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ISLAND DEVELOPMENT UNDER PRESSURE: POPULATION GROWTH AND DEMOGRAPHIC CHANGES IN SOUTH ANDAMAN

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ABSTRACT

This study analyzes population growth and demographic changes in South Andaman District from 1991 to 2001, assessing their consequences for developmental pressures on island ecosystems. The Andaman archipelago is a distinctive and ecologically fragile area where understanding population dynamics is essential for sustainable development planning. Utilizing census data from 1991 and 2001, spatial mapping and statistical analysis of essential demographic factors across the selected populated islands of South Andaman District were performed. Five thematic maps were generated for each time period to visualize patterns in population distribution, population density, settlement density, sex ratio, and literacy rates. Results indicate clear spatial patterns, with population density predominantly situated along the eastern coastline regions of South Andaman Island and in junction villages such as Govinda Nagar (Havelock Island) and Neil Kendra (Neil Island). Although the total population density was very low (<500 persons/km^2), the villages next to urban areas (Port Blair Municipal Council, Garacharma, and Bambooflat) displayed medium to high density levels. Temporal analysis revealed a trend towards increased density classifications from 1991 to 2001. The district had enhanced sex ratios and literacy rates, with most villages classified as medium to very high for both metrics. Analysis of labor participation indicated that 36.69% of the population was involved in economic activities, with "other workers" and "cultivators" constituting the primary occupational categories, signifying a mixed service-agricultural economy. The findings underscore the developmental challenges confronting South Andaman's delicate island ecosystem, especially in regions undergoing swift demographic transformations. The geographical concentration of population in particular areas indicate the necessity for focused development policies that reconcile human requirements with ecological sustainability. This research offers essential baseline data for policymakers to develop measures to reduce population-induced pressures on the island's finite resources.

Keywords: Population Dynamics, South Andaman Islands, Demographic Transition, Spatial Concentration, Island Development Pressure

1. INTRODUCTION

Island ecosystems constitute distinctive and fragile habitats where human activity and environmental processes interact within well-defined spatial limits. The Andaman and Nicobar archipelago, located in the Bay of Bengal, illustrates the intricate link between human population patterns and island environment. The South Andaman District has undergone notable demographic changes that necessitate thorough analysis to comprehend the ensuing developmental constraints on its finite resources and delicate environment.

Islands, due to their geographical characteristics, have limited resources and spatial constraints that make them especially susceptible to human-induced pressures (Briguglio, 1995). This susceptibility is exacerbated in tropical island ecosystems such as the Andamans, which possess remarkable biodiversity and unique species. As human populations expand and development accelerates on these islands, understanding demographic trends is crucial for sustainable development planning and environmental conservation initiatives.

The South Andaman District consists of ten inhabited islands of different sizes, ranging from the comparatively huge South Andaman Island (1347.97 km^2) to the somewhat smaller Viper Island (0.50 km^2). This district functions as the administrative and economic hub of the Andaman and Nicobar Islands Union Territory, with Port Blair as its capital. The historical settlement patterns of these islands have been influenced by colonial legacies, post-independence development strategies, and migration trends from mainland India (Sekhsaria, 2017).

Population dynamics in island environments such as South Andaman are particularly crucial since they directly affect resource usage patterns, land use alterations, and overall developmental pathways. Bera (2015) observes that island populations encounter distinct challenges due to constrained space, limited resources, and heightened vulnerability to natural calamities. These difficulties require focused consideration of demographic changes and their spatial expressions to guarantee sustainable development (Pelling and Uitto, 2001).

The demographic makeup of South Andaman has significantly transformed after India's independence (Tripathi, 2016). The district has undergone significant migration from mainland India, altering its demographic composition, settlement patterns, and cultural landscape. In contrast to numerous other islands locations globally experiencing population decline or slowdown, South Andaman has observed population growth, especially in proximity to urban hubs. This expansion affects resource management, infrastructural development, and environmental preservation.

The spatial analysis of demographic factors provides significant insights into the manifestation of population pressures across various geographical contexts within the district. Disparities in population density, settlement patterns, sex ratio, and literacy rates across islands and within villages on the same island illustrate the inequitable character of development and resource allocation. The geographical variations in island contexts often connect with proximity to urban areas, economic possibilities, and the availability of infrastructure. The developmental pressures stemming from population dynamics in South Andaman must be understood within the framework of its distinct geographical and ecological situation. The islands have tropical evergreen and semi-evergreen forests, mangrove ecosystems, coral reefs, and varied marine habitats. These natural systems not only sustain biodiversity but also deliver vital ecosystem services to local communities. The increase in population and spatial concentration in certain regions might interfere with biological processes and reduce the islands' natural capital (Bera, 2015).

Moreover, the demographic transformations in South Andaman have transpired concurrently with substantial governmental alterations in regional development strategies. The islands have undergone multiple development projects focused on infrastructural enhancement, connectivity improvement, and tourism promotion. These activities, although meeting human needs, have occasionally collided with conservation goals and principles of sustainable resource management.

This study aims to investigate population growth and demographic transformations in the South Andaman District from 1991 to 2001, emphasizing their spatial representations and consequences for development pressure. This study examines key demographic parameters—population distribution, density, growth rate, settlement patterns, sex ratio, literacy, and workforce participation—to elucidate the interactions between human populations and island environments in this region. The temporal comparison of census data from 1991 and 2001 enables the identification of patterns and transitions in demographic features that may signify new pressure areas for development planning.

The insights derived from this research are essential for both academic comprehension and guiding policy decisions that reconcile human growth requirements with ecological sustainability in this delicate island ecosystem. As South Andaman continues to develop, maintaining this balance becomes increasingly important for preserving its unique natural and cultural heritage for future generations.

2. STUDY AREA

The South Andaman District is one of the three administrative districts within the Andaman and Nicobar Islands Union Territory of India, located in the southeastern region of the Bay of Bengal **(Fig.1).** The district consists of several islands, with only ten islands being inhabited. The inhabited islands comprise South Andaman Island (1347.97 km^2), Little Andaman Island (731.0 km^2), Rutland Island (137.17 km^2), Havelock Island (113.93 km^2), North Sentinel Island (59.67 km^2), John Lawrence Island (41.98 km^2), Neil Island (18.90 km^2), Cinque Island (9.53 km^2), Flat Bay Island (9.36 km^2), and Viper Island (0.50 km^2).

