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Assessment of Social Infrastructural Need of a Micro Region: Scalogram Model Approach

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Abstract: ***The pattern of urbanization in Indian context in the past few decades has witnessed a sharp growth which leads to the inception of urban development authorities and metropolitan regional development authorities as regulatory bodies for megalopolis, metropolis and even for tier I and tier II cities with the purpose of catering more efficiently towards the rising infrastructural needs, setting land use pattern and need for the ever-rising demographic dividend of the concerned regions. In the consequent process with the expansion of metropolitan regional boundaries, many rural settlements also get subjected to be in the domain or development control of such regulatory bodies. The issue pertains to the micro regions which are not part of urban settlements or do not comprise of any urban areas, but has infrastructural needs on the basis of the existing demographical pattern, which any how falls under the district development schemes but are not subjected to the phenomenon of a stipulated district development plan or any master plan projection, as a result of which the social infrastructural gaps are not addressed bureaucratically in most of the situations and the dependence for facilitations of such amenities multiply on nearby urban settlements. This research paper aims to examine the social infrastructural gaps in context of a micro region which is a sub district model of Araku Valley Mandal within the district premise of Visakhapatnam, Andhra Pradesh as per Census 2011, showcasing the relevance of regional planning in a micro region and deciphers the ranking of settlement patterns pertaining to concerned need.***

Keywords: Settlement Pattern, Regional Planning and Social Infrastructure

1. Introduction

With the steady rise in urbanization globally the phenomenon of urban agglomeration becomes quite prominent and indispensable in context of urban settlements. In the concerned process the concept of satellite city, suburban areas or region (Kumar Routray, 1993), concept of Garden city by Ebenzer Howard in the nineteenth century (Blanco Pastor et al., 2023) and other similar indispensable derivatives of urban expansion got incepted due to the concentration of population in the Industrial Revolution era in settlements, where industrialization played a pivotal role as a mediator of livelihood. The suburban areas organically outgrown from the downtown areas of major metropolises primarily was for the quest of better quality of life(Deb & Okulicz-Kozaryn, 2023), affordable land prices and habitation which otherwise seemed extremely unaffordable in the central business districts or downtown areas in the concerned period. In the later course of the nineteenth century after witnessing the extreme migration towards the urban centers, the strong need for planning of city regions inclusive of the suburban areas were felt, whereby the paradigm of an urbanized region started becoming an integral pattern in context of the metropolises. In addition to the uptown areas, the attribute of satellite city initiated keeping in consideration the geographical and infrastructural limitations of an urbanized region with the steady outgrowth of the demographic dividends, giving rise to decentralization of urban centers (Schneider et al., 2015) and hence incepting the phenomenon of polycentric cities. In the consequent process of the mentioned series of events and henceforth, the onset of suburban areas and satellite cities, the need for regional planning was extremely felt and was incorporated bureaucratically with the formation of regional planning boards as an authoritative council for governance and development control regulatory aspects of a city region. The metropolitan region as evolved from a metropolis constituted of the downtown areas, urban agglomerations, suburban areas, satellite city which got evolved in the nearest vicinity and even agricultural land or semi-rural areas in the fringes were all incorporated within the domain of the concerned region and changes in the land use reflected too as a consequence of the stipulated process.

2. Context of Regional Planning

In the 1950s, Ford Foundation (Ahmad et al., 2013) played a pivotal role in giving proposition of Master Plan for mega cities like Delhi, Mumbai and Kolkata. The drafted plan had the envisioning of 20 years' timeline specifying the existing land use pattern with a forecast on the concerned, keeping in consideration the economic prosperity and social wellbeing through the stipulated development control regulations. In the context of rapid urbanization in due course of years since the post independent era, the phenomenon of regional planning was pertaining to only urban settlements with emphasis upon economical, demographic, land use pattern, demographic growth rates and infrastructural aspects, but with the consequent growth of adjoining premises of the city limits and extreme price hikes in the downtown and central business district zones, there was a formation of urban agglomerations (Tian & Mao, 2022) with the expanse of the settlement pattern and a substantial dividend of the demography shifted base to such agglomerations. The phenomenon of urban and metropolitan restructuring (Shaw & Satish, 2007) with the onset of metropolitan regions was extensively witnessed in the post liberalization 1991 era of Indian urban society where economy along with adoption of new lifestyle pattern played a key role in this restructuring. The expansion of the urban land use to cater the residential, infrastructural, public utility, recreational, commercial entities of the land parcel components for the emerging middle class and the connectivity of the urban centers (Maparu & Mazumder, 2021) to industrial hotspots with inception of special economic zones were some of the most commonly witnessed phenomena in context of urban development in the timeline of the decade post economic liberalization of 1991 where a

causality of economic development of an urbanized region with economic development and transport infrastructure was strongly established. In the consequent process, the metropolitan cities along with tier I cities got subjected to the city limit expanse with formation of development authorities for land use regulation purposes at the urban and regional context. The regional boundaries apart from the urban expansion and development authority governance-based zones, also comprise of the rural settlements reflecting various hierarchy of the settlement patterns.

