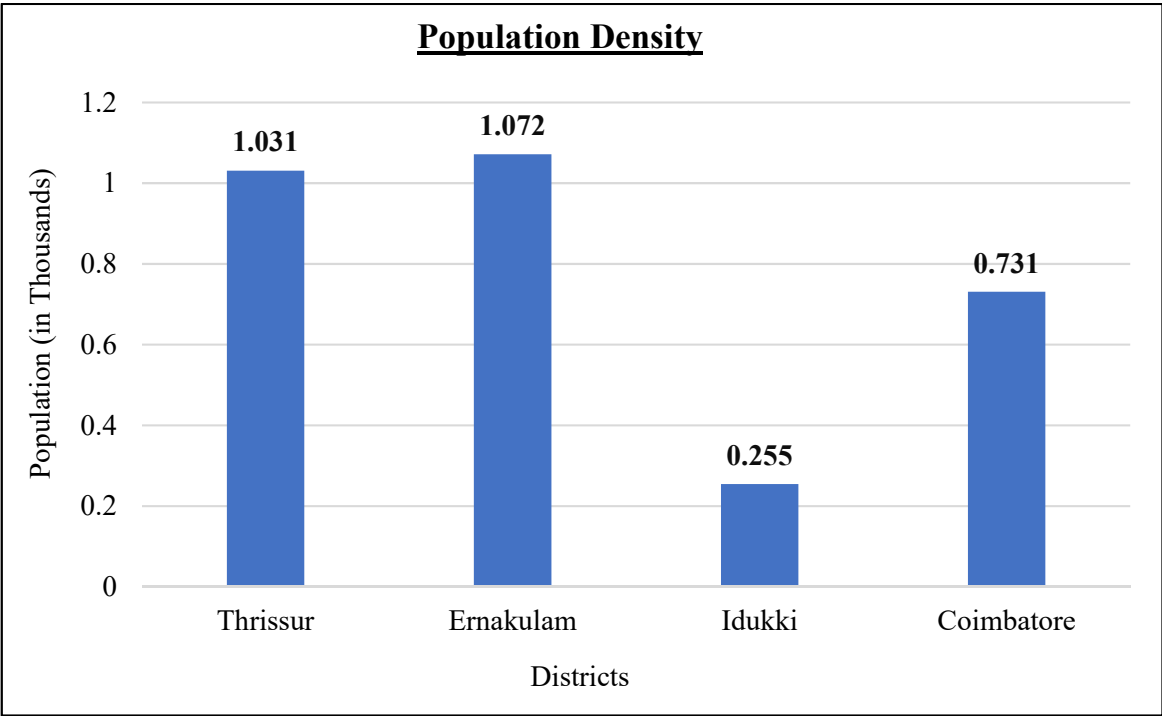


Figure 22. Population density of the districts in Periyar River basin

5. Socio-Economic Characteristics

Socio-economic characteristics in a demographic report encompass the social and economic attributes of a population, including education levels, employment status, income distribution, household size, occupational patterns, and access to basic services like healthcare, sanitation, and housing. These characteristics provide a comprehensive understanding of how people live, work, and interact within a given area, shedding light on the factors that influence their quality of life. Studying socio-economic characteristics is crucial because it helps identify disparities among different population groups, informs policymaking, and supports targeted interventions aimed at enhancing the well-being of communities. For the Periyar River Basin, analyzing these characteristics is particularly important as it directly impacts resource management, economic activities, and sustainable development within the region. The socio-economic profile of the basin's population influences how communities utilize water resources, engage in agriculture, industry, and services, and adapt to environmental challenges. This study can guide the planning of infrastructure projects, such as improving access to clean water, enhancing agricultural practices, and supporting economic diversification. Understanding the socio-economic dynamics also helps in managing the river basin's natural resources efficiently, ensuring equitable access and addressing potential conflicts between different user groups. Additionally, insights from this analysis are essential for developing strategies that promote inclusive growth, mitigate poverty, and enhance the resilience of communities in the face of environmental changes, thereby ensuring the sustainable management of the Periyar River Basin.

5.1 Educational levels and Health

Educational levels and health status are key drivers of demographic trends and vital elements in census data collection. Higher education levels influence economic opportunities and significantly affect fertility, mortality, and migration, shaping the overall population structure. Health, closely tied to education, impacts life expectancy, birth rates, and mortality. Collecting education and health data in the census supports policymakers in making informed decisions in public health, social services, and economic development.

According to the 2011 Census, educational attainment is categorized into various levels: Illiterate, Literate, Below Primary, Primary, Middle, Matric/Secondary, Higher Secondary/Intermediate, Non-Technical Diploma, Technical Diploma or Certificate, Graduate and above, and Unclassified. These classifications provide a comprehensive view of the population's educational background, ranging from basic literacy to advanced technical and academic qualifications. The Periyar River basin is mainly distributed across the districts of Idukki (57.6%), Ernakulam (33.1%), and Thrissur (6.8%), with smaller sections extending into Coimbatore (2.2%), Pathanamthitta (0.3%), and Kottayam (0.08%). Figure 23 shows the distribution of the population across various educational levels in the district of Idukki, based on the 2011 Census of India. The data shows that a significant portion of the population

9,23,010 individuals are literate, indicating that the majority of the population has basic reading and writing skills. while a smaller group 1,85,964 individuals remain illiterate. This disparity underscores the need for targeted literacy programs to address the needs of the illiterate population and further enhance overall educational outcomes which influence the socio-economic development.

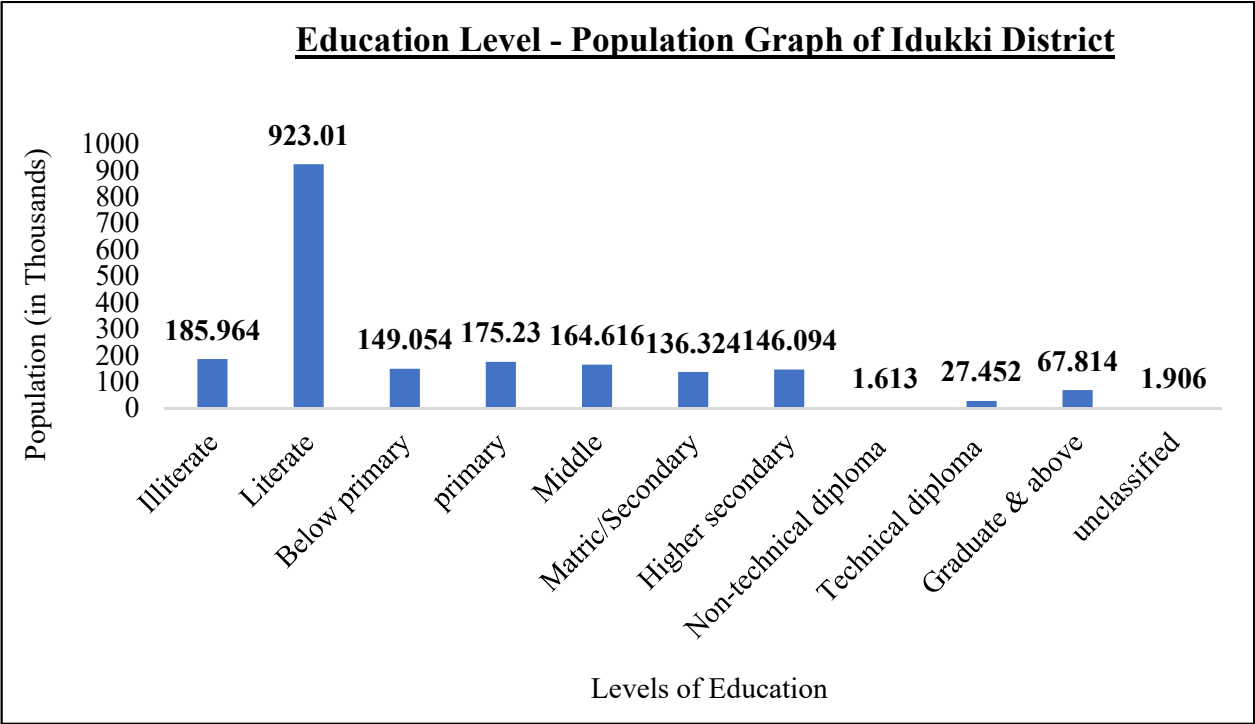


Figure 23. Education level of population in the Idukki District

Figure 24 shows the distribution of the population across various educational levels in the district of Ernakulam. As per the 2011 Census data of India, reveals a significant disparity in educational levels, with a substantial portion of the population 4,45,056 individuals having attained only primary education. While a relatively smaller proportion 4,26,712 remains illiterate, the district exhibits a notable progress in higher education as evidenced by the increasing number of individuals with secondary, higher secondary, and graduate degrees. This educational profile underscores the need for targeted interventions to enhance educational access and outcomes, particularly at the primary and secondary levels, to promote overall human development and economic growth in Ernakulam district. The distribution of the population across various educational levels in the district of Thrissur is shown in Figure25. The majority of the population, 26,78,548 individuals, falls under the Literate category, reflecting the overall high literacy rate in the district. Significant portions of the population have achieved educational levels such as Below Primary. This distribution offers valuable insights into the educational composition of Thrissur, highlighting the broad range of educational attainment and its implications for socio-economic development and workforce planning.

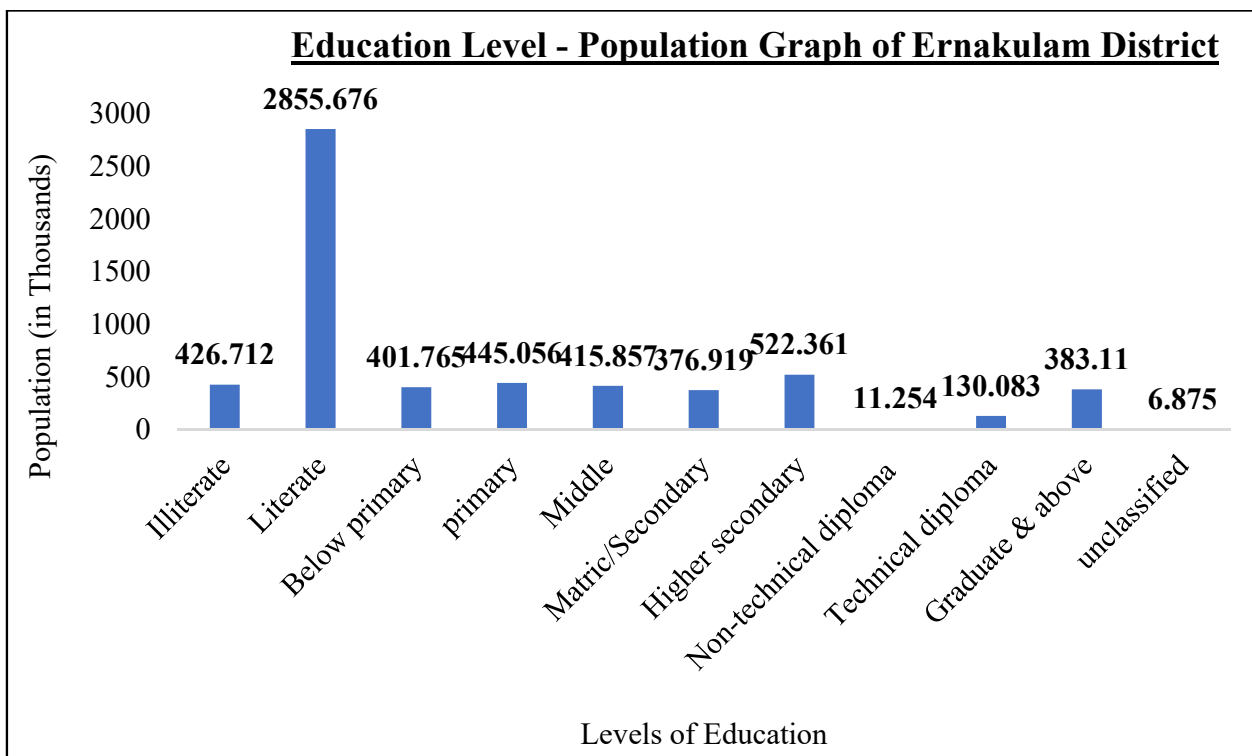


Figure 24. Education level of population in the Ernakulam District

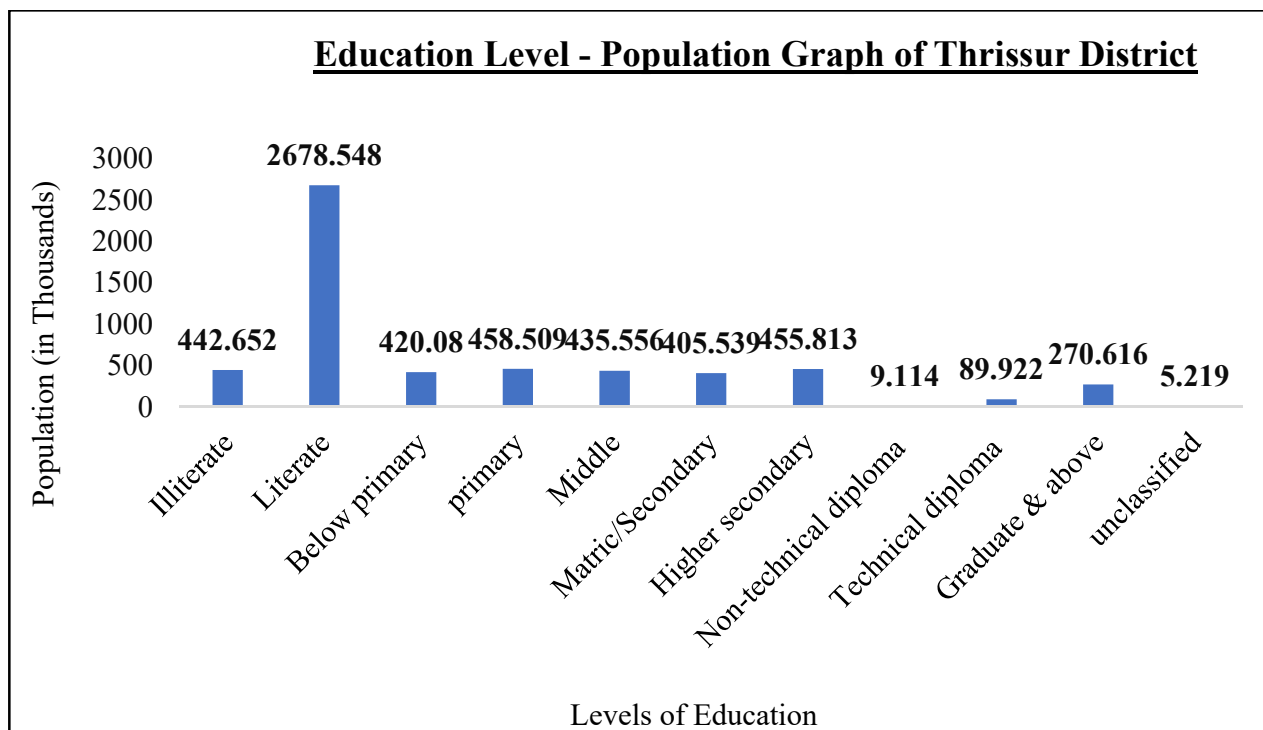


Figure 25. Education level of population in the Thrissur District

Figure 26 illustrates the population distribution across different educational levels in Coimbatore district of Tamil Nadu. The data shows a large portion of the population which is 26,35,907 individuals are literate. Higher literacy rates lead to increased innovation and productivity, contributing to long-term economic development. Literate individuals are better equipped to develop workplace skills, increasing their chances of finding and maintaining employment, which in turn enables them to contribute to the economy through spending.