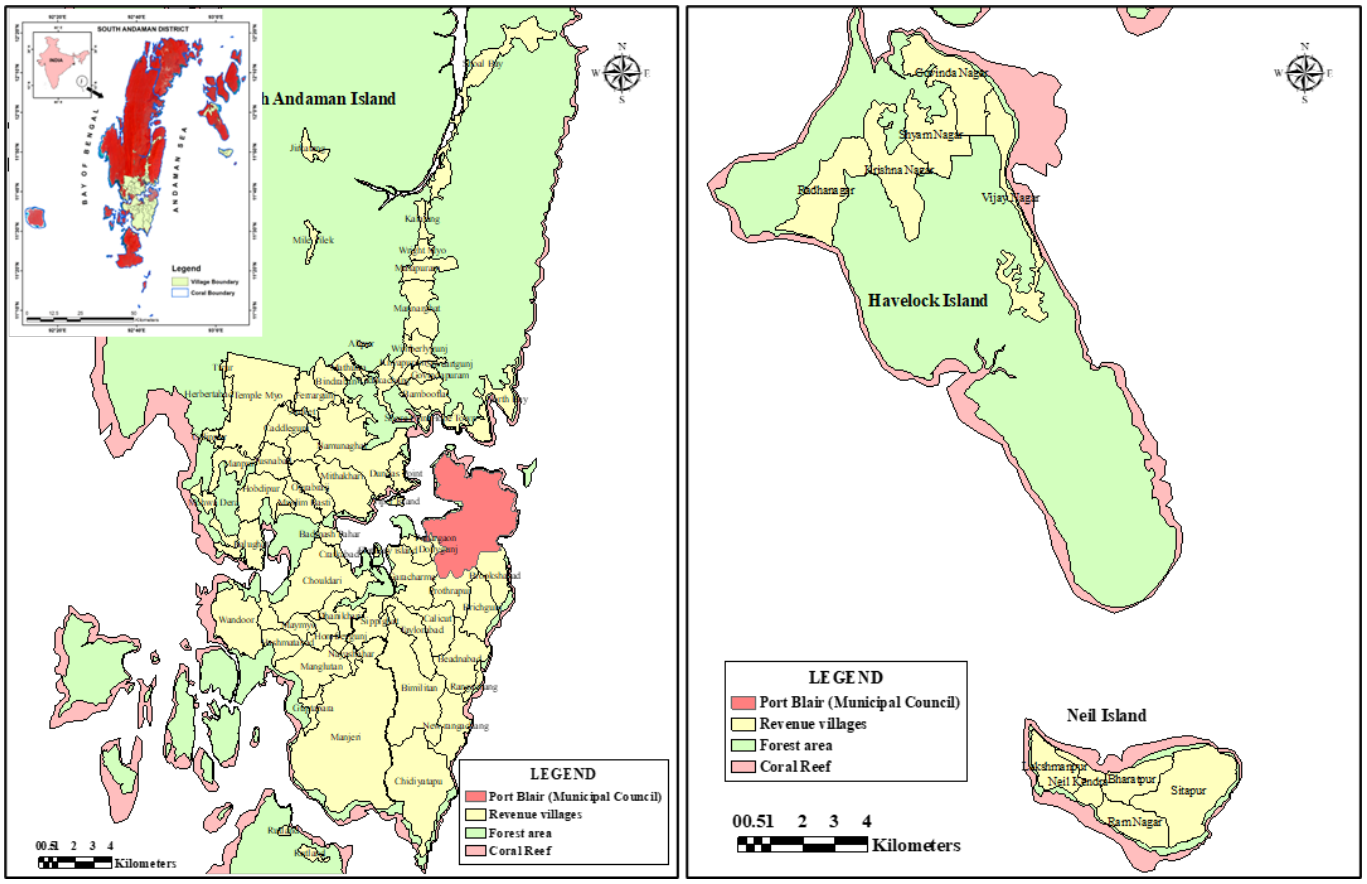

Fig. 1 Location map of the study area

The South Andaman District is administratively divided into three tehsils: Port Blair, Ferrargunj, and Little Andaman. The Port Blair tehsil encompasses an area of 1290 km^2 and comprises 68 census villages and 41 revenue villages according to the 2001 census. Ferrargunj tehsil covers an area of 1085 km^2, comprising 80 census villages and 53 revenue villages, whilst Little Andaman tehsil encompasses 731 km^2, containing 19 census villages and 5 revenue villages. The district comprises one statutory town (Port Blair) and two census towns (Bambooflat and Garacharma), collectively constituting the urban component of the district.

Port Blair, the administrative center and sole statutory town, functions as the capital of the Andaman and Nicobar Islands Union Territory. It serves as the principal access point to the islands and accommodates vital governmental offices, transportation infrastructure, and commercial establishments. The Port Blair Municipal Council region has undergone fluctuating growth rates over the decades, with notable decreases in growth rate recorded in recent census times.

The area is defined by undulating topography featuring hills and valleys. The geography ranges from flat coastal plains to hilly interiors, with elevations from sea level to around 700 meters above mean sea level. The islands possess lush tropical forests that encompass roughly 86% of the total surface, while the remaining segments are allocated for agriculture, habitation, and various other land uses. The district has a tropical climate characterized by distinct wet and dry seasons, with an annual precipitation of roughly 3000 mm, primarily from the southwest and northeast monsoons.

The district's coastline geography is characterized by a variety of features, including sandy beaches, rocky shoreline, coral reefs, and mangrove habitats. These coastal regions are essential for fishing communities, tourism advancement, and marine biodiversity. The eastern coast of South Andaman Island, characterized by milder terrain and better accessibility, supports a higher population density than the western part of the island (Bera et al., 2015).

The majority of communities in South Andaman District are situated near the coast and linked by a network of highways that enable intra-island transportation. Inter-island connectivity is sustained via ferries and small vessels that function as essential transit links. The spatial distribution of settlements exhibits a concentration pattern, with elevated densities noted near Port Blair and its vicinity, whereas distant islands and interior regions are characterized by sparse population.