The Regional Planning attributes can broadly be constituted with the aspects such as sustainability, environment, disaster management, promoting balanced development and inclusivity. Integrated spatial planning in context of land use pattern, infrastructural development and social wellbeing of the demography becomes a major attribute of inculcation for master plans for mega cities and gradually in due course of time became pertinent even for the tier I and tier II cities with formation of distinctive development authority and municipal corporations or municipalities for implementation of such master plans. In the consequent process of metropolitan region formation with newly defined boundaries the most common issues were some of the rural settlements and urban fringes play a major barrier in terms of disparity when compared to existing development pattern of the area coming under city limit. This phenomenon becomes prominent in metropolitan regions while integrating areas or land parcels belonging to rural settlements, disaster prone areas, satellite towns, suburban areas become a challenge in the concerned context of inclusivity. Therefore, inclusive development principles were adopted in metropolitan regional planning where areas which are categorized under morphologically feeble in terms of economic and social infrastructure or areas that are transition of peri urban or rural areas were subjected to inclusivity in due course of the concerned process.

In the context of a district region or its sub region which is intermediate within the range of an urban settlement division and a state division generically witnesses an apathy in regard to a bureaucratic implementation of consolidated district development plan since the post independent times, therefore inclusivity along with promoting of balanced regional development or integrated spatial planning becomes one of the major attributes for regional planning approach in Indian context as per the stipulations of URDPFI guidelines.

3. Literature Review

Regional planning has become an indispensable component of sustainable development, particularly in developing economies experiencing rapid urbanization, demographic transformation, and increasing regional disparities. It provides a strategic framework for the spatial allocation of resources, infrastructure development, economic activities, and environmental conservation across regions. Unlike conventional land-use planning, regional planning adopts a broader perspective by integrating economic, social, environmental, and institutional dimensions to promote balanced territorial development. In countries where uneven growth has resulted in significant disparities between urban and rural areas, regional planning serves as a mechanism to improve accessibility to public services, reduce socio-economic inequalities, and ensure equitable distribution of development opportunities (Friedmann, 1967). One of the primary objectives of regional planning is the development of robust social infrastructure, which encompasses education, healthcare, housing, public transportation, sanitation, recreation, and community facilities. Social infrastructure is fundamental to improving human capital, enhancing quality of life, and fostering inclusive economic growth. In many developing economies, however, infrastructure development has often been concentrated in metropolitan regions, leaving smaller towns and rural settlements underserved. Such spatial imbalances have intensified disparities in educational attainment, healthcare accessibility, employment opportunities, and living standards. Regional planning addresses these challenges by identifying infrastructure gaps, prioritizing investment based on regional needs, and promoting balanced allocation of public resources. Consequently, effective regional planning contributes not only to improved service delivery but also to enhanced social cohesion and regional resilience (UN Habitat, 2015). The interaction between regional planning and demographic dynamics is equally significant. Population growth, migration, urban expansion, fertility rates, ageing populations, and changing household structures directly influence the demand for social infrastructure and public services. At the same time, the availability of quality infrastructure affects demographic behaviour by shaping migration decisions, employment patterns, and settlement preferences. Developing economies frequently experience large-scale rural-to-urban migration driven by the concentration of educational institutions, healthcare facilities, industrial development, and employment opportunities in major cities. While such migration stimulates economic growth in urban centres, it also creates substantial pressure on housing, transportation, water supply, sanitation, and other public services. Regional planning seeks to manage these demographic shifts through spatial strategies that encourage balanced regional development, strengthen intermediate cities, and improve infrastructure provision in peripheral regions, thereby reducing excessive concentration in metropolitan areas (UN Habitat, 2020). Theoretical approaches to regional planning have evolved considerably over the past several decades. Traditional theories such as Central Place Theory and Growth Pole Theory primarily emphasized economic efficiency, industrial concentration, and hierarchical distribution of services. Although these theories contributed significantly to understanding regional development patterns, they were often criticized for overlooking social equity and environmental sustainability. Contemporary planning paradigms increasingly advocate integrated and participatory approaches that recognize the interdependence between economic growth, demographic transitions, environmental conservation, and social well-being. Modern regional planning therefore emphasizes inclusive governance, stakeholder participation, resilience, and evidence-based decision-making, enabling policymakers to respond effectively to rapidly changing demographic and socio-economic conditions. (Annapurna & Satish)

Recent literature also highlights the growing importance of spatial technologies in strengthening regional planning processes. Geographic Information Systems (GIS), remote sensing, spatial statistics, demographic modelling, and multi-

criteria decision analysis have substantially improved planners' ability to assess regional disparities, forecast infrastructure demand, and identify priority investment areas. These technologies facilitate data-driven planning by integrating demographic, socio-economic, environmental, and infrastructural datasets into comprehensive spatial analyses. As a result, governments can formulate more effective regional development policies that optimize infrastructure investments while considering future population growth and settlement expansion. The integration of digital technologies has therefore become an essential element of modern regional planning, particularly in developing economies where resource constraints necessitate efficient allocation of public investments (UN Habitat).