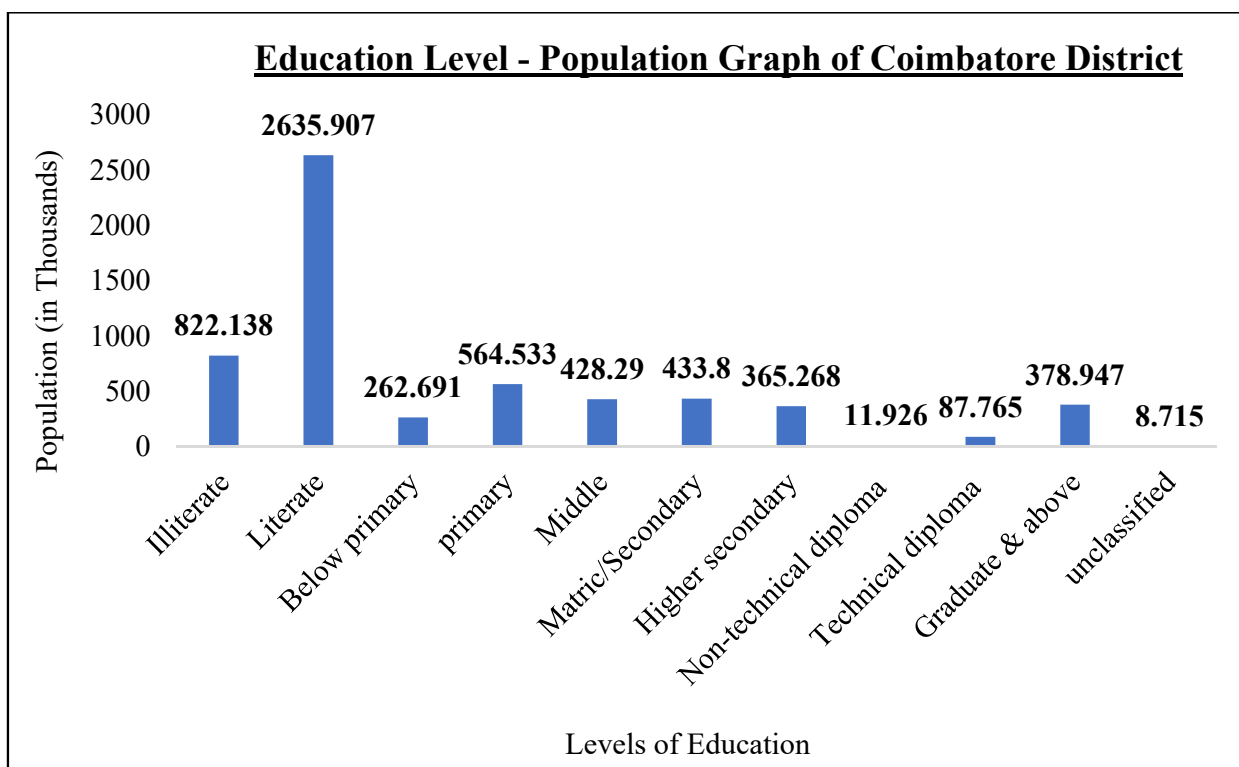


Figure 26. Education level of population in the Coimbatore District

Educational level data helps governments create effective policies related to education, job training, and social welfare programs. Achieving key educational goals is crucial for contributing to national development, requiring evidence-based strategies to justify higher investments in the social sector. In India, the importance of education in driving socio-economic growth highlights the need for a robust statistical base. In conclusion, the analysis of educational levels across various districts, including Thrissur, Ernakulam, Idukki and Coimbatore, reveals a strong foundation in literacy, with the majority of the population falling into the literate category. However, disparities remain in primary education and illiteracy rates, particularly in districts like Ernakulam and Idukki, where targeted interventions are necessary to enhance educational access and outcomes. The presence of individuals with higher secondary and technical qualifications shows potential for workforce development and economic growth. A robust focus on reducing illiteracy and strengthening foundational education is crucial for fostering long-term socio-economic development across these regions.

5.2 Population Health

The basin encompasses significant portions of districts in Kerala and a small portion of a district in Tamil Nadu. Idukki has the largest percentage of its area within the basin at 57.6%, followed by Ernakulam with 33.1%, Thrissur with 7%, Coimbatore with only 2.1% and Pathanamthitta with 0.2%. These figures highlight that Idukki and Ernakulam are the primary districts contributing to the population density of the basin, with Pathanamthitta and Coimbatore having a smaller influence due to their limited coverage.

5.2.1 Birth Rate

The birth rate, which measures the number of live births per 1,000 people, is a vital indicator of population growth. Figure 27 shows the distribution of birth rate across various districts in the basin. In Idukki, the birth rate is 10.37 per 1,000 people. This figure aligns with Kerala's state average of 13.6 births per 1,000 people, as reported by the Department of Economics and Statistics, Government of Kerala (2019), but is slightly below the state level, reflecting slower growth in the basin area of Idukki. In comparison, Ernakulam has a lower birth rate of 8.28, which is well below both the state average and the national average of 20.2 births per 1,000 people (2019).

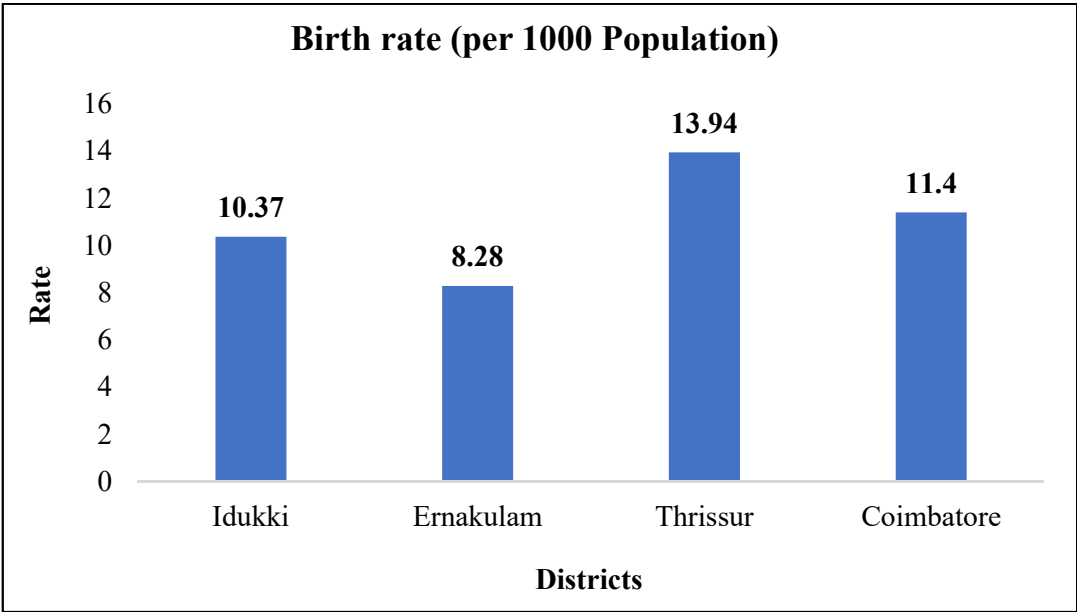


Figure 27. Birth rate (per 1000 population) across various districts in the basin

This indicates a particularly slow population growth in the basin portion of Ernakulam, possibly due to urbanization and demographic shifts. Pathanamthitta, on the other hand, has a higher birth rate of 13.97, followed by Thrissur at a rate of 13.94 which they closely match the state average and suggesting more rapid population growth in its part of the basin. Coimbatore’s birth rate of 11.4 is slightly below Tamil Nadu’s state average of 14.4 (Tamil Nadu Government, 2020), showing moderate population growth in the small portion of the district within the basin.

5.2.2 Death Rate

The death rate, which records the number of deaths per 1,000 people annually, is a critical demographic marker of population stability. Figure 28 shows the graph of death rate across various districts in the basin. Idukki has a death rate of 6.48 per 1,000 people, which is slightly higher than Kerala’s state average of 6.8, suggesting a relatively healthy population with low mortality in the basin. Ernakulam has a comparable death rate of 6.56, closely aligned with both the state and national averages. Pathanamthitta reports a higher death rate of 10.95, well above the state average, indicating a possible aging population or healthcare challenges in the basin area.

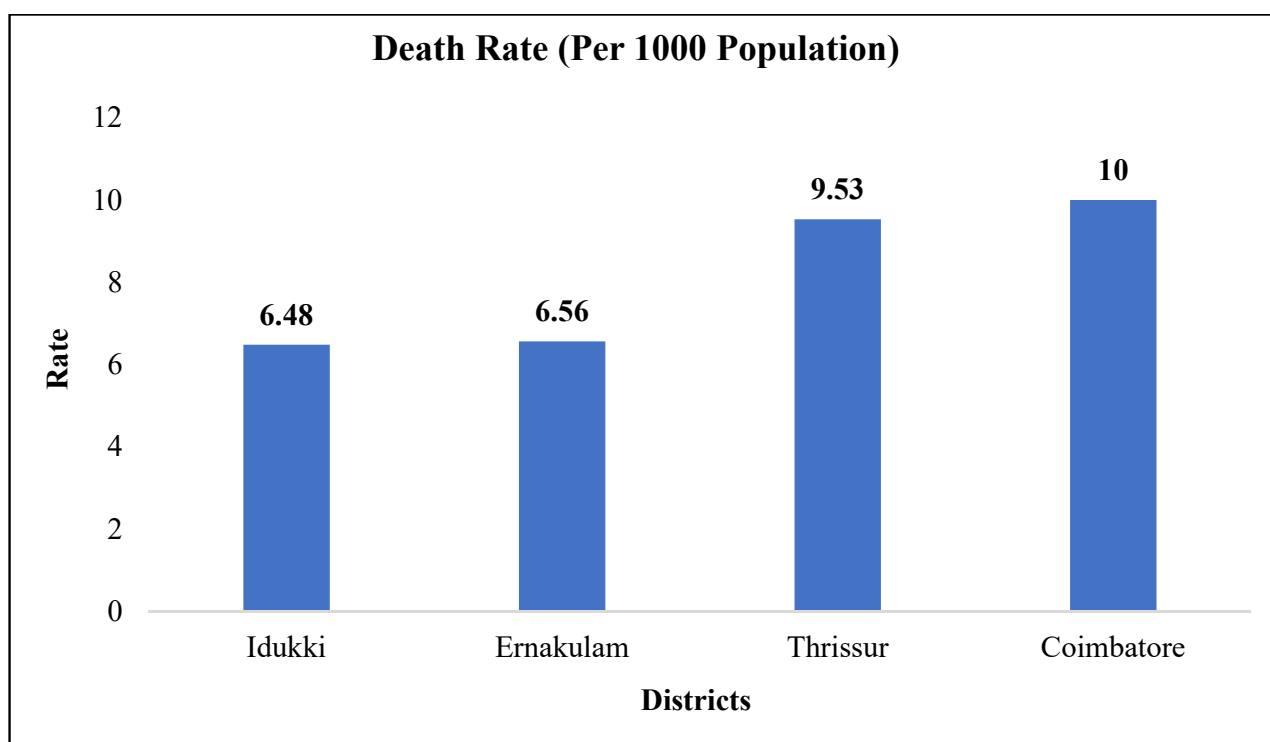


Figure 28. Death rate (per 1000 population) across various districts in the basin

In Coimbatore, the death rate stands at 10, which is slightly above Tamil Nadu's state average of 8.1 (2020). This may reflect health challenges or demographic shifts in the population of the basin portion within this district.

5.2.3 Life Expectancy

Life expectancy is a statistical measure that represents the average number of years a person can expect to live, based on current mortality rates and health conditions in a particular region or population. It reflects the overall health, economic, and social well-being of a society. Factors such as healthcare access, living standards, nutrition, lifestyle, and environmental conditions significantly influence life expectancy. Kerala has one of the highest life expectancies in the country. Figure 29 represents the life expectancy at birth graph of the Kerala state. The life expectancy at birth in Kerala has shown a consistent upward trend, reflecting the focus on healthcare and overall well-being.

Between 2014-2018, the total life expectancy was 75.3 years, with males at 72.5 years and females at 77.9 years. In the subsequent period from 2016-2020, there was a slight decrease, with the overall life expectancy become 75 years. The gender gap remains, as females continued to have a higher life expectancy (78 years) compared to males (71.9 years). This data highlights Kerala's continued efforts to enhance public health and social welfare, although addressing the persistent gender disparity in life expectancy remains an important focus. This measure is often used as an important indicator of the quality of life and progress within a country or community, helping governments and organizations tailor policies for public health and social welfare improvements.