The district's socio-cultural environment is diversified, consisting of settlers from mainland India, specifically from West Bengal, Tamil Nadu, Kerala, and Andhra Pradesh, who migrated during various historical periods. The area also hosts indigenous tribal groups, specifically the Jarawa and Sentinelese tribes, with the Sentinelese, numbering 39 individuals according to the 2001 census, being especially isolated on North Sentinel Island. The demographic diversity enhances the district's cultural mosaic and poses specific issues for growth planning and resource management.

3. METHODOLOGY

This study utilizes a thorough methodological framework to examine population growth and demographic changes in South Andaman District, concentrating on their geographical patterns and consequences for development pressure. The methodology integrates quantitative analysis of census data with spatial mapping techniques to yield both statistical and visual representations of demographic factors.

DATA SOURCES

The principal data for this study were sourced from the Population Census of India for the years 1991 and 2001. The census results included village-level insights into several demographic factors, including total population, gender distribution, literacy rates, workforce participation, and household numbers. The selected census periods were intended to analyze population trends within this decade, facilitating temporal comparison while ensuring methodological consistency. Census data from 2011 were employed for district and tehsil-level analysis to discern wider demographic trends; however, spatial mapping at the village level was restricted to 1991 and 2001 data due to administrative boundary alterations post-2001. Supplementary data concerning island areas and administrative divisions were obtained from the Town Planning Unit Andaman Public Works Department, 2009.

DEMOGRAPHIC PARAMETERS

To carefully assess population characteristics and their spatial variations, the following demographic parameters were chosen for analysis:

- Population Distribution: Aggregate number of residents in each village, tehsil, and island to ascertain concentration patterns.
- Population Density: The ratio of individuals per square kilometer determined by dividing the total population by the land area.
- Population Growth Rate: The percentage variation in population between two successive census intervals.
- Settlement Density: The quantity of households per square kilometer, offering insights into residential trends.
- Sex Ratio: The quantity of females per 1,000 males, reflecting gender distribution.
- Literacy Rate: The proportion of individuals aged seven years and above who are literate.
- Work Participation Rate: The proportion of both primary and marginal workers within the overall population, further categorized by occupational classifications.

GEOSPATIAL ANALYSIS AND MAPPING

Spatial analysis was performed at village levels to elucidate the many aspects of demographic patterns. The study concentrated on 99 revenue villages located throughout the populated islands of South Andaman District for village-level analysis.

Thematic maps were produced utilizing Geographic Information System (GIS) to illustrate spatial patterns of the chosen demographic characteristics. Base maps of the islands were digitized from census maps, and census data were included into this spatial framework by attribute linking. Five thematic maps were generated for each time period (1991 and 2001) to illustrate:

- Total population distribution
- Population density patterns

- Settlement density patterns
- Distribution of sex ratio
- Status of literacy

To facilitate effective display and comparison analysis, each parameter was categorized into five classes utilizing the natural breaks approach, which optimizes value arrangement based on intrinsic data groups. These classifications were uniformly designated as: Very Low, Low, Medium, High, Very High.

LIMITATIONS

The methodology recognizes various constraints that may affect the interpretation of results:

- The research predominantly depends on census data, gathered every ten years, which may not reflect transient demographic variations.
- Village boundaries sometimes alter between census intervals, requiring modifications for temporal analysis.
- Information regarding transient populations, especially seasonal tourists and temporary laborers, is insufficiently represented in census statistics.
- Remote islands and tribal regions may have undergone under-enumeration during census activities, thereby compromising the precision of demographic data in these areas.

Notwithstanding these constraints, the methodological framework offers a comprehensive way for examining geographical patterns of demographic factors and their consequences for development pressure in South Andaman District. The integration of spatial mapping and statistical analysis provides significant insights into population dynamics and their correlation with the island's limited resources and developmental potential.

4. RESULTS AND DISCUSSION

POPULATION DISTRIBUTION AND GROWTH PATTERNS

The analysis of population distribution in South Andaman District uncovers various spatial patterns marked by concentration in specific geographic areas. According to the 2001 census, the district's total population was 208,471, comprising 114,262