4. Study Area and Background

The present research investigates a micro-regional unit from the standpoint of balanced regional planning at the district and sub-district scales, with particular emphasis on evaluating the adequacy and distribution of social infrastructure within a settlement that functions administratively as a mandal under the Visakhapatnam district of Andhra Pradesh. The selected study area is Araku Valley Mandal, a region renowned for its exceptional natural landscapes, distinctive geographical and geological characteristics, and ecological significance. Owing to its picturesque environment, pleasant climate, tribal heritage, and scenic terrain, Araku Valley has emerged as one of India's most prominent tourist destinations, attracting a substantial number of domestic and international visitors annually. Despite its tourism potential and strategic importance, the region continues to exhibit disparities in infrastructure development, thereby necessitating a comprehensive regional planning approach to ensure balanced socio-economic growth.

Visakhapatnam district, situated along the northeastern coast of Andhra Pradesh, possesses a rich historical legacy that spans several centuries and reflects significant political, cultural, and economic transformations. Historically, the district formed part of the ancient Kalinga Kingdom, with references to the region appearing in classical literary works such as the Mahabharata as well as the geographical accounts of Ptolemy. Throughout different historical periods, the region came under the administration of several influential dynasties, including the Mauryas, Satavahanas, Eastern Chalukyas, Cholas, and the Gajapati rulers of Odisha. Its strategic location along the Bay of Bengal facilitated maritime trade and commercial exchange, contributing substantially to its economic prominence during ancient and medieval times. European influence in the region commenced during the seventeenth century when the Dutch established trading settlements along the coast. Subsequently, the British East India Company expanded its control over the coastal territories, recognizing Visakhapatnam as an important commercial and maritime center. During British rule, the district witnessed the establishment of naval facilities, shipbuilding activities, and improved port infrastructure, transforming it into a vital node for trade and strategic defense. Industrial activities gradually expanded, laying the foundation for the district's future economic development.

The district also occupies a notable position in India's freedom movement. It was the homeland of distinguished freedom fighter Alluri Sitarama Raju, who spearheaded the historic Rampa Rebellion against British colonial administration during the early twentieth century. The region became an active center of nationalist activities, with local communities participating significantly in the struggle for independence. Following India's independence in 1947, Visakhapatnam experienced accelerated industrialization and infrastructural development. Considerable investments were made in transportation, education, healthcare, and public utilities, strengthening the district's economic and social foundation. A major milestone in this transformation was the establishment of the Visakhapatnam Steel Plant during the 1980s, which significantly enhanced industrial production, employment generation, and regional economic growth. During the subsequent decades, particularly from the 1990s onwards, Visakhapatnam evolved into one of the fastest-growing urban and industrial centres in eastern India. Alongside manufacturing and port-based industries, the district diversified into sectors such as information technology, pharmaceuticals, education, tourism, and services, attracting substantial domestic and foreign investment. The city's scenic coastline, favourable climatic conditions, and expanding urban infrastructure further strengthened its reputation as a major tourism destination. Natural attractions including Ramakrishna Beach, Rushikonda Beach, Kailasagiri, and particularly the picturesque Araku Valley have become significant contributors to the regional tourism economy.

Beyond its economic significance, Visakhapatnam district is distinguished by its rich cultural and religious heritage. The region is home to several historically significant temples and pilgrimage centers, among which the Sri Varaha Lakshmi Narasimha Temple occupies a prominent position. Numerous cultural festivals, including the annual Visakha Utsav, celebrate the district's diverse traditions, performing arts, handicrafts, and multicultural identity, thereby enhancing its socio-cultural importance. Simultaneously, the district encompasses extensive forested landscapes and biodiversity-rich ecosystems, particularly within the Eastern Ghats. Protected areas such as the Kambalakonda Wildlife Sanctuary support diverse flora and fauna while contributing to ecological conservation and nature-based tourism. Visakhapatnam stands among Andhra Pradesh's most economically vibrant districts. The Visakhapatnam Port Authority, one of India's busiest major ports, plays a pivotal role in facilitating international trade and logistics, while the Visakhapatnam Steel Plant continues to serve as a major industrial anchor for the region. These strategic assets have stimulated employment, urban expansion, and regional economic development. Nevertheless, rapid urbanization, industrial growth, and increasing tourism have also introduced several developmental challenges, including pressure on urban infrastructure, environmental degradation, land-use transformation, and disparities in the distribution of social infrastructure across urban, peri-urban, and rural settlements. Addressing these issues through integrated and balanced regional planning has become increasingly important to ensure sustainable development while preserving the district's environmental resources and cultural heritage. Overall, the historical evolution of Visakhapatnam