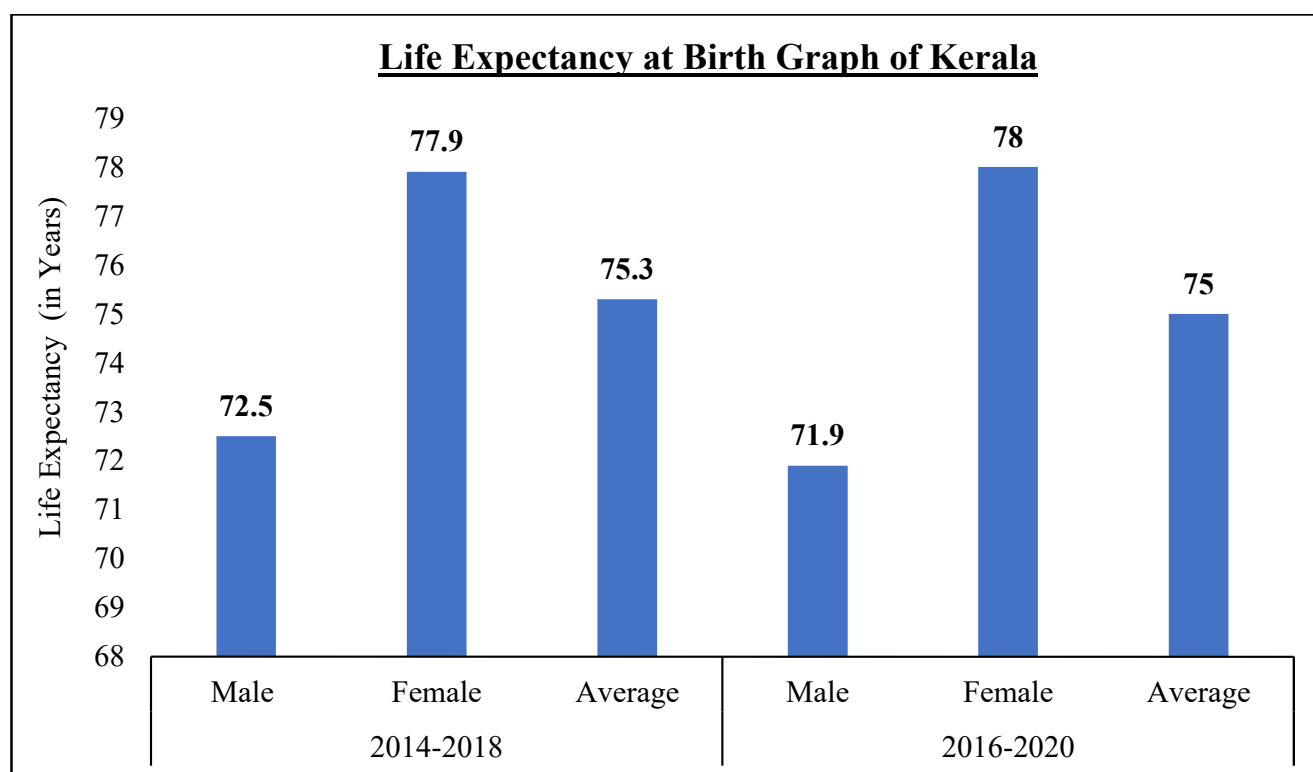


Figure 29. Life expectancy at birth graph of the Kerala

This indicates a particularly slow population growth in the basin portion of Ernakulam, possibly due to urbanization and demographic shifts. Pathanamthitta, on the other hand, has a higher birth rate of 13.97, followed by Thrissur at a rate of 13.94 which they closely match the state average and suggesting more rapid population growth in its part of the basin. Coimbatore's birth rate of 11.4 is slightly below Tamil Nadu's state average of 14.4 (Tamil Nadu Government, 2020), showing moderate population growth in the small portion of the district within the basin.

5.2.4 Infant Mortality Rate (IMR)

The infant mortality rate (IMR), measuring the number of infant deaths per 1,000 live births, is a key indicator of healthcare quality, particularly in maternal and child health. Figure 30 presents a graphical representation of infant mortality rates among districts within the Periyar River Basin.

Idukki shows a remarkably low IMR of 2.47 per 1,000 live births, which is significantly better than Kerala's state average of 10 (2019) and far below the national average of 30. This suggests excellent healthcare services in the basin portion of Idukki. In Ernakulam, the IMR is 5.39, also lower than the state average, indicating good healthcare services, though there is room for improvement. Thrissur has a slightly higher IMR of 6.42, which is still better than the state average but higher than other districts within the basin, reflecting some healthcare challenges for infants in the region. Coimbatore's IMR of 10 mirrors Tamil Nadu's state average of 15 (2020), indicating that the small portion of Coimbatore within the basin faces challenges in reducing infant mortality rates compared to Kerala.

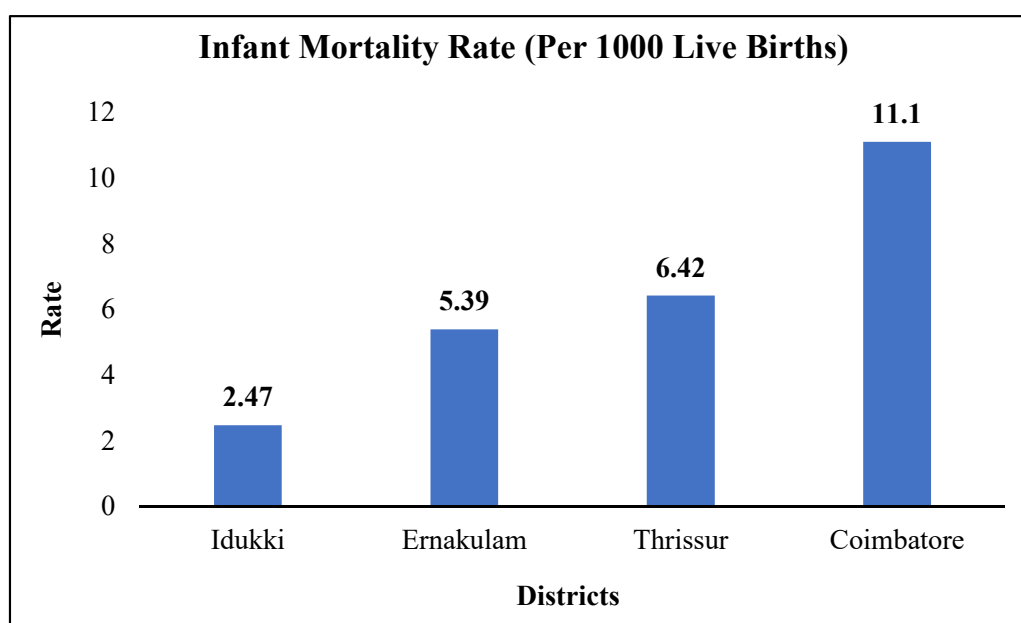


Figure 30. Infant mortality rate (per 1000 live births) graph across various districts

5.2.5 Maternal Mortality Ratio (MMR)

The maternal mortality ratio (MMR) reflects the number of maternal deaths per 100,000 live births and is a critical measure of women’s health and the effectiveness of healthcare services during childbirth. Figure 31 depicts a graphical representation of maternal mortality ratios among districts within the Periyar River Basin.

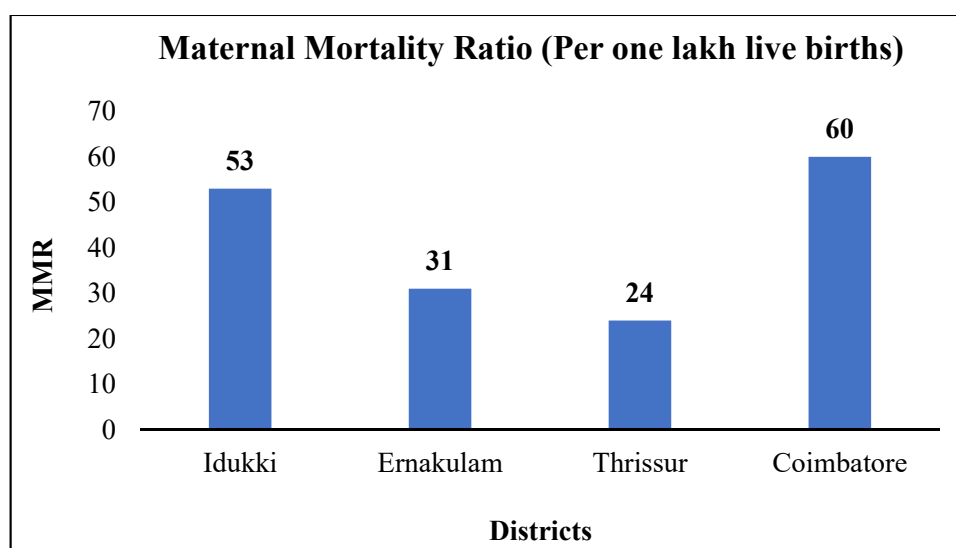


Figure 31. Maternal Mortality Ratio (per 1000 live births) graph across various districts in the basin

Idukki has an MMR of 53, which is notably higher than Kerala’s state average of 42 (2019) and higher than the national average of 113 (2018). This highlights the need for improved maternal healthcare services in the basin portion of Idukki. In Ernakulam, the MMR stands at 31, below the state average, suggesting better maternal healthcare services in this region. Thrissur shows the lowest MMR among the districts at 24, indicating high-quality maternal healthcare services in its part of the basin. Coimbatore, while having an MMR similar to Tamil

Nadu's average of 60, also reflects challenges in maternal healthcare, especially in the basin's small coverage area within this district.

Idukki has an MMR of 53, which is notably higher than Kerala's state average of 42 (2019) and higher than the national average of 113 (2018). This highlights the need for improved maternal healthcare services in the basin portion of Idukki. In Ernakulam, the MMR stands at 31, below the state average, suggesting better maternal healthcare services in this region. Thrissur shows the lowest MMR among the districts at 24, indicating high-quality maternal healthcare services in its part of the basin. Coimbatore, while having an MMR similar to Tamil Nadu's average of 60, also reflects challenges in maternal healthcare, especially in the basin's small coverage area within this district.

The population density and health parameters of the Periyar river basin reveal significant variations between districts, driven by the differing proportions of area each district covers within the basin. Idukki, which has the highest coverage, shows relatively positive trends in infant health but faces challenges in maternal health. Pathanamthitta shows a major hike in the graph of death rate as well as birth rate. Ernakulam demonstrates good overall health indicators but has a notably low birth rate, suggesting slower population growth. Thrissur, with limited coverage in the basin, faces higher mortality rates but otherwise aligns with state health trends. Coimbatore, covering only a small portion of the basin, faces greater challenges in both infant and maternal health compared to the other districts. These variations highlight the need for targeted healthcare interventions in specific areas of the Periyar river basin to address these demographic and health challenges.

5.3 Total Working Population

The working population is a critical demographic component that reflects the economic vibrancy of a region. This section differentiates between the total and working populations, examines gender-specific workforce participation, and discusses major occupational patterns within the Periyar River Basin. The data sourced from sub-districts within the basin highlight significant demographic trends influencing the socio-economic landscape of the region.

5.3.1 Importance of the Working Population

The working population drives regional economic growth, sustains household incomes, and underpins broader socio-economic development. A higher working population leads to increased tax revenues, enabling governments to invest in essential infrastructure, healthcare, and education. Conversely, a low working population can strain public resources and reduce economic opportunities, particularly in areas with high dependency ratios.

The working population forms the backbone of economic activity, contributing to the production of goods and services and generating income that fuels growth. A robust working population attracts investment, creates jobs, and improves living standards. Moreover, a skilled and educated workforce supports the development of innovative industries and the adoption of new technologies, enhancing the region's economic competitiveness.

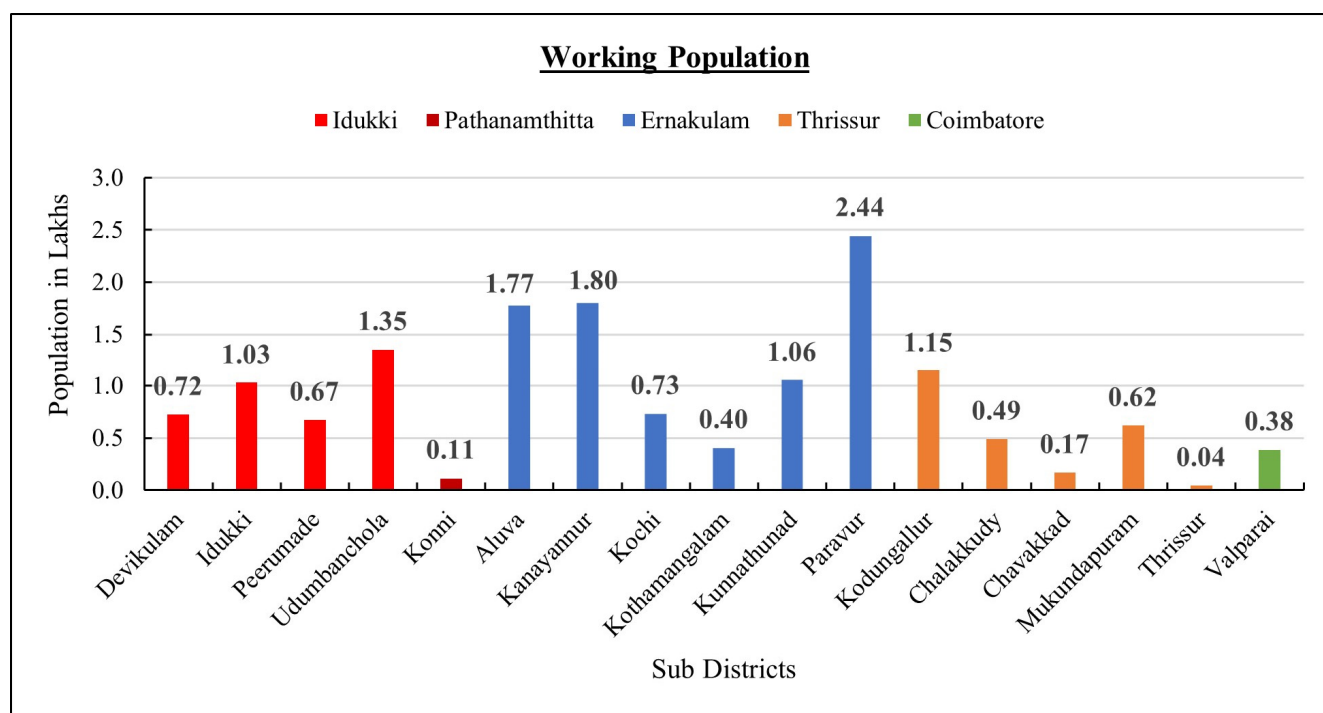


Figure 32. Graph depicting the total working population within the study area.