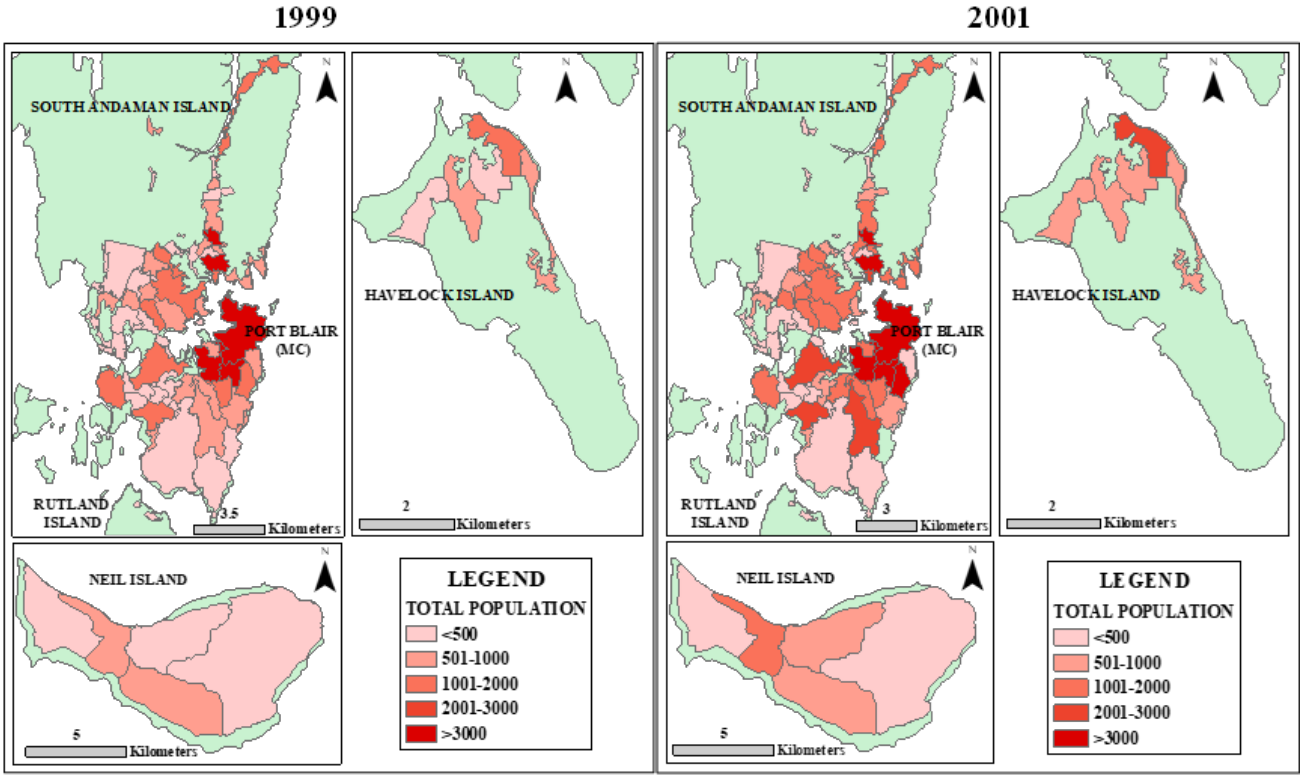

Fig. 2 Revenue village-wise total population distribution of the several islands of South Andaman as per the 1991 and 2001 census

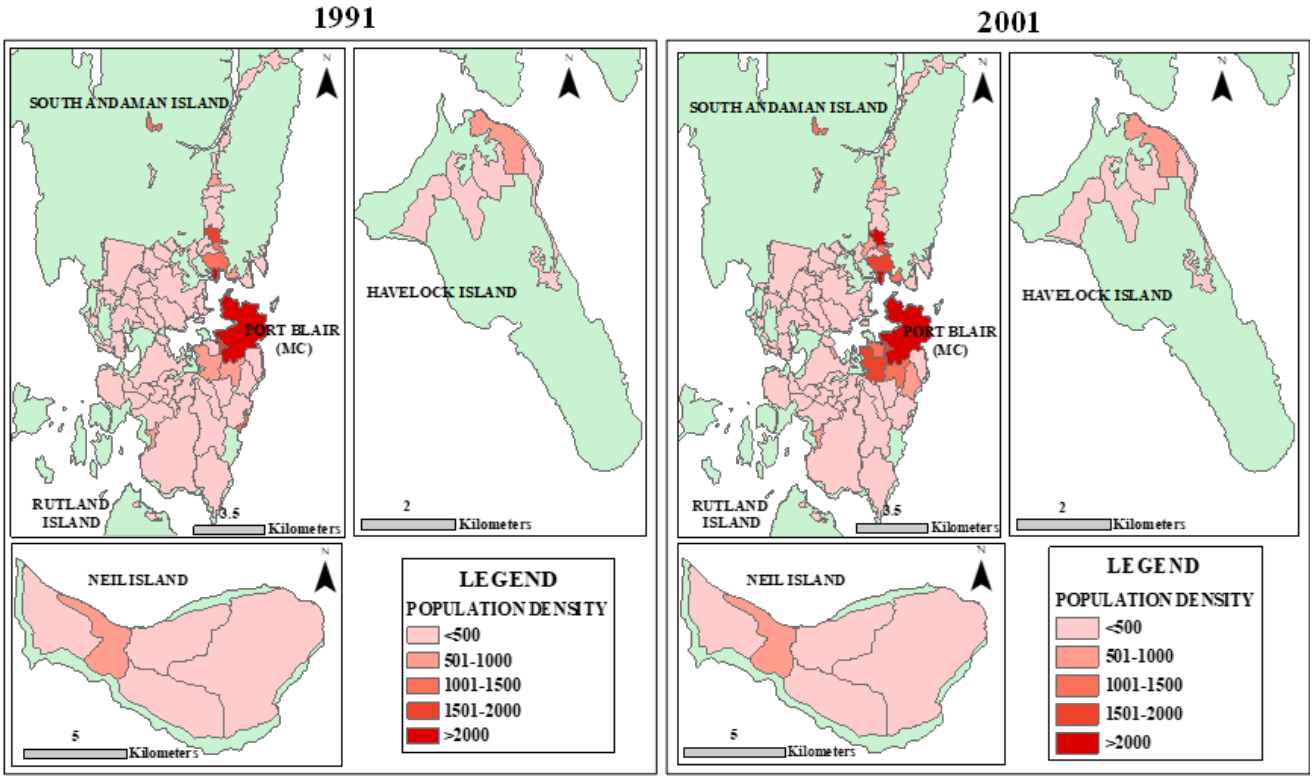

Fig. 3 Population density patterns by revenue village on various islands in South Andaman according to the 1991 and 2001 census.

males (54.8%) and 94,209 females (45.2%). By 2011, this number had increased to 238,142, indicating a decadal growth rate of 14.23%. The growth rate, albeit substantial, indicates a reduction relative to prior decades, implying a gradual demographic change.

The population distribution across the district's three tehsils exhibits significant disparity, with Port Blair tehsil comprising 69.6% of the total population (165,754 persons), followed by Ferrargunj tehsil at 22.5% (53,565 persons), and Little Andaman tehsil with only 7.9% (18,823 persons). The concentration in Port Blair tehsil highlights its function as the administrative and economic nucleus of the district, a trend characteristic of island regions where development often centralizes around administrative centers **(Fig. 2)**.

South Andaman Island comprises 87.1% of the district's population, followed by Little Andaman Island at 8.4%, Havelock Island at 2.6%, and Neil Island at 1.4%. The six remaining inhabited islands collectively represent under 1% of the population. This markedly uneven distribution illustrates the differential advancement of infrastructure and economic prospects among islands, alongside differences in accessibility and the availability of habitable land.

The population distribution maps by village **(Fig. 2)** for 1991 and 2001 indicate that communities on the eastern coast of South Andaman Island possess much larger populations compared to those on the western coast. villages including Garacharma, Prothrapur, Bambooflat, and Wimberlygunj are classified in the "very high" population category (>3000 individuals), but western villages such as Manjari, Mohwa Dera, Temple Myo, and Hobdipur are categorized as having "very low" populations (<500 individuals). The east-west difference corresponds with findings from other island contexts, where development patterns on leeward and windward coasts differ markedly due to accessibility, monsoon exposure, and historical settlement backgrounds.