district reflects a remarkable transition from an ancient maritime settlement and colonial trading center to a modern industrial, commercial, and tourism hub. Its development trajectory illustrates the successful integration of economic modernization with cultural continuity and environmental richness. However, sustaining this growth requires comprehensive regional planning strategies that promote equitable infrastructure development, strengthen social services, and conserve the district's unique ecological and cultural assets. Within this broader context, Araku Valley Mandal represents a significant case for examining how balanced regional planning can enhance social infrastructure provision while supporting inclusive and sustainable regional development.

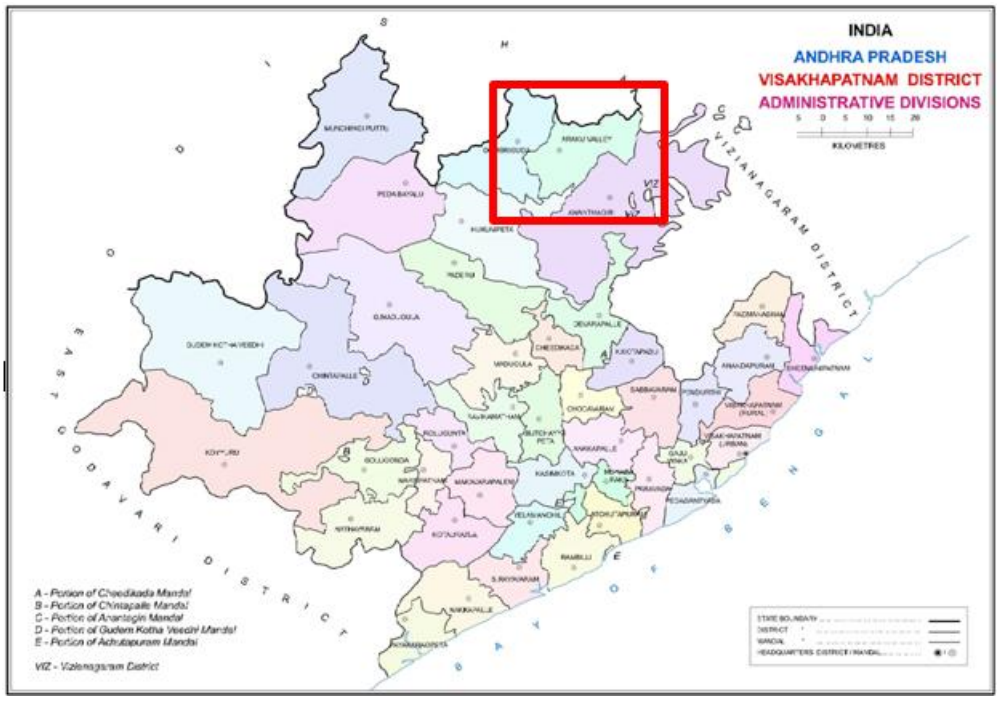

Image 1: Administrative Divisions of Visakhapatnam District, Source: DCHB Visakhapatnam 2011

5. Methodology of the Study

The selected micro region of Araku Valley Mandal comprises of 167 rural settlements in number with a total demographical count of 56674 with an area spread of 22143 Hectares (Census, 2011). The selected region comes under the categorization of an administrative region type which is a mandal or a sub region of Visakhapatnam District and the data sets considered pertains to the Census 2011 records and administrative setups and divisions of the concerned district. The Araku valley mandal doesn't comprise of any urban settlement, the total count of 169 settlements is rural both in context of demographic dividends and infrastructural facilitations. This study aims at identifying the social infrastructural need with regard to the settlements of the region, correlation of the demographic ascends to that of the infrastructural support and finally ranking of the settlement order in terms of infrastructural weightage thereby concluding with the relevance of balanced regional development approach for district development consideration of a micro or a sub region within a district profile which is devoid of any urban settlement.

In the consequent process the settlements were arranged in descending orders with respect to its demographic dividends for the settlements having population of above 500 whereby the settlement named Yandapallivalasa comprise of the highest population count of 3850. There is total 27 of rural settlements out of the total count of 167, which has a population mark of above 500. The set of rural settlements above 500 population mark is considered for the assessment of the social infrastructural need pattern is primarily because of the factor of independence in context of the governance-based parameters as most of these settlements possess their distinctive functioning panchayat units duly recognized by the Zilla Parishad. The settlement named Ranajilleda bears the lowest population count of 506 in the selected category of 500 and above population settlements.