Figure 32 shows that the total working population in the Periyar River Basin is 1,493,682, accounting for approximately 39.7% of the total population of 3,763,537. This gap between the total and working populations is due to dependent groups such as children and the elderly, and individuals who are not seeking employment or are unable to work due to health issues or other constraints. Contributing factors include gender disparities, low educational attainment, limited formal employment opportunities, and socio-economic barriers. High male out-migration from rural areas like Thrissur further reduces the local workforce, while cultural norms and family responsibilities often restrict women's participation, lowering overall workforce engagement.

Paravur taluk in Ernakulam district has the highest working population, with 244,206 individuals, representing 16.3% of the total working population in the basin. This is largely due to Paravur's proximity to Kochi, which offers numerous employment opportunities in industries, trade, and services. Its developed infrastructure and urban environment attract a significant working-age population. Kanayannur and Aluva taluks in Ernakulam also have high working populations, contributing to Ernakulam's dominance, which accounts for 55% of the basin's total working population. Ernakulam's status as a major urban and industrial hub with diverse job opportunities in IT, manufacturing, trade, and services, along with excellent infrastructure and connectivity, supports this high workforce participation. Conversely, Thrissur taluk of Thrissur district has the lowest working population, partly because only a small part of it lies within the basin, limiting its contribution to the workforce. Additionally, its focus on cultural and agricultural activities may reduce formal employment opportunities.

Figure 33 revisits the percentage of the working population relative to the total population, providing critical insights into the employment rate within the region. When comparing

working population ratios, the Valparai sub-district of Coimbatore district has the highest proportion, with 54.2% of its total population engaged in work. Valparai's plantation-based economy, dominated by tea and coffee estates, requires extensive labour, resulting in a high working population ratio. Following Valparai, Udumbanchola taluk in Idukki district has a working population of 51%, and Devikulam, Peerumade, and Idukki taluks each contribute 48%. Although Idukki's overall contribution to the basin's working population is lower, the district's internal working population ratios are among the highest due to its agriculture-focused economy, relying on manual labour for farming and plantation activities.

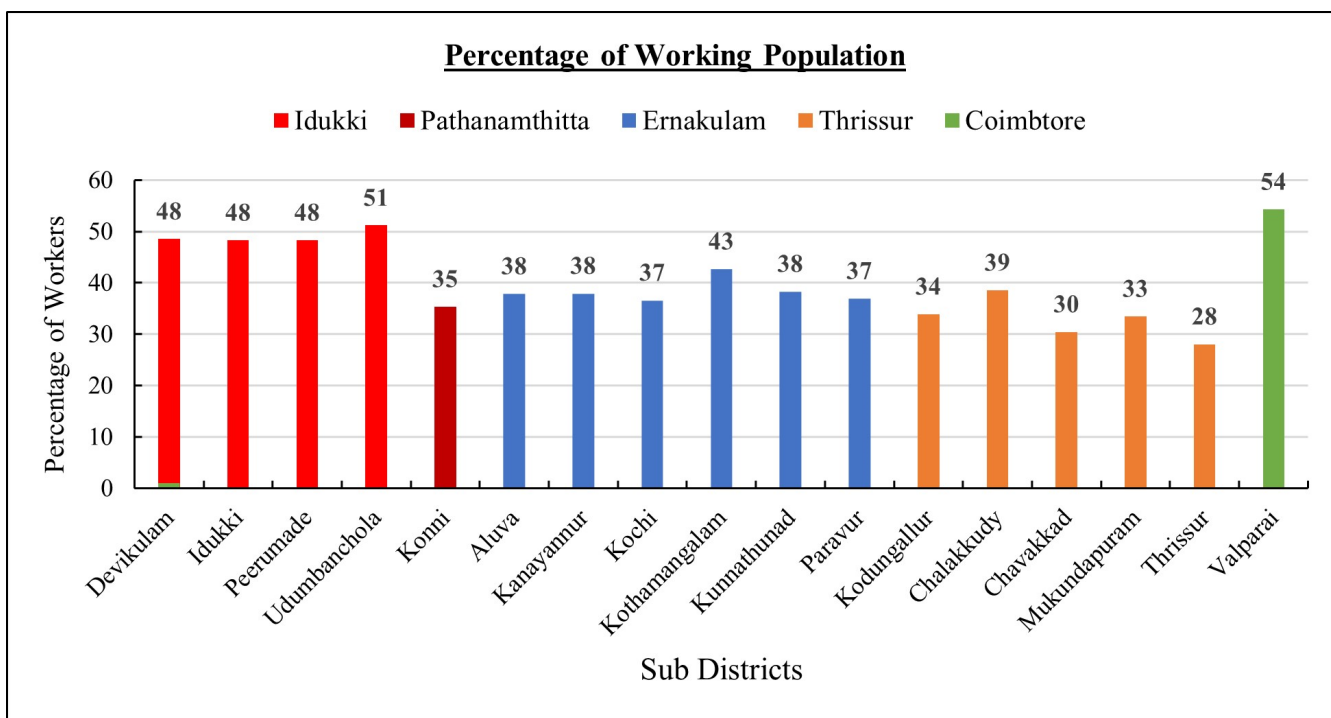


Figure 33. The percentage of the working population relative to the total population.

5.4 Total work force Participation Ratio

From the graph figure 34 we can see that, the male working population in the Periyar River Basin stands at 1,046,504, while the female working population is 451,016. This indicates a significant gender gap in labour force participation, with males accounting for approximately 70% of the working population and females comprising the remaining 30%. This disparity may be influenced by sociocultural norms, educational attainment, and access to employment opportunities for women in the region.

The gender-based analysis of the workforce in the Periyar Basin highlights significant differences in male and female participation across various sub-districts. Paravur taluk in Ernakulam district records the highest male population, accounting for 17.6% of the total male workforce in the basin. This high concentration of working-age males is primarily due to Paravur's proximity to Kochi, which offers extensive employment opportunities in industrial, commercial, and service sectors. The region's developed infrastructure and job prospects in nearby urban centres further drive this demographic trend. Following Paravur, Kanayannur and Aluva taluks contribute 12% each to the total male workforce. Collectively, Ernakulam

district contributes 58% to the total male workforce, largely due to its urbanization, industrial growth, and diverse employment opportunities in sectors like IT, trade, and manufacturing. In contrast, Idukki district contributes only 22.5% of the total male workforce, reflecting its predominantly agriculture-based economy with fewer formal job opportunities for men.

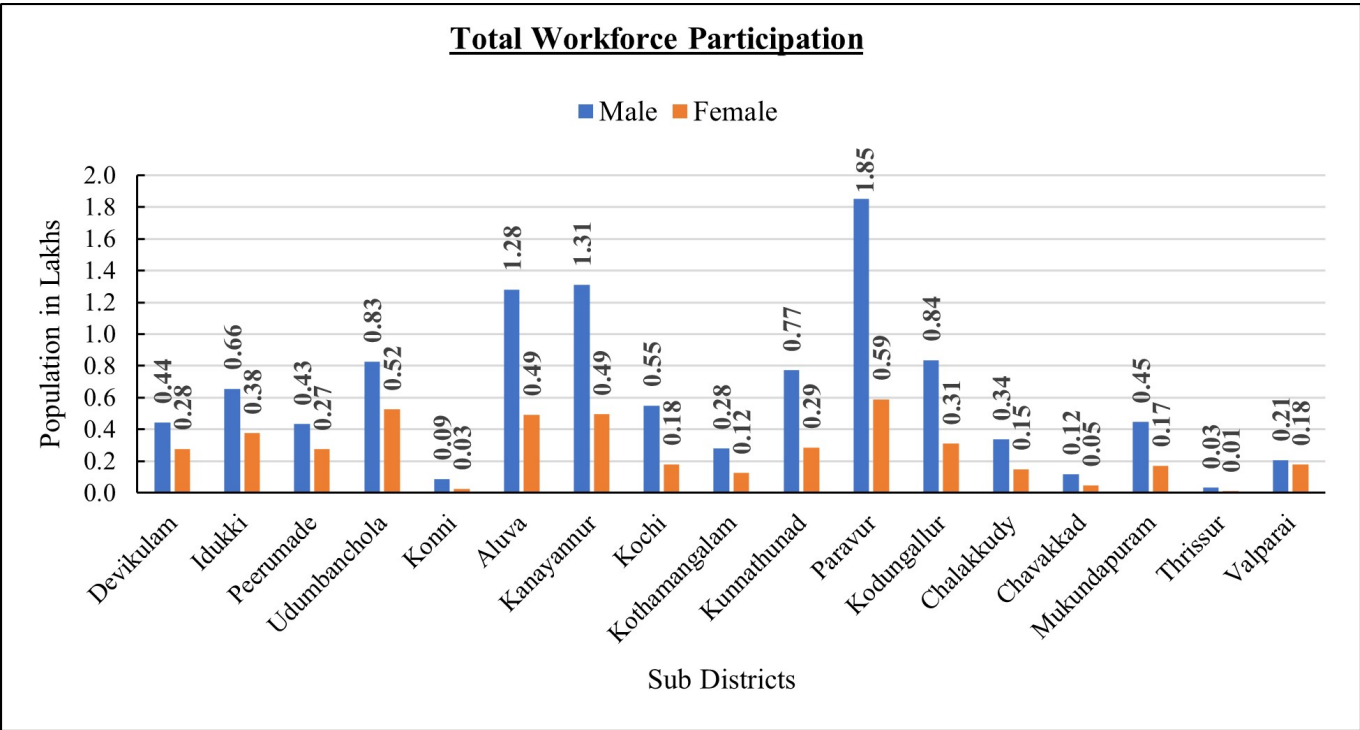


Figure 34. The total workforce participation of males and females in the Periyar

In terms of the female workforce, Paravur taluk also leads with the highest female population, comprising 13% of the total female workforce. This is influenced by lower out-migration rates among women and greater access to local employment, healthcare, and education. The urban environment of Paravur offers ample job opportunities in the service sector, attracting a significant number of women. Udumbanchola taluk in Idukki district follows, contributing 11.6% to the total female workforce, driven by the taluk’s agricultural and plantation economy where women are extensively employed in labour-intensive sectors like tea, coffee, and spice cultivation. This makes Udumbanchola the only taluk in Idukki with notably high female workforce participation. Ernakulam district leads overall, contributing 48% to the total female workforce due to its urban environment that supports diverse job opportunities in education, healthcare, retail, and services, along with robust social infrastructure such as childcare and healthcare facilities that encourage higher female workforce participation. Idukki district contributes 32.3% to the total female workforce, reflecting the significant involvement of women in agricultural activities.

A comparative analysis of the male and female workforces reveals that Ernakulam’s male workforce is significantly higher than that of Idukki, primarily due to the presence of diverse industrial and commercial opportunities in Ernakulam, unlike Idukki’s limited agricultural and plantation-based job market. Additionally, Idukki’s female workforce contribution is higher than that of its male workforce, despite the lower overall number of women compared to

men. This trend is driven by high male out-migration for employment outside the region, leaving a higher proportion of women in local jobs, particularly in agriculture, plantations, and related services. Consequently, women’s participation in Idukki’s workforce plays a critical role in the local economy, demonstrating a unique demographic pattern where female engagement in economic activities surpasses that of men.

5.5 Occupational Patterns in the Periyar Basin

Ernakulam’s sub-districts exhibit a diverse economy with significant workforce engagement in trade, services, and manufacturing, reflecting its urban and semi-urban nature. In contrast, Idukki’s sub-districts, such as Devikulam and Peerumade, primarily rely on agriculture and plantations, with tea, coffee, and spice cultivation being key employment drivers. These distinct occupational patterns underscore the need for tailored economic policies that address the unique characteristics of each area.

The working population is divided into four categories: other workers, household industries, cultivators, and agricultural labourers. The "other workers" category includes professionals, service sector employees, industrial workers, construction labourers, and those engaged in trade, transport, and public administration. Household industries consist of small-scale, family-run businesses producing goods like handicrafts, food products, and textiles. Cultivators manage their own or leased land, while agricultural labourers work on land owned by others, typically on daily wages without ownership or control over farming operations.

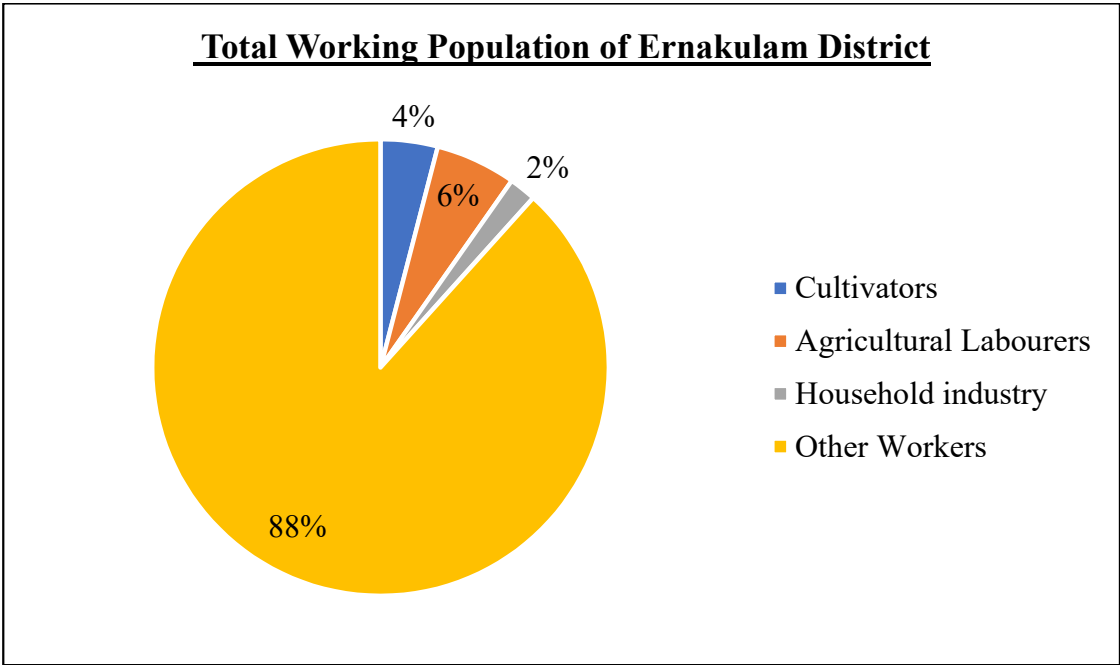


Figure 35. The occupational distribution of Ernakulam district

Figure 35 presents the occupational distribution of the working population in Ernakulam district, highlighting a predominant concentration of "other workers," which constitutes the largest segment of the workforce. Ernakulam’s high number of "other workers" is attributed to its urban landscape, robust service sector, and extensive industrial activities. Key

employment sectors include information technology, trade, transport, and public administration. In contrast, household industries constitute the smallest portion of the workforce. This is primarily due to the district's preference for large-scale industrial and commercial enterprises over smaller, home-based businesses, reflecting its advanced urban and industrial infrastructure. Additionally, only 4% of the workforce is engaged as cultivators, and 6% as agricultural labourers, illustrating the shift from traditional agricultural roles to service and industrial sectors as a result of ongoing urbanization and industrial growth.