The temporal comparison between 1991 and 2001 indicates a general population growth in most villages, with some transitioning to higher population categories. The growing concentration around the Port Blair Municipal Council and the advent of Govinda Nagar at Havelock Island as a prominent population hub are particularly noteworthy. This trend of population concentration in urban centers mirrors the "urban primacy" phenomenon seen in numerous island territories, where constrained space and resources direct development towards principal towns.

POPULATION DENSITY AND SETTLEMENT PATTERNS

Population density analysis offers essential insights into human impact on constrained island space. In 2001, the population density of South Andaman District was 67 persons per square kilometer, rising to 76 persons per square kilometer by 2011. This district-level statistic reveals considerable geographical disparities, as Port Blair tehsil exhibited a density of 128 persons/km^2 in 2011 (an increase from 110 in 2001), whilst Ferrargunj tehsil recorded 49 persons/km^2 (up from 45) and Little Andaman tehsil had 25 persons/km^2 (up from 24).

The population density maps **(Fig. 3)** indicate that the majority of communities in South Andaman, Neil, and Havelock Islands are classified within the "very low" density group (<500 persons/km^2).

Nevertheless, the settlements adjacent to the Port Blair Municipal Council demonstrate significantly greater population densities. In 1991, Shore Point was classified in the "very high" density category (>2000 persons/km^2), whereas Jirkatang and Wimberlygunj were categorized as "high" density (1501-2000 persons/km^2). By 2001, numerous other villages, including Garacharma, Wimberlygunj, Hope Town, Govindapuram, Prothrapur, Dollygunj, and Brichgunj, had transitioned to higher density classifications, signifying increasing population pressure in these regions.

The patterns of settlement density, quantified as households per square kilometer, closely resemble the patterns of population density. of 2001, the settlement density of South Andaman District was 15 households per square kilometer, rising to 19 houses per square kilometer by 2011. The settlement density maps **(Fig. 4)** indicate that settlements with medium, high, and very high settlement densities are primarily located in the eastern region of South Andaman Island, especially around Port Blair Municipal Council and Bambooflat. On Havelock and Neil Islands, Govinda Nagar and Neil Kendra exhibit significantly higher settlement densities than other villages on these islands.

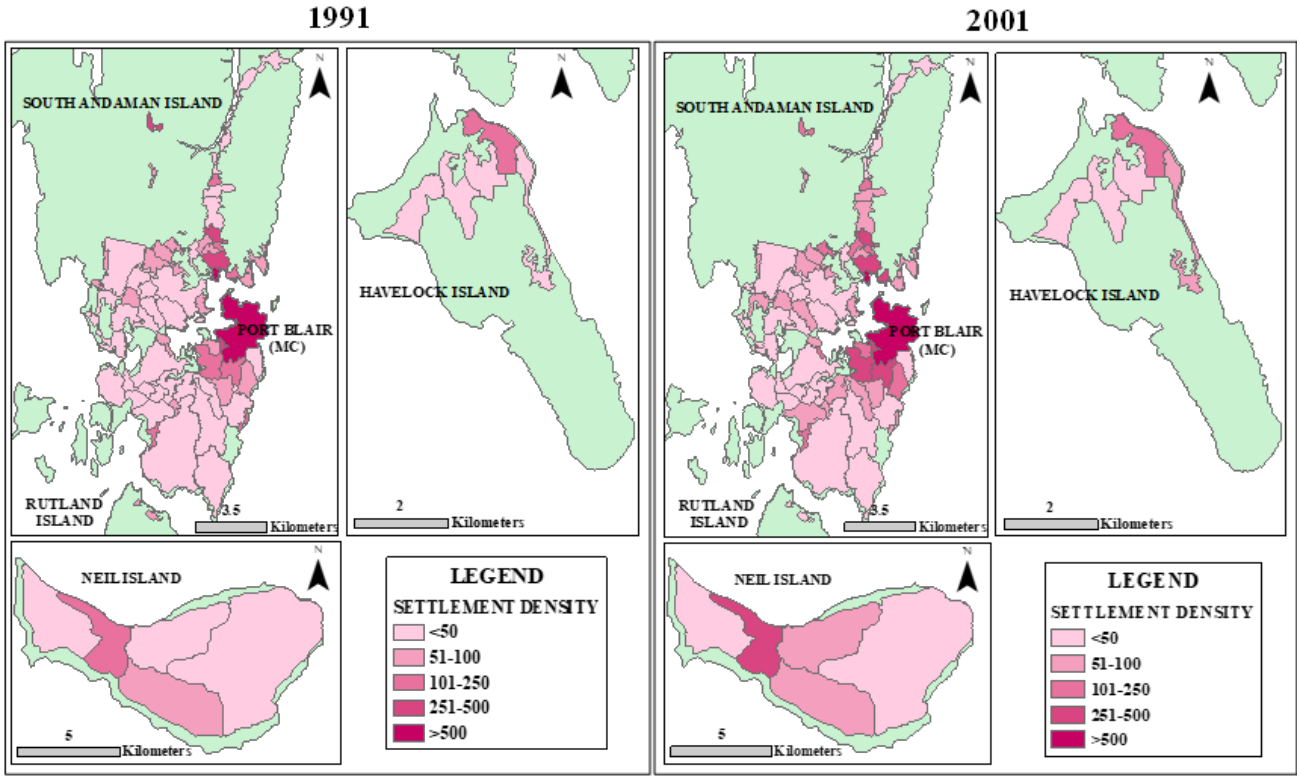

Fig. 4 Revenue village wise settlement density pattern based on 1991 and 2001 census on several South Andaman Islands

These density patterns illustrate the cumulative impact of physical geography, infrastructure advancement, and economic prospects. The eastern coast of South Andaman Island has superior harbor facilities, milder terrain, and enhanced connectivity relative to the western shore, hence drawing a greater concentration of settlements This tendency corresponds with "coastal squeeze" in island situations, when inhabitants progressively aggregate in coastal regions due to economic incentives, resulting in heightened resource utilization in constrained coastal areas (Pontee, 2013).