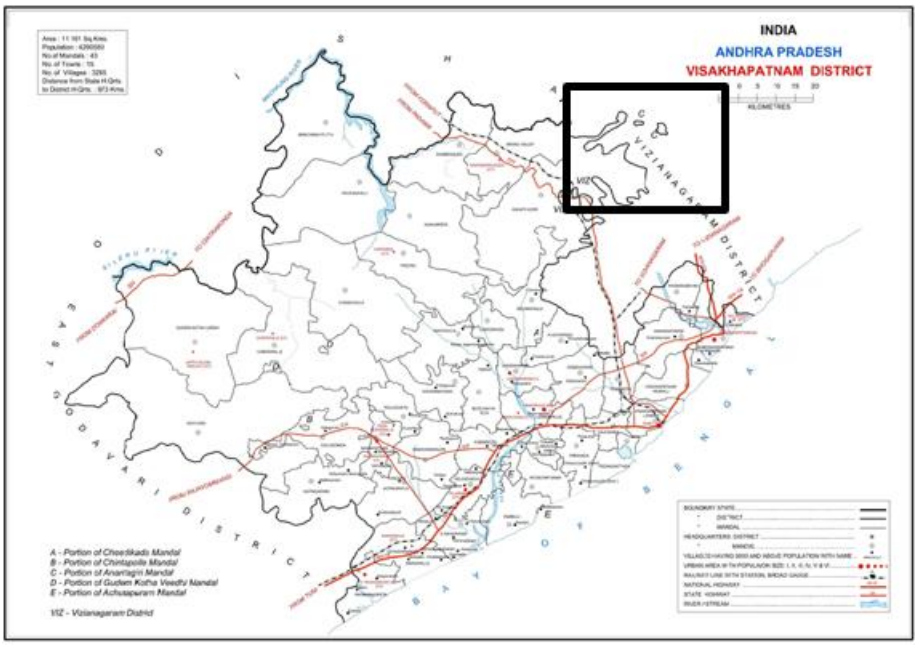

Image 2: Mandal Divisions of Visakhapatnam District, Source: DCHB Visakhapatnam 2011 (Araku Valley Mandal demarcated)