Figure 36 shows the occupational distribution within the Idukki district, where a significant proportion of the workforce is engaged in agriculture. Approximately 28% of the working population are agricultural labourers, and 20% are cultivators, highlighting Idukki's reliance on agriculture and plantation work. The district's economy is heavily dependent on its rural and hilly terrain, which is conducive to plantation crops such as tea, coffee, and spices. Household industries account for only 1% of the workforce due to geographic and economic factors that limit the viability of small-scale, home-based industries in remote and rural settings. The "other workers" category, representing 51% of the working population, includes individuals employed in construction, tourism-related services, and small-scale industrial activities, reflecting a gradual diversification of Idukki's economic base beyond agriculture.

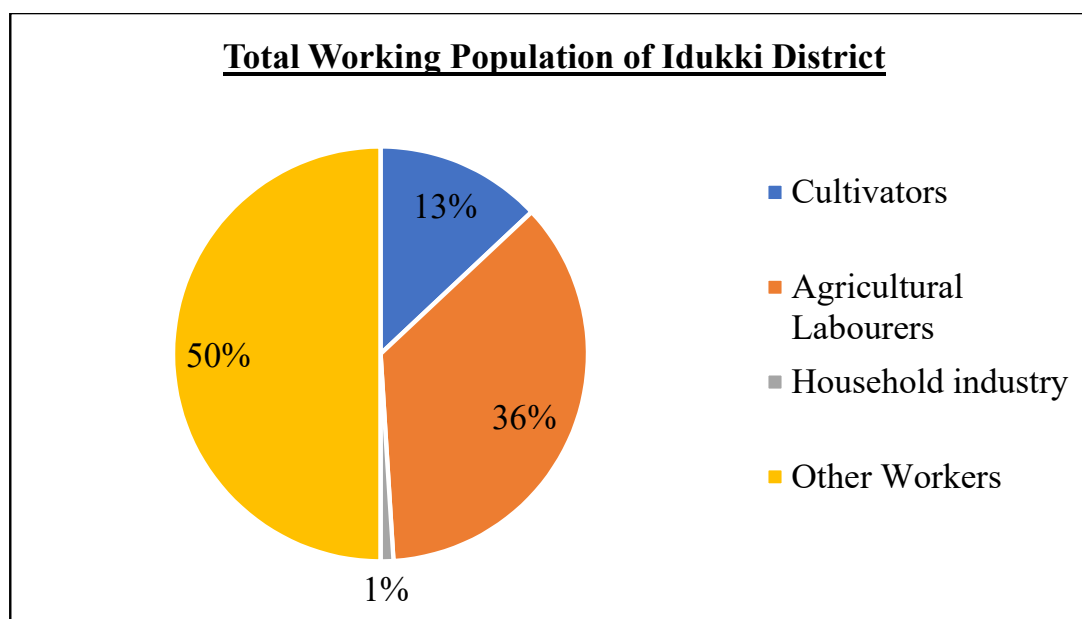


Figure 36. The occupational distribution of Idukki district

Comparing Ernakulam and Idukki reveals stark contrasts in workforce engagement. Ernakulam's economy centred around services and industries, supports urbanization and workforce diversification. In contrast, Idukki's demographic profile reflects a rural setting with strong agricultural dependence. These differences shape the socio-economic landscape of each district, influencing development priorities and the need for region-specific workforce and economic strategies.

Studying male and female occupations and their contributions to various sectors such as agricultural labourers, cultivators, other workers, and household industries is crucial for the

Periyar River Basin because it provides insights into the socio-economic dynamics that shape resource use and livelihoods in the region. Understanding the gender distribution in these occupations helps identify which groups are most dependent on the river’s resources, such as water for agriculture and industry, and highlights the socio-economic vulnerabilities of different demographic groups. This analysis aids in designing targeted interventions and policies that address gender-specific needs, promote equitable access to resources, and enhance economic opportunities for both men and women. It also supports sustainable basin management by ensuring that economic activities align with the ecological health of the river, thereby balancing human development with environmental conservation. Additionally, this study can guide investments in infrastructure, training, and capacity-building programs that empower both male and female workers, fostering inclusive growth within the basin.

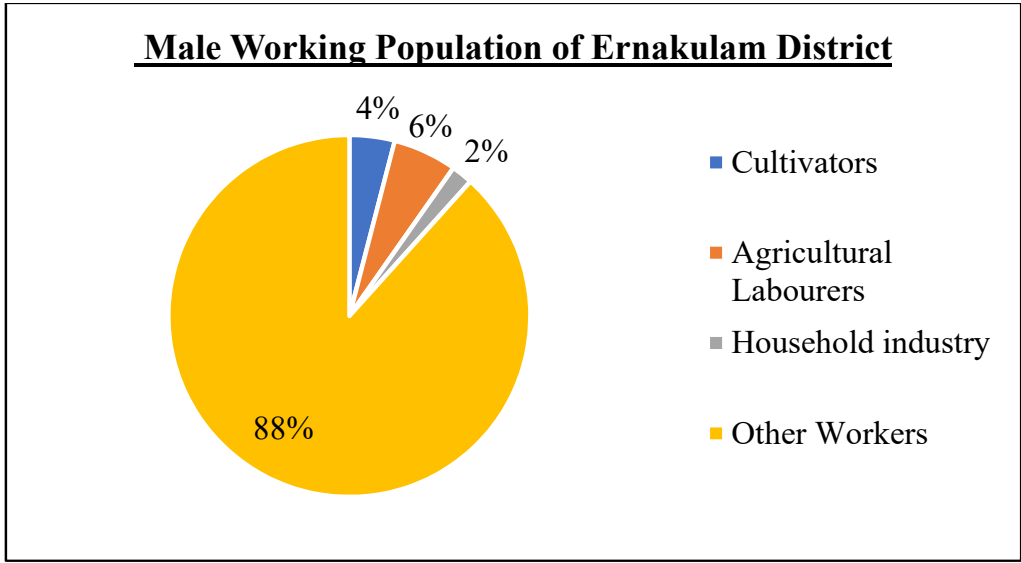


Figure 37. The occupational distribution of the male working population in Ernakulam district.

Figure 37 illustrates the occupational distribution of the male working population in Ernakulam district, highlighting that 89% of the male workforce is engaged in the "other workers" category. This high percentage is driven by the district’s urban and industrial environment, which provides diverse employment opportunities outside the agricultural sector. Men are predominantly employed in manufacturing, construction, transportation, trade, information technology, and public administration, where both formal and informal job roles are readily available. The significant demand for male labour in these varied sectors underscores the district’s industrial nature. Conversely, agricultural labourers and cultivators constitute only 5% and 4% of the male workforce, respectively. This low participation in agriculture reflects Ernakulam’s urbanization and its shift towards IT, service, and industrial jobs, rather than traditional agricultural activities.

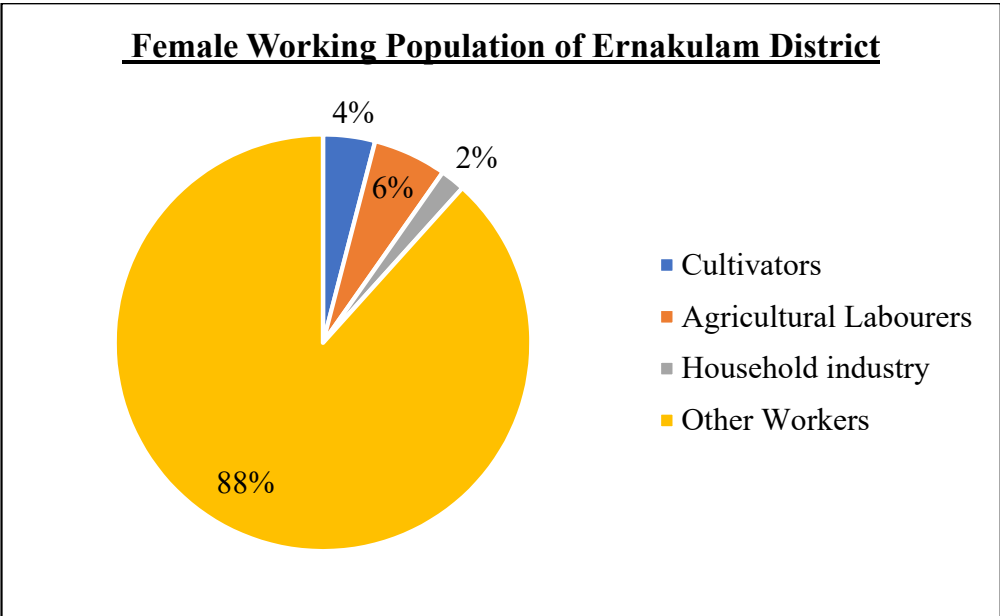


Figure 38. The occupational distribution of the female working population in Ernakulam district.

Figure 38 presents the occupational distribution of the female working population in Ernakulam district, showing that 87% of women are classified under "other workers." This high engagement reflects the increasing involvement of women in non-agricultural sectors, particularly in urban settings. Women are primarily employed in retail, healthcare, education, hospitality, administrative roles, and other service-oriented industries. The availability of flexible work arrangements and service-based job opportunities significantly boosts female workforce participation in these sectors. Agriculture remains a minor occupation for women, with only 8% as agricultural labourers and 3% as cultivators, underscoring the impact of urbanization and the prevalence of non-agricultural employment opportunities for women in Ernakulam.

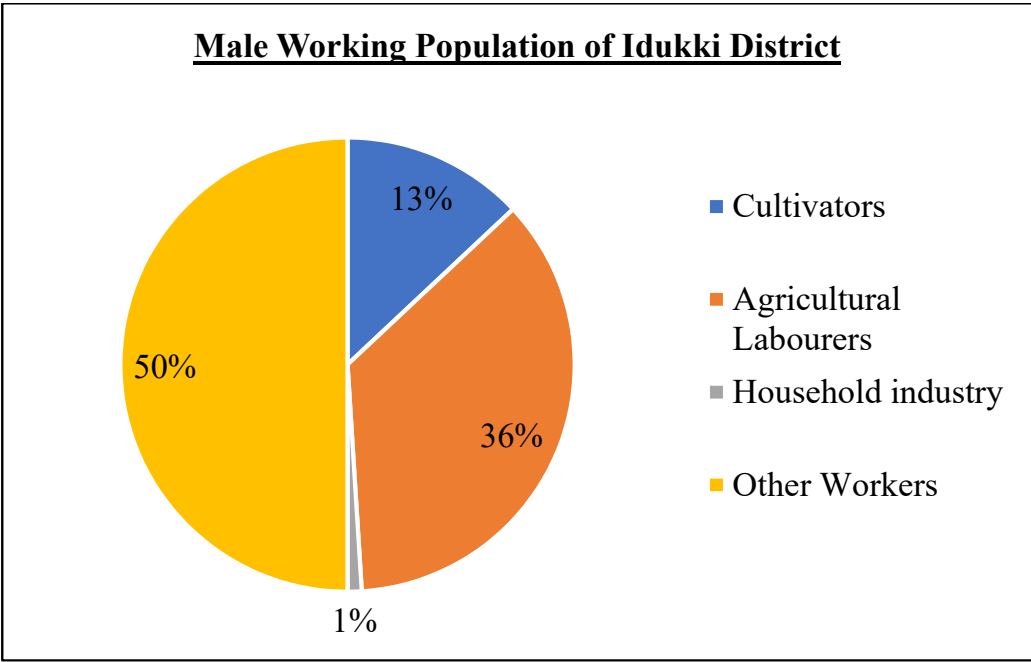


Figure 39. The occupational patterns of the male working population in Idukki district

Figure 39 depicts the occupational distribution of the male working population in the Idukki district, where "other workers" represent the largest category, comprising 52% of the male workforce. This reflects a gradual diversification beyond agriculture into construction, tourism, small-scale industries, and public services, which are increasingly absorbing the male workforce. Despite these shifts, agriculture remains a significant employment sector, with 24% of males working as agricultural labourers and 23% as cultivators. The district's strong reliance on agriculture and plantations, supported by its rural and hilly terrain, sustains a large portion of the male workforce in traditional roles related to tea, coffee, and spice cultivation.

Figure 40 shows the occupational distribution of the female working population in Idukki district, where "other workers" account for 50% of the total female workforce, the highest among all occupational categories.