DEMOGRAPHIC COMPOSITION: SEX RATIO AND LITERACY

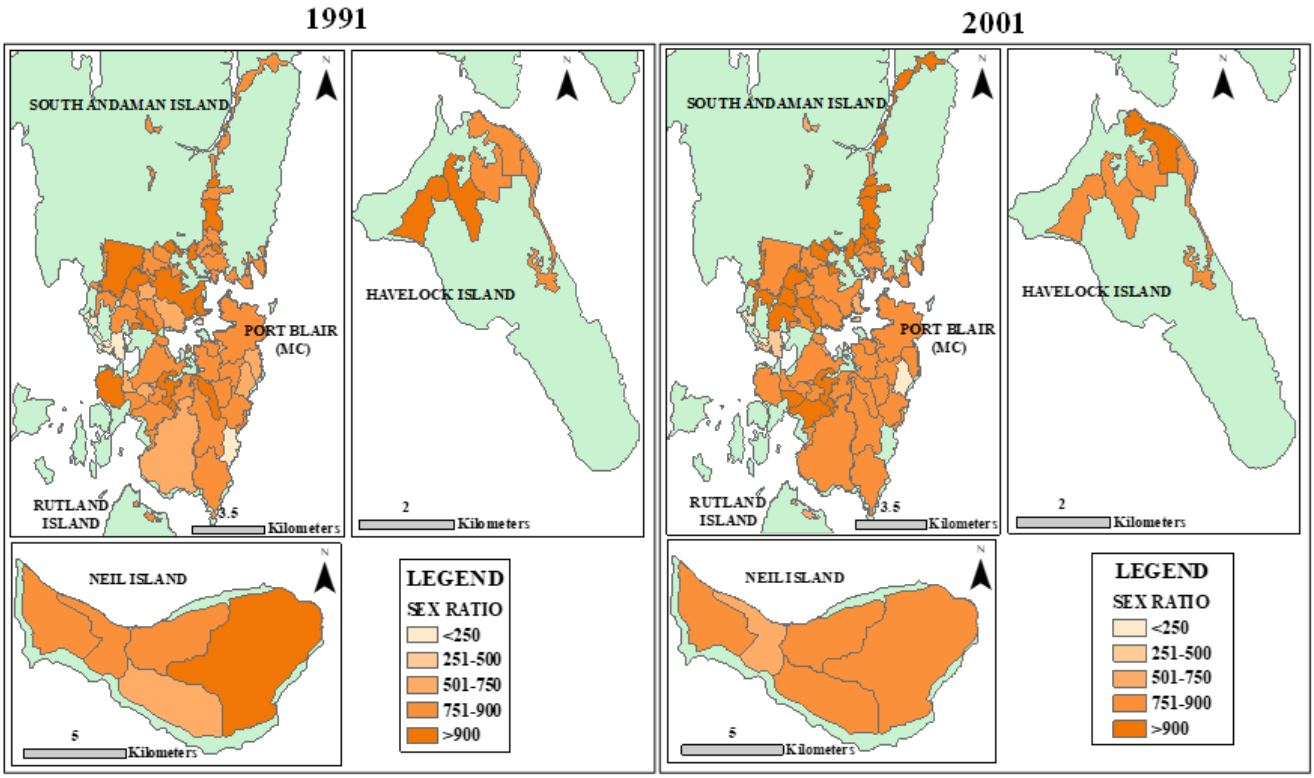

Fig. 5 Revenue village wise sex ratio patterns based on 1991 and 2001 census on many South Andaman Islands

The sex ratio in South Andaman District has been steadily improving, rising from 824 females per 1,000 males in 2001 to 870 in 2011. This tendency indicates a progressive normalizing of the demographic makeup that has previously exhibited male predominance due to migration trends. In 2011, Ferrargunj recorded the highest sex ratio among tehsils at 919, succeeded by Little Andaman at 889 and Port Blair at 854. The enhancing sex ratio signifies a shift towards family-oriented settlement patterns, contrasting with previous male-centric labor migration.

The village-specific sex ratio maps **(Fig. 5)** for 1991 and 2001 exhibit significant regional variance. In 1991, Mohwa Dera, Balughat, and New Rangachang exhibited extremely low sex ratios (<250 females per 1,000 males), whereas Temple Myo, Caddlegunj, Namunaghar, and various other villages in South Andaman Island, along with Sitapur in Neil Island and Radhanagar and Krishna Nagar in Havelock Island, displayed exceedingly high sex ratios (>900). By 2001, many villages such as Wandoor, Sitapur, and Temple Myo had transitioned to lower sex ratio categories, whereas others like Govinda Nagar, Bindraban, Colinpur, and Manpur moved to higher categories.

The spatial disparities in sex ratio indicate localized economic activities, as forestry and plantation regions generally exhibit lower sex ratios due to male-dominated employment patterns, whereas agricultural settlements tend to provide more balanced ratios. The enhancement in the sex ratio indicates a maturation of settlement patterns, characterized by rising family migration and natural population expansion, which complement previous trends of male-dominated labor migration.