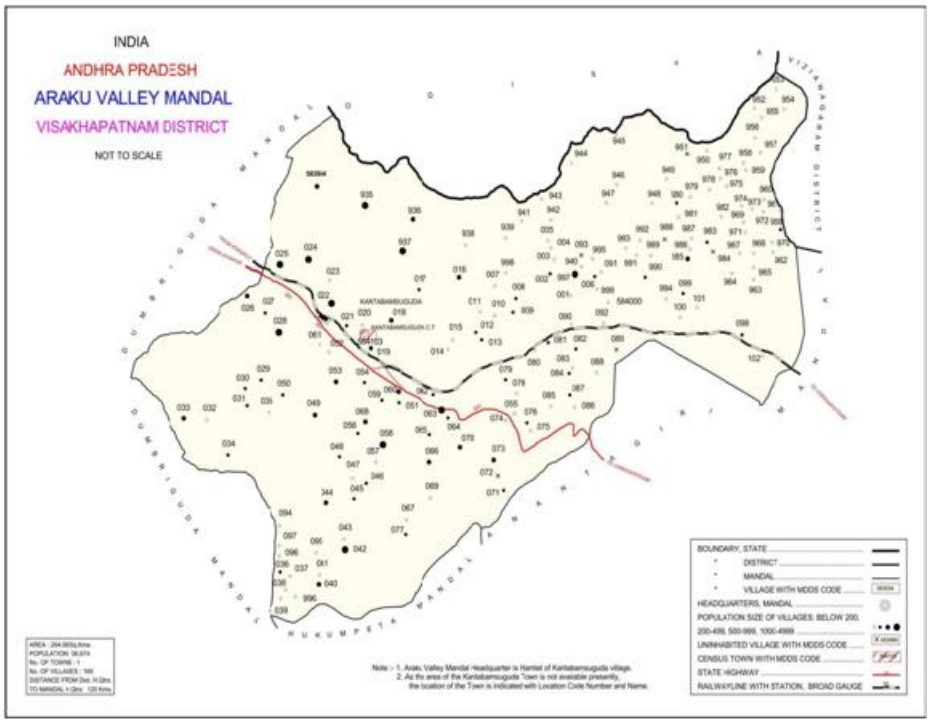

Image 3: Map of Araku Valley Mandal, Source: DCHB Visakhapatnam 2011

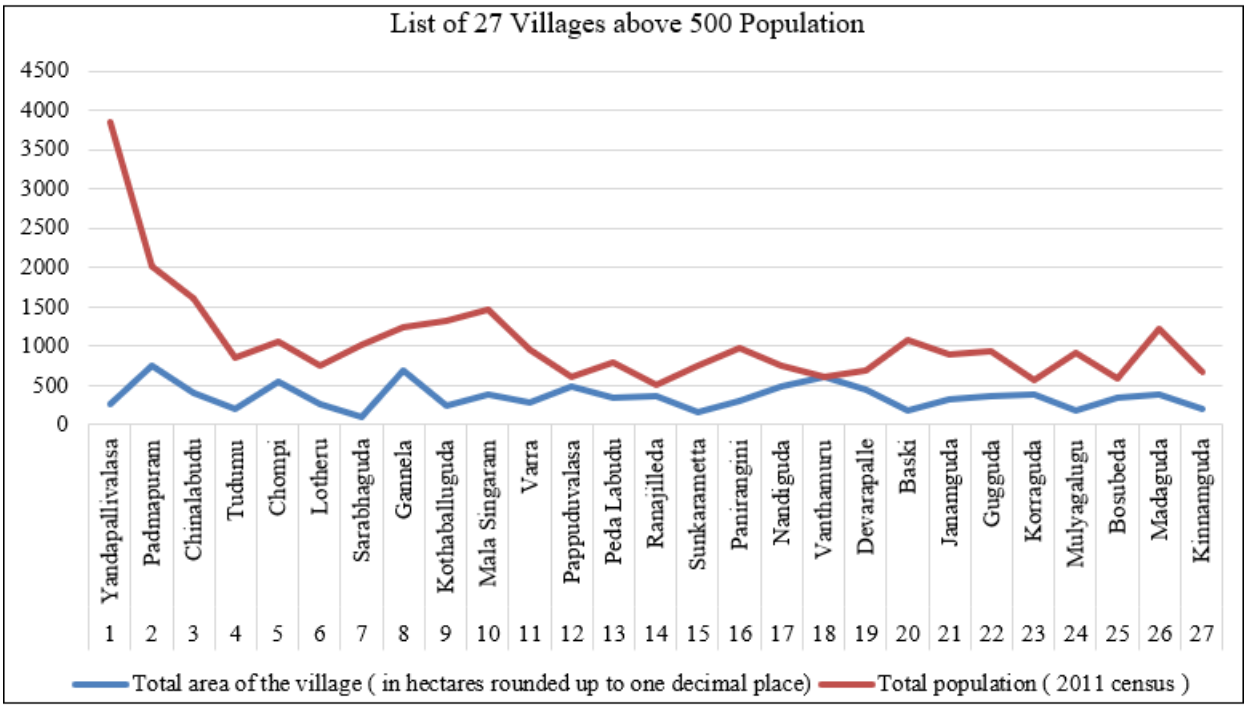

Figure 1: Chart showing list of 27 Rural Settlements with above 500 Population, out of total 163 villages in the selected Araku Valley Manday (DCHB 2011)
Source: Author

In the consequent process after the listing of settlements above 500 population in descending order of demographic count, the settlements are further assessed with the intent of foreseeing the distribution pattern of social infrastructures primarily in the broader categorization of Institution, Primary and Secondary Education organization, Health care centers, Health Clinics, Hospital or Nursing home, medical shop. These broader categories constitute total 24 number count of social infrastructures which are stipulated as in the chart prepared for the further assessment on the basis of comprehension of the data sets procured from District Census Handbook, Visakhapatnam from Census 2011. The following chart lists the ranking of the 27 settlements with respect to the derived infrastructural weightage factor. The present study adopts the Scalogram Analysis technique to evaluate the spatial distribution of social infrastructure and establish the functional hierarchy of settlements within Araku Valley Mandal, Visakhapatnam District, Andhra Pradesh. Scalogram analysis is a widely accepted quantitative regional planning tool that enables researchers to identify settlement hierarchy by assessing the presence and concentration of socio-economic infrastructure. The technique assists planners in understanding disparities in service provision and provides a scientific basis for prioritizing infrastructure investment and balanced regional development. The study considered 27 settlements having a population of more than 500 persons, based on the Census of India (2011). Settlements with populations below this threshold were excluded because of their relatively small demographic base and limited infrastructural significance in the regional service network. Each selected settlement was treated as an individual spatial unit for assessing the availability of social infrastructure. Twenty-four indicators representing education and healthcare infrastructure were selected to evaluate the functional importance of each settlement. Educational indicators included pre-primary schools, primary schools, middle schools, secondary schools, senior secondary schools, degree colleges, engineering colleges, medical colleges, polytechnics, vocational training institutes, management institutes, non-formal training centres, and special schools for persons with disabilities. Healthcare indicators comprised mobile health clinics, primary health sub-centres, primary health centres, community health centres, maternity and child welfare centres, dispensaries, family welfare centres, tuberculosis clinics, veterinary hospitals, allopathic hospitals, and alternative medicine hospitals. These facilities collectively represent the minimum essential social infrastructure required to support human development and regional accessibility.