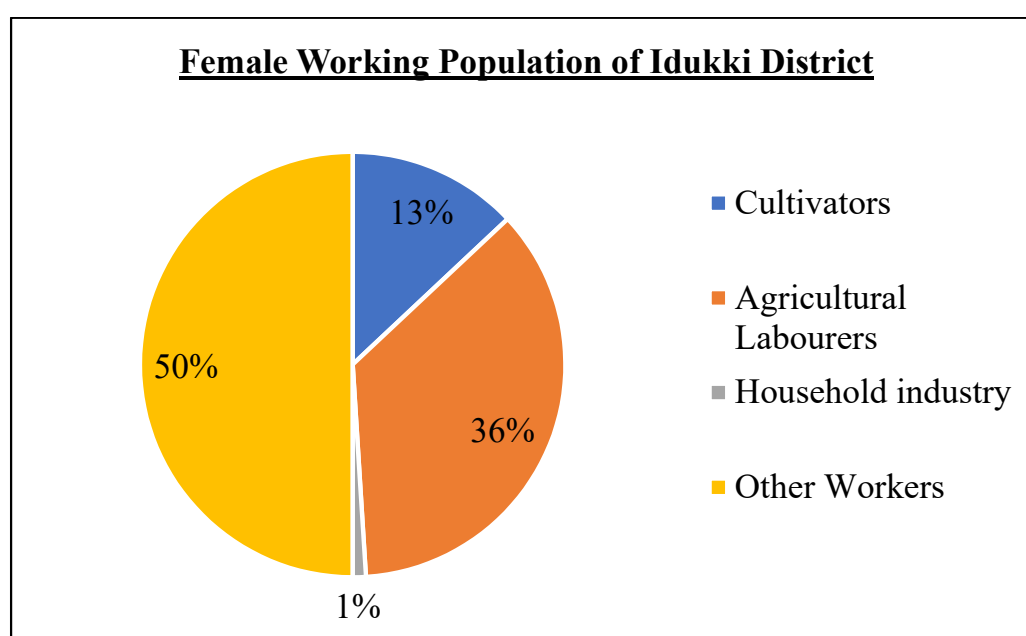


Figure 40. The occupational patterns of the female working population in Idukki district

This shift is attributed to the growing participation of women in non-agricultural sectors such as small-scale manufacturing, construction, tourism, and administrative jobs. However, agriculture still plays a vital role for women, with 36% engaged as agricultural labourers and 13% as cultivators. The labour-intensive nature of plantation work, such as tea, coffee, and spice cultivation, continues to provide substantial employment for women, reflecting the district's deep-rooted agricultural economy and cultural acceptance of female participation in these roles.

The comparative analysis of Ernakulam and Idukki districts reveals stark contrasts in occupational patterns among male and female workers. In Ernakulam, the dominance of "other workers" for both genders highlight the district's urban and industrial landscape, where diverse non-agricultural employment opportunities are prevalent. The minimal engagement in agricultural roles reflects the district's ongoing transition away from traditional sectors. In contrast, Idukki's workforce remains deeply tied to agriculture, with a substantial proportion of both male and female workers engaged in agricultural labour and

cultivation. However, the rising share of "other workers" in Idukki indicates a gradual economic diversification, offering alternative employment opportunities outside agriculture. This district-wise comparison underscores the varying socio-economic dynamics and employment structures that define the male and female workforce in these regions, highlighting the need for tailored economic and development policies that address their distinct occupational landscapes.

5.6 Income Levels

In Kerala, the Per Capita NSDP for 2021-2022 reached ₹148,810, up from ₹132,531 the previous year. Likewise, the Per Capita GSDP rose to ₹57,274,734, compared to ₹51,170,291, shows a notable improvement in the economic performance of the state and higher income levels during this period. In Tamil Nadu, the NSDP for the same period increased to ₹154,557 from ₹143,482, while the GSDP rose to ₹134,328,684 from ₹124,465,002. This illustrates strong economic growth in Tamil Nadu, driven by its larger industrial base and more diverse economy. For comparison, the national average GSDP stands at ₹46,031,334, and the national average NSDP is ₹125,181.79. Both Kerala and Tamil Nadu surpass the national averages in terms of economic output and income levels, with Tamil Nadu showing greater absolute growth and Kerala maintaining solid per capita performance.

The economic data of the Periyar basin, with higher NSDP and GSDP than the national average, reflects strong regional economic activity and income levels. This information is crucial for resource allocation, development planning, and assessing the socioeconomic conditions of the basin. To better understand the economic analysis on a smaller scale, district-wise income data is essential. Accordingly, the Net District Value Added (NDVA) at constant prices for each district in the basin has been analyzed to provide a more detailed assessment, is shown in Figure 41

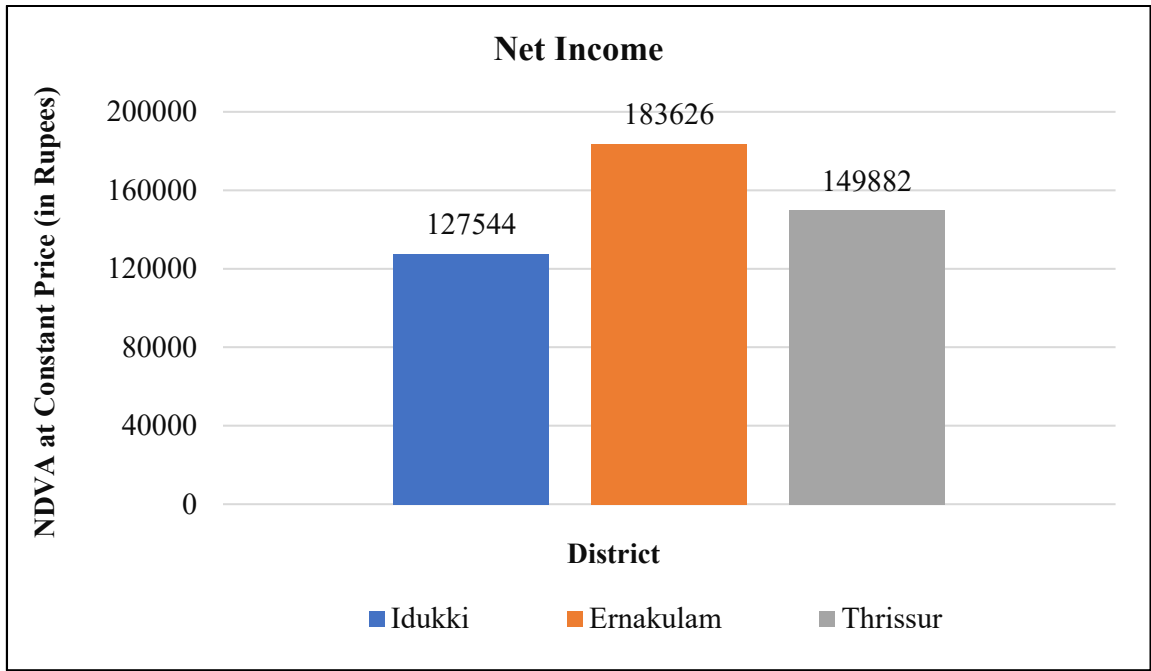


Figure 41. Net District Value Added (NDVA) at constant prices for each district in the basin

The graph provides Net District Value Added (NDVA) at constant prices for four districts in Kerala, all of which fall within the Periyar River basin. NDVA at Constant Prices refers to the total net value produced by all sectors within a district, adjusted for inflation and subtracting depreciation. This metric provides a clear picture of the real economic productivity of each district.

Ernakulam, with the highest NDVA, is the most economically productive region, driven by its developed infrastructure, trade, and industrial sectors, leading to higher income levels. Since one-third of the Periyar River basin (33.1%) is spread across Ernakulam district, this NDVA can be considered a significant indicator of the overall economic activity and income levels within the basin. More than half of the basin, however, is spread over Idukki district, where the income levels are moderate due to the district's reliance on agriculture and hydropower. Idukki ranks third in NDVA among the districts in the basin, reflecting its mixed economic output. Thrissur has the second-highest NDVA among the districts; however, only a small portion of the Periyar River basin, about 7%, lies within Thrissur, making its contribution to the basin's overall economic activity less significant compared to Ernakulam and Idukki. Despite this, Thrissur's economic output remains notable due to its productive sectors. In addition, Coimbatore has an NDVA of ₹9,202,231, which is significantly higher compared to other districts in the Periyar Basin, indicating a stronger economic status. However, the district's area within the basin is relatively small, covering only 2.1%, compared to larger portions in Idukki, Ernakulam, and Thrissur. This suggests that despite its smaller area, Coimbatore's economic output remains substantial.

6. Class I – VI Towns

The distribution of the urban population occurs across settlements of varying sizes, ranging from small towns to massive cities with populations in the tens of millions (Pacione, 2001). Analyzing urban growth by the size classification of towns can provide insights into the stages of a country's urban development. Variations in growth rates across different town sizes also highlight the scale of rural-to-urban migration (Bhagat, 2004).

In India, the urban population is currently growing at an annual rate of around 2.3 percent. The number of urban agglomerations and towns increased from 3,697 in 1991 to 4,369 in 2001. Projections suggest that the country's urban population will rise from 28.3 percent in 2003 to approximately 41.4 percent by 2030 (United Nations, 2004). This growth in urban population is closely tied to overall population increase and migration. By 2001, the number of urban agglomerations or cities with populations exceeding one million had risen to 35, up from 25 in 1991. Despite there being over 4,000 urban agglomerations, around 38 percent of the urban population resides in just 35 large urban areas, reflecting the significant concentration of urbanization in the country (Sudhira, 2008).

In India, towns are classified by the Census of India based on specific criteria. The towns are broadly categorized into statutory towns and census towns. Statutory towns are places with urban local bodies (ULBs) like municipalities, municipal corporations, cantonment boards, etc. These towns are legally recognized by the government and have a formal urban status. Census towns are identified by the Registrar General and Census Commissioner of India based on specific criteria. A settlement is classified as a census town if it has a minimum population of 5,000. According to Census of India, the towns are classified based on their size classes based on their population are depicted in Table 1. Analysis on the growth of number of towns and the urban population in these, based on size classes, reveals the nature of urbanization taking place in the country. The transformation of towns into cities and urban agglomerations sparks interest in investigating potential patterns driving the process of organic urbanization. In the Periyar River basin, there are 54 total towns including both census and statutory towns of which, 2 Class II towns, 26 Class III towns, 17 Class IV towns, 8 Class V towns, and 1 Class VI town, reflecting a diverse distribution of settlements that can guide planning and resource allocation in the region. It is represented in the figure 42.

Table 6. Classification of towns by size class

Class	Population size
I	100,000 & above
II	50,000 to 99,999
III	20,000 to 49,999
IV	10,000 to 19,999
V	5,000 to 9,999
VI	less than 5,000

The predominant class of towns in the Periyar River basin is Class III, with populations ranging from 20,000 to 49,999, accounting a total of 26 towns. Class I towns, with populations exceeding 100,000 are absent in the basin. This variation in town sizes presents both opportunities and challenges for regional development, infrastructure planning, and resource management. Meeting the needs of the towns will require customized strategies to promote balanced growth and ensure sustainable urbanization across the basin. Effective implementation of master or development plans is crucial for managing the growth and regulation of urban areas.

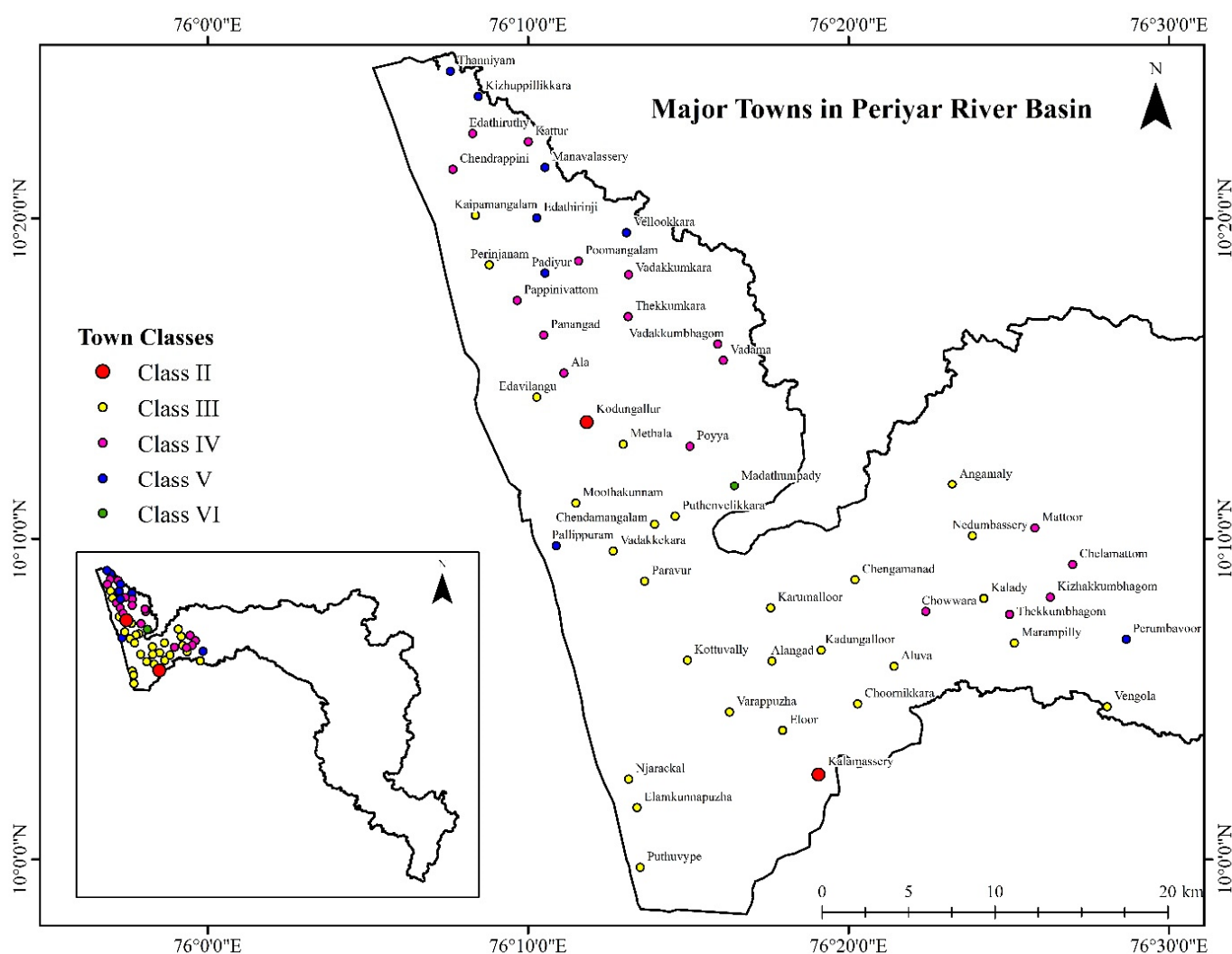


Figure 42. Class I – VI Towns in Periyar River Basin

7. Population Projection

A population projection estimates the future size and composition of a population, including details by age and gender. It's based on current population figures and assumptions about fertility, mortality, and migration trends. Population projections are useful in demographic analysis providing better understanding about future population trends and dynamics. Evaluating factors such as birth rates, death rates, immigration, and emigration help to create models that predict how populations may change in future.

The cohort component method projects India's population for the next 25 years, extending to 2036, based on data from the 2011 census. This method used when population projections by age and sex are needed for five years, 10 years or longer periods of time. The cohort-component method is widely used for population projections because it provides a detailed approach to forecasting population changes by breaking the population down into specific groups. It also allows planners to project the total size of the population. The results can be used in all aspects of local and regional development plans.