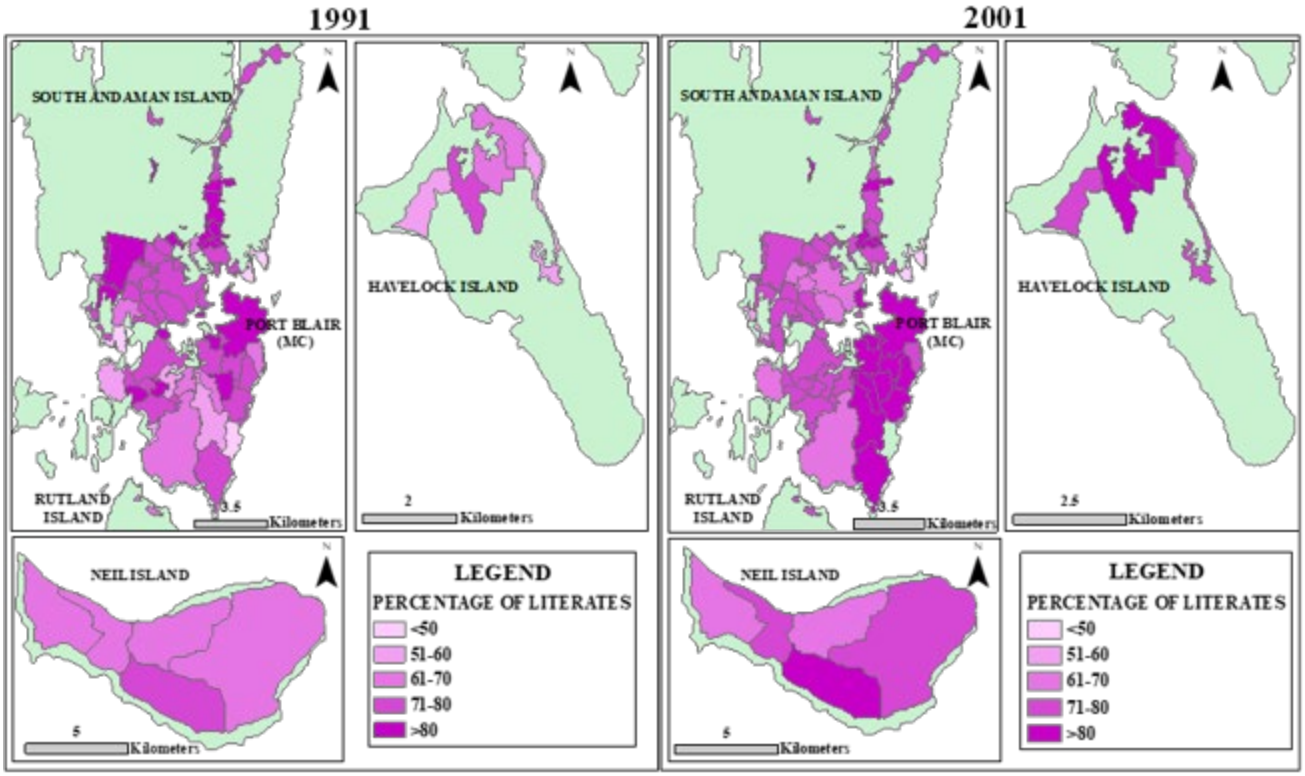

Fig. 6 Revenue village wise literacy status on different islands of South Andaman as per 1991 and 2001 census

Literacy rates in South Andaman District have improved, attaining 89.13% in 2011. The male literacy rate (92%) surpassed the female literacy rate (85.56%), however the disparity has diminished over time. The district's literacy rate exceeds the Union Territory average of 86.63%, suggesting superior access to educational resources.

The village-specific literacy maps **(Fig. 6)** for 1991 and 2001 indicate that the majority of villages exhibit medium to very high literacy rates. In 1991, only Mohwa Dera, North Bay, and New Rangachang had significantly low literacy rates (<50%), whereas villages such as Temple Myo, Manpur, Dollygunj, Calicut, and Hasmatabad demonstrated markedly high rates (>80%). As of 2001, North Bay was the sole locality classified inside the very low literacy category, but several villages, including Krishna Nagar, Shyam Nagar, Govinda Nagar, Ram Nagar, Chidiyatapu, Pothrapur, Dollygunj, and Rangachang, had attained very high literacy rates.

The elevated literacy rates in the district can be attributed to successful educational programs and adequate access to schools. The enduring low literacy rates in many distant villages underscore the difficulties of delivering educational services in isolated island settings.

WORK PARTICIPATION AND OCCUPATIONAL STRUCTURE

Analysis of work participation offers insights on economic activities and livelihood patterns. In 2001, the work participation rate in South Andaman district was 36.69%, while 63.31% were categorized as non-workers. Of the workforce, 90.48% were primary workers (worked for over six months in the reference year), whilst 9.52% were secondary workers.

The proportion of workers and non-workers between islands **(Fig. 7)** exhibits considerable diversity, with Flat Bay Island exhibiting the largest percentage of workers (almost 100%), followed by Viper Island (75%) and Rutland Island (76%). Conversely, the rural and urban regions of South Andaman Island exhibited lower workforce percentages, each roughly 36%. These discrepancies indicate disparities in economic prospects and demographic makeup among the islands.

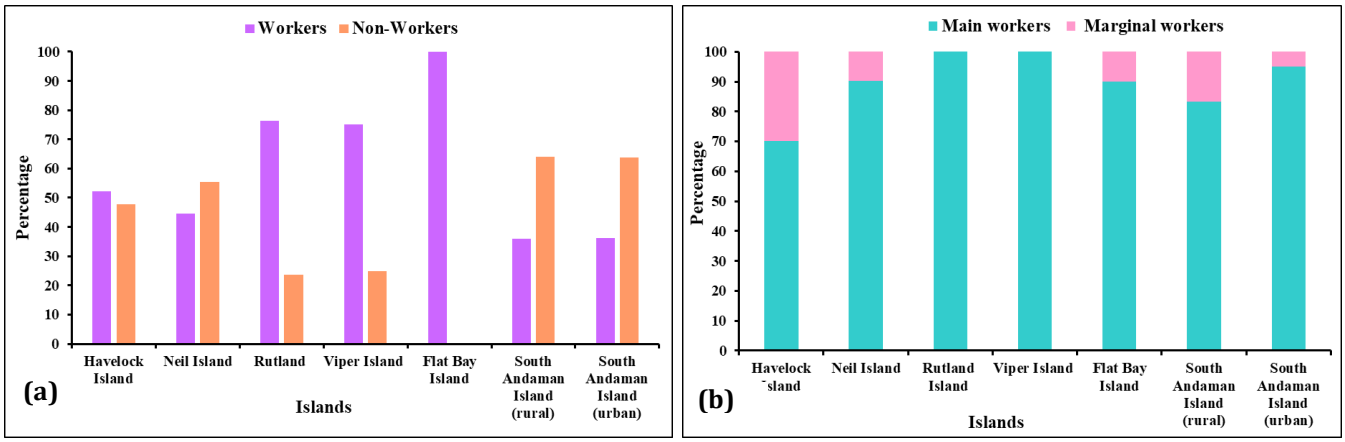

Fig. 7a) Island wise distribution of census 2001 worker and non-worker population, b) Island wise proportion of marginal and main workers, census 2001