Sr.No.	Name village	Location code no.	Total area of the village (in hectares rounded up to one decimal place)	Total population (2011 census)	Number of households (2011 census)	Number of educational amenities available. (If not available within the village , the distance range code viz; a for < 5 Kms, b for 5-10 Kms and c for 10+ kms of nearest place where facility is available is given). Weightage Data Code: (a=0.4, b=0.2, c=0.1)												Number of Medical Amenities available. (If not available within the village , the distance range code viz; a for < 5 Kms, b for 5-10 Kms and c for 10+ kms of nearest place where facility is available is given). Weightage Data Code: (a=0.4, b=0.2, c=0.1)											Total Settlement Weightage
						Pre-Primary school (PP)	Primary school (P)	Middle school (M)	Secondary School (S)	Senior Secondary school (SS)	Degree college of arts science & commerce (ASC)	Engineering college (EC)	Medical college (MC)	Management institute (MI)	Polytechnic (PI)	Vocational training school /ITI	Non-formal training centre (NFTC)	Special school for disabled (SSD)	Community health centre (CHC)	Primary health centre (PHC)	Primary health sub centre (PHS)	Maternity and child welfare centre (MCW)	T.B. clinic (TBC)	Hospital-allopathic (HA)	Hospital-alternative medicine (HO)	Dispensary (D)	Veterinary hospital (VH)	Mobile health clinic (MHC)	Family welfare centre (FWC)	
1	Vandapallivalasa	584025	235	3830	678	0.4	2	1	2	2	0.4	0.1	0.1	0.1	0.1	0.4	0.1	0.1	0.4	0.2	0.4	0.1	0.1	0.1	0.1	0.1	0.4	1	0.1	11.8
2	Pedrapuram	584024	748	2022	472	0.4	3	2	1	0.4	0.4	0.1	0.1	0.1	0.1	0.4	0.1	0.1	0.4	0.2	0.4	0.1	0.1	0.1	0.1	0.1	0.4	1	0.1	11.2
3	Chinalabudo	583937	408	1600	339	0.1	4	0.2	0.4	0.1	0.4	0.1	0.1	0.1	0.1	0.4	0.1	0.1	0.4	1	1	0.1	0.1	0.1	0.1	0.1	0.4	0.1	0.1	9.7
4	Mala Singaram	583935	387	1462	332	0.2	3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	1	0.1	7.2
5	Kothabalagada	584063	249	1321	198	0.1	2	1	1	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.4	0.1	0.1	0.1	0.1	0.1	0.2	1	0.1	7.8
6	Gamela	583997	692	1239	225	0.1	2	1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	7.9
7	Mudagada	584058	374	1213	278	0.2	1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	5.1
8	Ruski	584042	197	1083	206	0.1	1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6
9	Chanji	584028	538	1051	233	0.4	2	1	0.4	0.4	0.4	0.1	0.1	0.1	0.1	0.4	0.1	0.1	0.4	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.4	1	0.1	8.4
10	Sarabhagada	584022	108	1008	244	0.4	2	0.4	0.4	0.4	0.4	0.1	0.1	0.1	0.1	0.4	0.1	0.1	0.4	0.2	0.4	0.1	0.1	0.1	0.1	0.1	0.4	1	0.1	8
11	Pattirangini	584019	307	973	226	0.2	2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	6.2
12	Vavva	584033	292	955	192	0.2	3	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	1	0.1	7.1
13	Gorgada	584044	368	938	209	0.1	1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.4	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1	5.5
14	Mahagalaga	584016	178	907	222	0.2	1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	1	0.1	5.2
15	Janangada	584070	320	902	208	0.1	1	1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.4	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1	5.6
16	Tadanu	583936	208	856	170	0.2	4	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.4	1	0.1	0.1	0.1	0.1	0.1	0.4	0.1	0.1	8.5
17	Peda Labuda	584018	341	782	180	0.2	2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.4	0.2	0.1	0.1	0.1	0.1	0.1	0.2	1	0.1	6.4
18	Nandigada	584053	480	761	172	0.2	2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	1	0.1	6.2
19	Sankarametta	584073	150	761	198	0.1	2	1	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.4
20	Lotheru	583985	270	757	165	0.1	3	1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	8.1
21	Devatapalle	584040	448	681	141	0.1	2	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.2
22	Kinnangada	584066	198	670	162	0.1	1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1	5
23	Pappadavalasa	584026	481	611	142	0.4	1	0.2	0.2	0.4	0.4	0.1	0.1	0.1	0.4	0.2	0.1	0.1	0.4	0.2	0.4	0.1	0.1	0.1	0.1	0.1	0.4	1	0.1	6.7
24	Vanthuram	584049	611	601	132	0.2	2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	1	0.1	6.2
25	Bondeda	584060	339	587	145	0.2	1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	5.2
26	Korragada	584068	384	566	121	0.1	1	1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.4	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1	5.5
27	Ranjileda	583934	338	506	118	0.2	2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.4	0.2	0.1	0.1	0.1	0.1	0.1	0.2	1	0.1	6.4
Total Infrastructural Weightage						5.30	53.00	16.00	10.90	6.90	5.70	2.70	2.70	2.70	3.00	5.50	2.70	2.70	5.70	12.50	11.10	2.70	2.70	2.70	2.70	2.70	5.90	18.30	2.70	