7.1 Cohort Component Method for Population Projection

The cohort component technique uses the components of demographic change to project population growth. The technique projects the population by age groups, in addition to other demographic attributes such as sex and ethnicity. This projection method is based on the components of demographic change including births, deaths and migration.

Cohort Component Summary Equation,

$$P_{t+n} = \text{Survived Population} + \text{Births} + \text{Net Migrants}$$

P_{t+n} - Future population at time $t+n$, where n is the time interval.

Survived population - The portion of the current population that survives to the next time period.

Births - The number of new individuals added to the population through reproduction during the time interval.

Net migration – The difference between the number of people who enter (immigrate) and leave (emigrate) the population during the time period.

7.2 Methodology for the Cohort Component Method:

The steps involved in Population Projection using Cohort Component Method are as follows:

7.2.1 Data Collection

The cohort component method requires data from both the most recent and the prior census. Collect information on the number of births during the past 10 years. Information on births should be compiled by the age of the mother so that age-specific fertility rates can be calculated. These rates are used to project the number of births that occur during the projection period.

7.2.2 Aging a Population into the Future

By utilizing survival rates, the cohort component method projects how each age group of the population will age over time. This ultimately provides a detailed forecast of the future population distribution.

7.2.3 Adding Births

The number of births occurring during the projection period can be determined by using the following equation.

$$\text{Number of Births} = \text{Age specific fertility rates} \times \text{Number of womens}$$

The number of women in their reproductive years are need to be taken. An age-specific fertility rate indicates the probability that a woman in her reproductive years will give birth in

a given year. The results give an annual number of expected births. Then total number of births can be calculated by,

$$\text{Total Number of Births} = \text{Number of Births} \times \text{Projection Period}$$

7.3 Population Projection in Periyar River Basin

According to the Census of India 2011, the population of Kerala was 33,406,061, or 2.76 per cent of India's population. In the state's overall population, 48 percent are males and 52 percent are females. The decadal growth rate of Kerala's population was 4.9 per cent, the lowest among Indian States. The following studies are based on projected population for Kerala upto 2036. The Periyar River basin covers areas in the state of both Kerala and Tamil Nadu. The Periyar river basin extends across four districts in Kerala namely Idukki, Pathanamthitta, Ernakulam, and Thrissur and one in Tamil Nadu (Coimbatore). Most of the river basin area is in the Idukki and Ernakulam districts. The following figure 42, figure 43, figure 44, figure 45, figure 46 represents the trend in the population projections for the subdistricts within our river basin. For the purpose of this study, only the subdistricts located within the basin's boundaries have been taken into account.

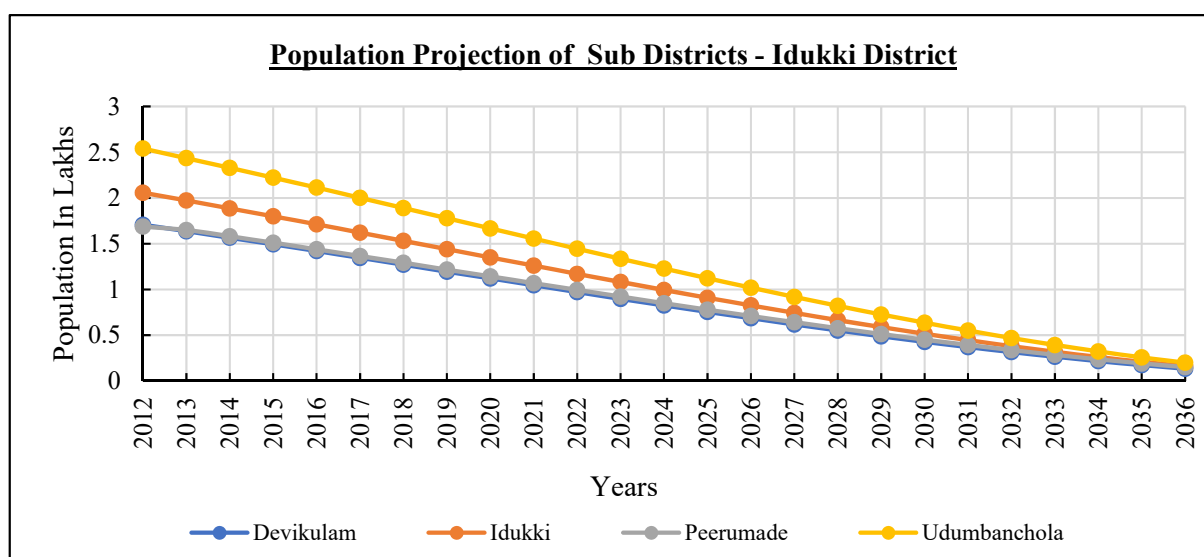


Figure 43. Population Projection of Sub Districts Idukki District

Figure 43 illustrates population trends across sub districts for Idukki district. Around 57% of the area, covering 3,025 square kilometres, is situated in the Idukki region within the Periyar River basin. The projected population graph of Idukki district shows a consistent declining trend in population across all four sub-districts from 2012 to 2036. In all the subdistricts the initial population was more than 1.5 lakhs according to 2011 census and declining to around less than 15,000. This represents a decline of approximately 92% over a 25-year period, indicating an average annual population decrease of 3.8%. The Idukki District is experiencing a significant decline in population, which may be due to various factors such as migration, low birth rates, or other demographic changes. Frequent landslides and floods, shifts in weather patterns, and limited economic opportunities significantly contribute to the declining population in Idukki.

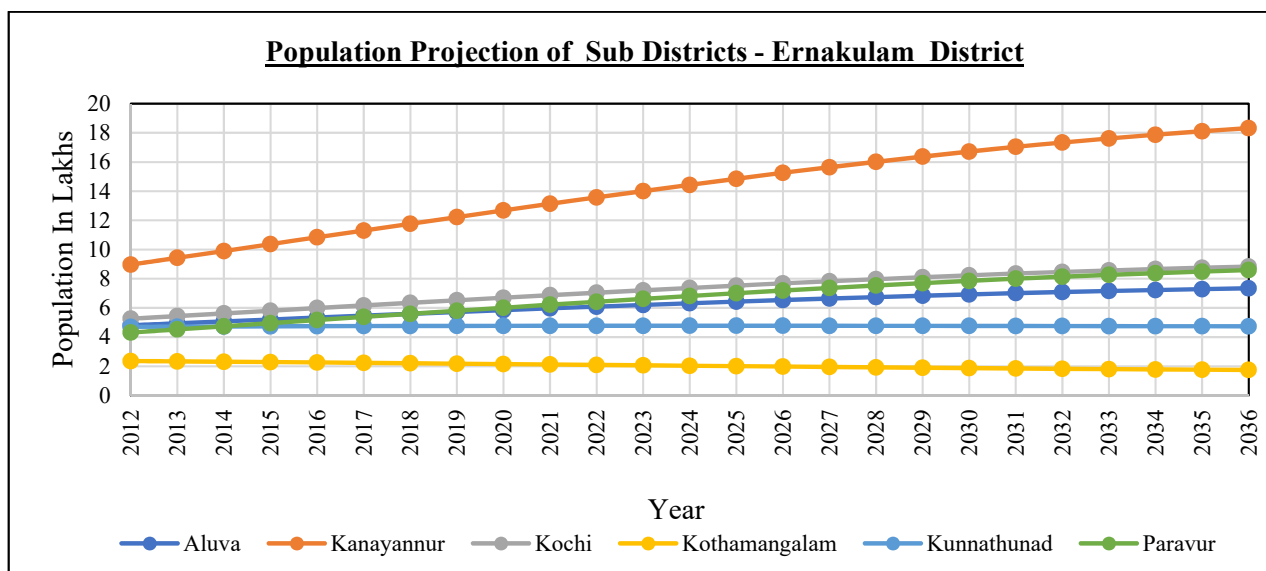


Figure: 44. Population Projection of Sub Districts in Ernakulam District

Figure 44 shows a general upward trend in population across all sub-districts, indicating a growing population in Ernakulam District. Almost 33.1% (1735.3 km²) of the basin area comes under Ernakulam district. Kanayannur sub-district shows the most significant population growth, with a steady increase from approximately 9 lakhs in 2012 to around 18 lakhs by 2036. This represents a growth rate of about 100% over the 25-year period, 4% in each year. This is because Kanayannur is a significant hub of economic activity in Kerala, especially with industries such as food processing, rubber, and textiles. Kanayannur, particularly areas like Kochi, Kalamassery, and Thrippunithura, is rapidly urbanizing due to the expansion of commercial activities, IT parks, and industries. Urbanization leads to more job opportunities which attracts people from rural areas and other districts. Kochi and Paravur grows moderately. Also, Aluva, Kunnathunad grow steadily while Kothamangalam shows a slight decline. The reasons for increasing in population growth can be economic opportunities, infrastructure development, urbanisation and various Government initiatives like Kochi smart city project, Kochi Water Metro, Tourism etc.

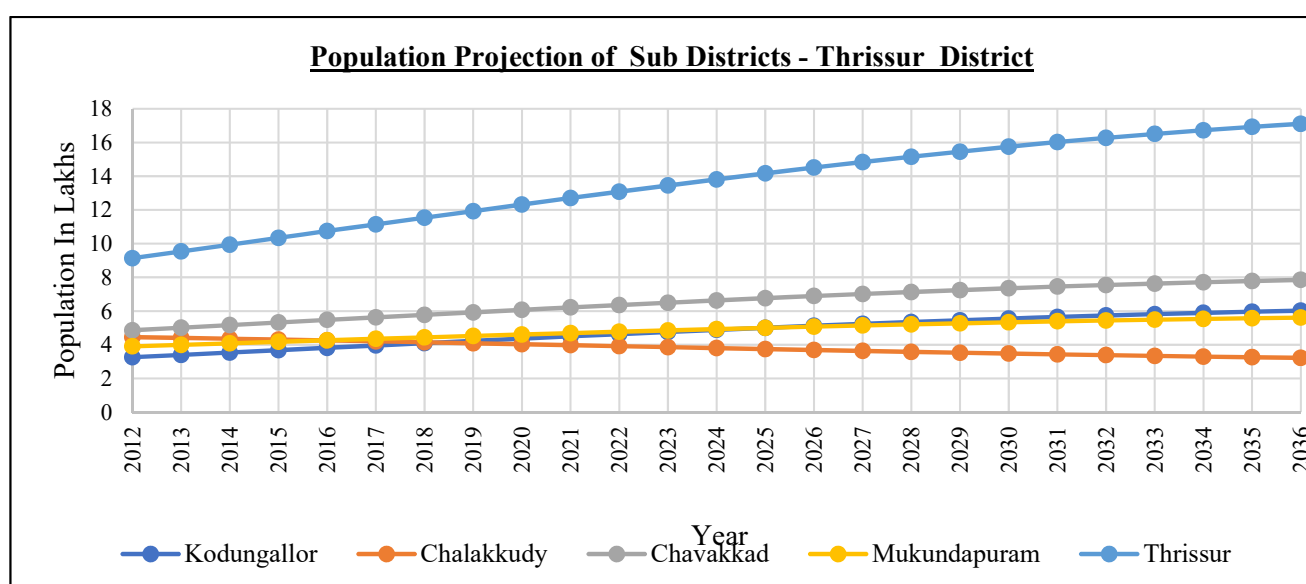


Figure 45. Population Projection of Sub Districts in Thrissur District

Considering the population projection for Thrissur, Figure 45 shows general upward trend in the population. Thrissur covers only 6.8% (358.1 km²) of area within the Periyar river basin. The projected population of Thrissur sub district increasing from 9 lakhs to 17 lakhs within the period. This significant growth indicates that Thrissur is likely to become a major urban centre in the district. Other sub districts such as Kodungallor, Chalakkudy, Chavakkad, Mukundapuram shows the trend in a steady manner.

In the Pathanamthitta district, only 0.3% (14.5 km²) of the Konni Sub District falls within our river basin. Consequently, the population trend in Konni Sub District shows a significant reduction of about 90%. A small portion of the Valparai subdistrict with an area of 114 km² also comes in the river basin. The graph shows a consistent increase in population over the years in Valparai.