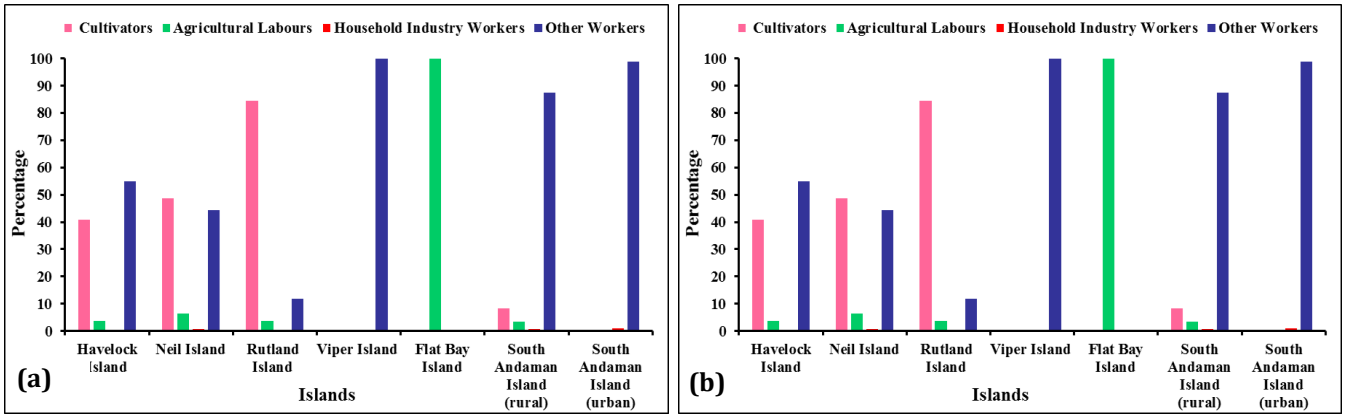

Fig. 8 a) Main workers' distribution: island wise and category wise based on census 2001, b) Distribution of marginal workers: island wise and category wise based on census 2001

The examination of the occupational structure indicates that "other workers" **(Fig. 8)** comprising government personnel, service providers, and those involved in trade, commerce, and transport—predominate in Viper Island, South Andaman metropolitan areas, and Flat Bay Island. Cultivators constitute the main category in Rutland Island, with a notable presence in Havelock and Neil Islands as well. Agricultural laborers dominate Flat Bay Island, but household industry workers represent a negligible proportion across all islands.

The occupational distribution illustrates the district's economic framework, integrating agriculture-based livelihoods in rural regions with service and managerial employment in urban centers. The prevalence of "other workers" in urban regions signifies the substantial influence of government and service sectors within the island's economy, a trait commonly observed on small island territories where public administration frequently serves as a primary source of formal employment.

IMPLICATIONS FOR DEVELOPMENT PRESSURE

The population trends identified in the South Andaman District have considerable implications for developmental pressures and resource management. The demographic concentration in the eastern coastal regions of South Andaman Island and adjacent metropolitan centers exerts localized strain on land, water resources, and infrastructure. Pelling and Uitto (2001) observed that concentration patterns in island environments can exacerbate susceptibility to environmental pressures and natural hazards.

The rising population and settlement density in several communities, especially those near Port Blair, Bambooflat, and Garacharma, indicate escalating urbanization pressure. This tendency aligns with the findings in other small island environments, where restricted land availability directs expansion towards established settlement nodes, resulting in

increased resource utilization and possible environmental degradation in these regions (Bera, 2015). The demographic shift, shown in improved sex ratios and literacy rates, signifies societal advancement while also implying increasing consumption habits and resource requirements as living conditions improve. Higher literacy generally correlates with enhanced awareness of resource management challenges, alongside heightened consumption expectations, hence generating intricate dynamics for sustainability planning.

The occupational structure, highlighting "other workers" and cultivators, indicates a developing economy that increasingly relies on service industries while sustaining agricultural production. This dual economic framework generates varied demands on land utilization, potentially leading to conflicts among agricultural expansion, urban development, and conservation requirements.

The declining population growth rate of 14.23% from 2001 to 2011 indicates a demographic transition towards stabilization, which may mitigate certain growth-related pressures. Nonetheless, even modest growth in an island setting with restricted carrying capacity necessitates meticulous management to prevent resource depletion and habitat destruction.

The demographic trends in South Andaman District underscore the necessity for spatial planning strategies that acknowledge varying population pressures throughout the island and execute targeted interventions to tackle specific local issues while preserving overall ecological integrity.

5. CONCLUSION

This study examined population growth and demographic changes in South Andaman District from 1991 to 2001, uncovering unique spatial patterns with considerable implications for island development. The findings indicate a significant population concentration in eastern coastal regions and metropolitan centers, resulting in localized development pressures. Although the general population density in the district is comparatively low, certain regions surrounding the Port Blair Municipal Council are experiencing increasing demographic pressure. The chronological analysis indicates a general trend towards higher density classifications across many villages, especially those with superior infrastructure and economic prospects.

The demographic composition reveals positive trends, characterized by improving sex ratios and literacy rates, signifying advancements in social development. The occupational structure, characterized by "other workers" and cultivators, indicates a dual economy that integrates service sector employment with agricultural activity, illustrating the district's transitional growth phase. This dual structure imposes varied demands on finite island resources.

The regional variability in population distribution and demographic characteristics highlights the necessity for tailored development strategies instead of uniform policies throughout the district. Future planning must consider these varying influences while recognizing the intrinsic biological fragility of island ecosystems. Sustainable development in South Andaman necessitates the equilibrium of human need and resource preservation, especially in densely populated areas.

This research establishes a basis for spatial planning in South Andaman; nevertheless, subsequent studies integrating more current data and supplementary parameters might improve comprehension of changing demographic dynamics. Ultimately, development policies must aim to distribute population pressure more evenly across habitable areas while recognizing ecological boundaries and indigenous rights, ensuring that South Andaman's unique island characteristics is preserved alongside human development.

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CONFLICT OF INTERESTS

None.

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