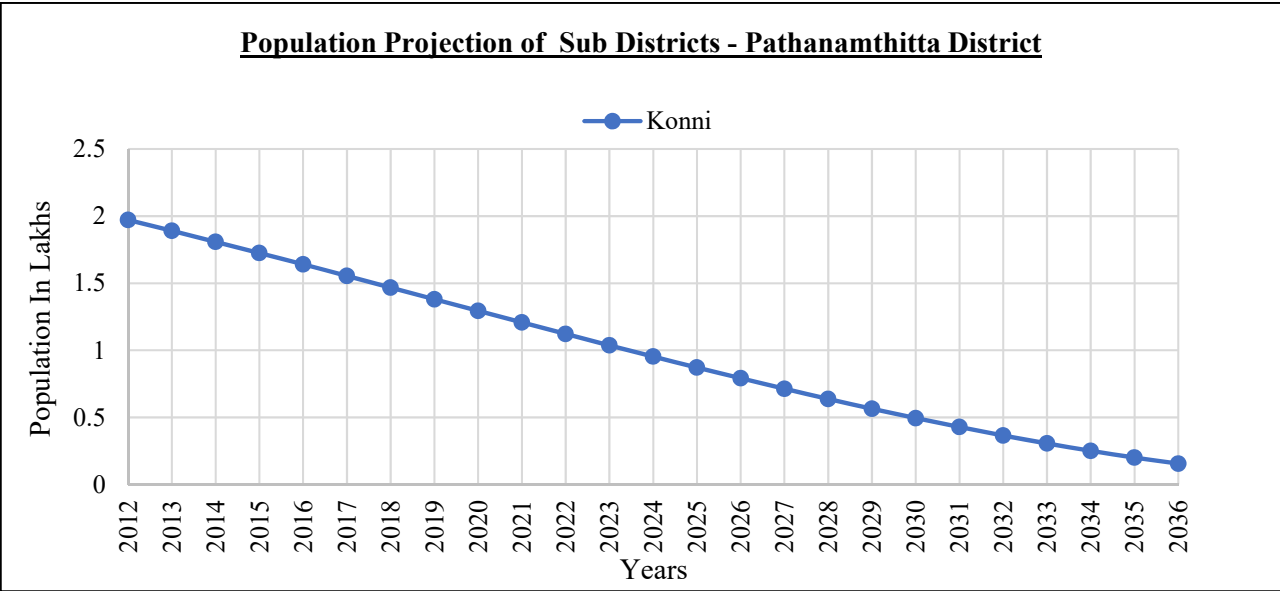


Figure: 46. Population Projection of Sub Districts in Pathanamthitta District

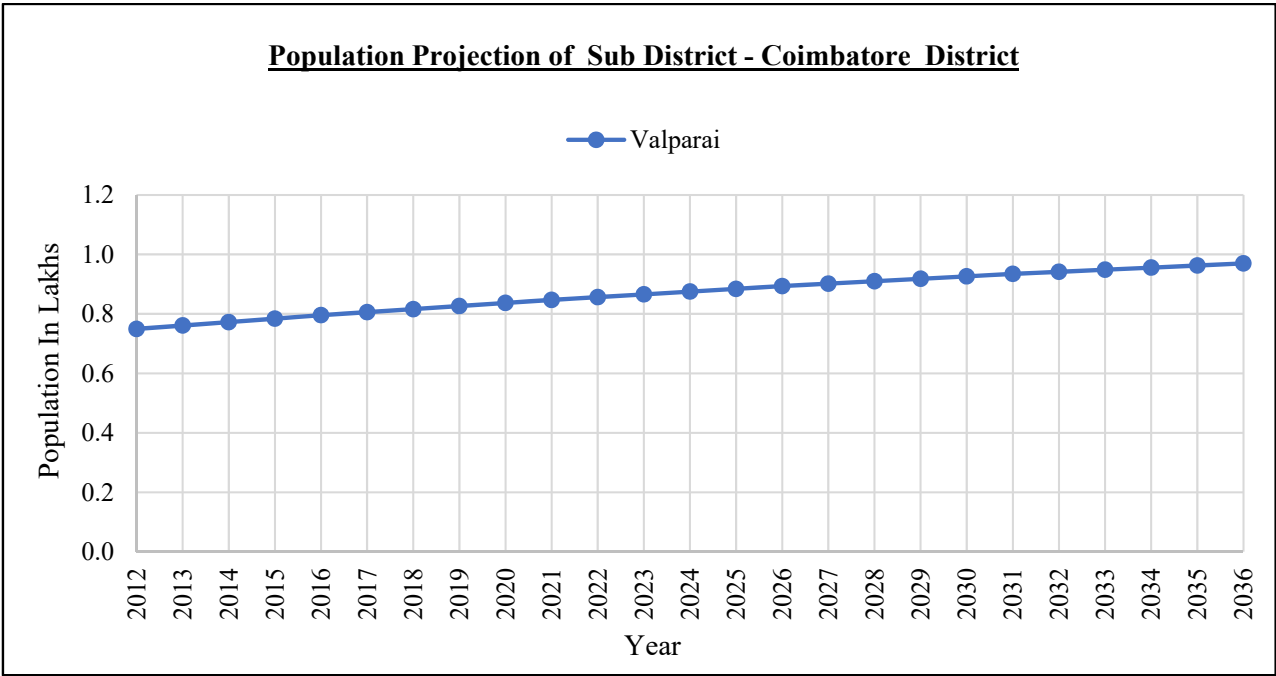


Figure: 47. Population Projection of Sub Districts in Coimbatore District

The Idukki and Ernakulam districts cover a significant portion of the Periyar river basin. The Population Projection for the districts of Idukki and Ernakulam from 2012 to 2036 is tabulated and provided in Table 7. The changes in population trend of these two districts plays an important role in the demographic status of the basin.

Table 7. Projected Population for Idukki & Ernakulam Districts

Year	Projected Population	
	Idukki	Ernakulam
2012	10,70,879	3369812
2013	10,32,098	3458064
2014	9,92,746	3547118
2015	9,52,938	3636950
2016	9,12,782	3727127
2017	8,71,088	3812077
2018	8,29,273	3897057
2019	7,87,516	3981939
2020	7,45,992	4066511
2021	7,04,748	4150681
2022	6,63,153	4229831
2023	6,22,132	4308055
2024	5,81,911	4385291
2025	5,42,492	4461263
2026	5,04,104	4535933
2027	4,66,076	4603291
2028	4,29,425	4668867
2029	3,94,138	4732358
2030	3,60,409	4793845
2031	3,28,397	4852914
2032	2,97,771	4903230
2033	2,69,036	4950758
2034	2,42,472	4995374
2035	2,18,148	5036866
2036	1,96,162	5075062

Idukki's population is steadily decreasing over time, while Ernakulam's population is consistently increasing. The rate of decline for Idukki appears to be more rapid than the rate of growth for Ernakulam. The population projection for the region provides valuable insights into the future demographic trends. The data highlights the factors contributing to population growth, including migration, economic opportunities, and improvements in living conditions.

8. Findings and Summary

The demographic analysis of the Periyar River Basin, based on the 2011 Census data, reveals significant insights into the population characteristics and distribution within the basin. The key findings are summarized below:

Population Distribution and Growth Trends

- The Periyar River Basin has a total population of 3.76 million, representing less than 1% of India's total population.
- The population is unevenly distributed across the basin, with Ernakulam district contributing the largest share (57.8%) despite covering only 33.1% of the basin's area.
- Idukki district, which spans 57.6% of the basin, contributes just 20.3% of the total population due to its challenging terrain and limited urbanization.
- The basin exhibits a predominantly urban population, with 58% residing in urban areas and 42% in rural areas.
- Ernakulam district has consistently shown population growth, with a 27.4% increase between 1951-1961 and a marginal rise of 1 lakh in the 21st century until 2011.
- Idukki district experienced a population decline of 1.79% in 2011 compared to 2001, attributed to out-migration of the younger working-age population and declining birth rates.

Age Structure and Sex Ratio

- Idukki district shows a declining younger population and an increasing elderly segment, with the 0-4 age group comprising 37,443 males and 36,355 females (sex ratio of 971).
- Ernakulam district has a more balanced age distribution, with a significant working-age population, particularly in the 25-29 age group (116,775 males and 121,550 females).
- The basin exhibits a largely balanced sex ratio, with variations influenced by socio-economic factors such as employment opportunities, migration patterns, and living conditions.
- Thrissur taluk has the highest sex ratio of 1206, attributed to high levels of male out-migration and improved living conditions contributing to higher female longevity.
- Devikulam taluk in Idukki district has the lowest sex ratio of 994, with the male population slightly exceeding the female population due to the predominance of male workers in labour-intensive industries and harsh living conditions.

Household Composition

- Ernakulam district has the largest number of households, with Paravur taluk leading at 1,62,127 houses, followed by Kanayannur (1,22,047) and Aluva (1,15,905).
- Thrissur district shows a moderate number of households, with Kodungallur having 83,253 and Thrissur taluk having a significantly lower count at 3,748.
- The average household size is highest in Thrissur district at 4.1, followed by Ernakulam (4) and Idukki (3.9).

Population Density

- The population density of the basin varies significantly, with Ernakulam district having the highest density of 1,241 persons per sq.km, followed by Thrissur (1,979) and Idukki (253).
- The basin's population density is influenced by factors such as urbanization, economic opportunities, and access to resources, with densely populated areas facing challenges related to housing, transportation, and infrastructure.

In summary, the demographic analysis of the Periyar River Basin highlights the uneven distribution of population, with Ernakulam district dominating in terms of population size, urbanization, and household composition. The basin exhibits a largely balanced sex ratio, with variations influenced by socio-economic factors. The age structure shows contrasting patterns between Idukki and Ernakulam districts, with Idukki experiencing a declining younger population and an increasing elderly segment, while Ernakulam has a more balanced age distribution and a significant working-age population. These demographic trends have significant implications for resource allocation, infrastructure development, and sustainable management of the Periyar River Basin.

Recommendations

Based on the demographic analysis, the following recommendations are proposed for effective management of the Periyar River Basin:

1. Targeted resource allocation: Allocate resources based on the specific needs of different districts within the basin, considering factors such as population density, age structure, and household composition.
2. Sustainable urbanization strategies: Develop sustainable urbanization strategies for densely populated areas like Ernakulam to address challenges related to housing, transportation, and infrastructure while promoting environmental conservation.
3. Balanced development: Promote balanced development across the basin by investing in economic opportunities and infrastructure in less populated districts like Idukki to reduce disparities and encourage sustainable growth.

4. Gender-inclusive policies: Design gender-inclusive policies to ensure equal access to water resources and related services for both men and women, addressing their specific needs and challenges.
5. Demographic monitoring: Continuously monitor demographic changes within the basin to inform policy decisions and adapt management strategies accordingly.
6. Stakeholder engagement: Engage with local communities, government agencies, and environmental organizations to develop collaborative policies that reflect the needs and priorities of all parties involved.
7. Capacity building: Invest in capacity building and awareness programs to educate the population on sustainable water management practices and their role in conserving the Periyar River.

By implementing these recommendations and incorporating demographic considerations into river basin management, the Periyar River Basin can achieve sustainable development while ensuring equitable access to water resources for all its inhabitants.

9. Role of Demographic Data in the Condition Assessment & Management of the Periyar River Basin

The Basin Demography Report serves as a critical tool for the Condition Assessment and Management of the Periyar River Basin (CAMP). By providing comprehensive demographic data, the report facilitates a nuanced understanding of the socio-economic dynamics that influence environmental resources and management strategies within this vital ecosystem. The Periyar River, being the longest river in Kerala and a crucial water source for millions, is significantly affected by demographic trends. The report details population density, urbanization patterns, age distribution, and socio-economic conditions across the basin, which encompasses six districts: Idukki, Ernakulam, Thrissur, Pathanamthitta, Kottayam in Kerala, and Coimbatore in Tamil Nadu.

Population Density and Urbanization

With a total population of approximately 3.76 million residing in the basin, understanding population density is essential for effective resource management. High population density can lead to increased demand for water resources, thereby affecting water quality and availability. The report highlights urbanization trends that are critical for planning infrastructure and managing water usage effectively. Urbanization in the Periyar River Basin has exacerbated flooding, increased pollution levels, and intensified industrial pressures on the river ecosystem. The unplanned expansion of urban areas has reduced natural drainage and increased surface runoff, elevating the risk of floods during the monsoon season. Additionally, the proliferation of industries along the basin, particularly in Ernakulam, has led to the discharge of untreated industrial effluents, significantly impacting water quality. This

rapid urban and industrial growth poses a serious threat to the ecological health of the basin, necessitating stringent management and pollution control measures.

Socio-Economic Conditions

The demographic insights provided in the report include literacy rates, employment patterns, and economic activities prevalent in the region. This information is vital for developing targeted programs aimed at improving education and economic opportunities. For instance, understanding the reliance of local communities on agriculture and fisheries allows policymakers to formulate strategies that promote sustainable practices while ensuring livelihoods. The tribal communities of the Periyar River Basin primarily depend on traditional livelihoods such as subsistence agriculture, collection of forest produce, and seasonal labour in plantations. Their socio-economic conditions are often characterized by low-income levels, limited access to education, healthcare, and infrastructural facilities. Studying these communities is essential for the Condition Assessment and Management of the Periyar River Basin (CAMP) as their sustainable practices and reliance on natural resources directly influence the ecological balance, making them key stakeholders in effective river basin management strategies.

Facilitating Sustainable Resource Management

The insights from the Basin Demography Report are instrumental in shaping sustainable management practices for the Periyar River Basin. The following aspects illustrate how these insights can be applied:

Water Resource Allocation: The report aids in assessing how demographic changes affect water demand across different sectors such as agriculture, industry, and domestic use. This understanding is crucial for developing equitable water allocation strategies that meet the needs of all stakeholders while protecting the river's health.

Pollution Control Measures: With urban centres like Ernakulam being significant sources of pollution due to industrial activities, demographic data can help identify pollution hotspots. Targeted interventions can then be designed to mitigate pollution impacts on water quality.

Community Engagement: The report emphasizes the importance of engaging local communities in management efforts. By understanding demographic characteristics such as age distribution and socio-economic status, stakeholders can develop inclusive policies that reflect community needs and foster participation in conservation efforts.

Supporting Policy Formulation

The comprehensive data presented in the Basin Demography Report supports informed decision-making among policymakers.

Targeted Policy Development: By analyzing demographic trends alongside environmental data, policymakers can develop targeted policies that address specific challenges faced by

different communities within the basin. For instance, areas with high indigenous populations may require tailored approaches that respect traditional practices while promoting sustainable resource use.

Climate Change Adaptation: The report provides insights into how demographic shifts may influence vulnerability to climate change impacts. Understanding these dynamics allows for proactive measures to enhance resilience among communities reliant on natural resources.

The Basin Demography Report is an invaluable resource for enhancing Condition Assessment and Management of the Periyar River Basin. By integrating demographic data with environmental management strategies, it enables a holistic approach to addressing the complex interplay between human populations and natural resources. This comprehensive understanding will ultimately lead to more effective governance, sustainable development practices, and improved ecological outcomes for one of Kerala's most vital river basins. In summary, leveraging this report will not only facilitate better management of the Periyar River but also ensure that socio-economic considerations are at the forefront of environmental decision-making processes within the basin.

References

Bhagat, R. B. (2004). Dynamics of urban population growth by size class of towns and cities in India. *Demography India*. 33(1), 47.

Cauvery Basin report, 2014

cds.edu - Last accessed 30/08/2024

ernakulam.nic.in - Last accessed 21/08/2024

idukki.nic.in - Last accessed 22/08/2024

KSPCB. 1981. Periyar action plan- phase1, status survey and project identification

lsgkerala.gov.in - Last accessed 20/08/2024

nmcg.nic.in - Last accessed 19/08/2024

Pacione, M., 2001, *Urban Geography: A Global Perspective*. Routledge, London

Sudhira, H. S. (2008). *Studies on urban sprawl and spatial planning support system for Bangalore, India*. Published doctorate thesis, Indian Institute of Science Department of Management Studies.

The State of the World's Cities 2004/2005 - Globalization and Urban Culture Report, 2004

www.ecostat.kerala.gov.in – Last accessed 26/08/2024

www.unesco.org - Last accessed 13/08/2024

www.unfpa.org - Last accessed 16/08/2024



Centres for Periyar River Basin Management Studies
(cPeriyar)

© cPeriyar, cGanga and NRCD, 2024



Centre for Ganga River Basin Management and Studies
(cGanga)