Figure 2: Chart showing list of 27 Rural Settlements ranked in order of the derived infrastructural weightage factor
Source: Author

The intent of deriving the infrastructural weightage factor values is to establish a correlation between the demographic dividend and the infrastructural distribution pattern for all the listed settlements. In the concerned process the presence and occurrence of a particular infrastructure in a settlement is numerically marked and to derive an overall weightage, the consideration for presence of an infrastructural unit if not in a settlement but in a nearby range has been coded with a coefficient value for the derivation of the aforesaid. Therefore, the coefficients denoted are as follows which are adopted in the methodology:
(a=0.4, b=0.2, c=0.1), where the distance ranges are coded as such:

a for < 5 Kms, b for 5-10 Kms and c for 10+ kms of nearest place where the social infrastructural facility is available.

The present study adopts the Scalogram Analysis technique to evaluate the spatial distribution of social infrastructure and establish the functional hierarchy of settlements within Araku Valley Mandal, Visakhapatnam District, Andhra Pradesh. Scalogram analysis is a widely accepted quantitative regional planning tool that enables researchers to identify settlement hierarchy by assessing the presence and concentration of socio-economic infrastructure. The technique assists planners in understanding disparities in service provision and provides a scientific basis for prioritizing infrastructure investment and balanced regional development. The study considered 27 settlements having a population of more than 500 persons, based on the Census of India (2011). Settlements with populations below this threshold were excluded because of their relatively small demographic base and limited infrastructural significance in the regional service network. Each selected settlement was treated as an individual spatial unit for assessing the availability of social infrastructure. Twenty-four indicators representing education and healthcare infrastructure were selected to evaluate the functional importance of each settlement. Educational indicators included pre-primary schools, primary schools, middle schools, secondary schools, senior secondary schools, degree colleges, engineering colleges, medical colleges, polytechnics, vocational training institutes, management institutes, non-formal training centres, and special schools for persons with disabilities. Healthcare indicators comprised mobile health clinics, primary health sub-centres, primary health centres, community health centres, maternity and child welfare centres, dispensaries, family welfare centres, tuberculosis clinics, veterinary hospitals, allopathic hospitals,

and alternative medicine hospitals. These facilities collectively represent the minimum essential social infrastructure required to support human development and regional accessibility.

Each infrastructure variable was assigned a functional weight according to its order of service and regional significance. Facilities catering to higher-order regional functions, such as primary schools and senior secondary schools, were assigned comparatively higher weights, whereas specialized institutions available only in selected settlements received lower fractional weights based on their functional rarity. The weighting scheme reflects the relative contribution of each facility to settlement centrality rather than merely its numerical presence. The cumulative weighted score for every settlement was obtained by summing the assigned values of all available infrastructure indicators, resulting in a Total Settlement Weightage that represents the overall functional importance of each settlement. Following computation of the composite scores, settlements were arranged in descending order of total weightage to establish the regional hierarchy. The ranking process identifies settlements functioning as major service centres, intermediate centres, and lower-order villages. Higher-ranked settlements generally exhibit a greater concentration and diversity of educational and healthcare services, indicating their wider regional influence and capacity to serve neighbouring settlements. Conversely, lower-ranked settlements are characterized by limited infrastructure availability and dependence on higher-order centres for essential services.

The scalogram approach assumes that settlements possessing a greater diversity of higher-order services perform broader regional functions and consequently occupy higher positions within the settlement hierarchy. The resulting hierarchy therefore reflects the spatial organization of service centres within the study region and facilitates the identification of infrastructure gaps. Furthermore, the methodology enables planners to recognize underserved settlements requiring priority intervention while avoiding duplication of facilities in already well-served locations.

6. Analysis and Conclusion

With the denoting of coefficients pertaining to the presence, frequency of occurrence, distance range for the social infrastructural facilitations the derived ranking gives an holistic preview of the distribution pattern and the correlation of the demographic dividend of each settlement to that of its infrastructural weightage factor, hence incepting a baseline for formulation of a district development plan on consideration of social infrastructure with the intent of balanced regional development and regional inclusivity as mentioned in the part of regional planning approach in context of Indian society. The substantiation of deriving order of settlements on the basis of infrastructural weightage factor are elaborated as follows:

Achieved Ranking	Sr.No.	Name village	Total area of the village (in hectares rounded up to one decimal place)	Total population (2011 census)	Number of households (2011 census)	Primary school (P)	Mobile health clinic (MHC)	Middle school (M)	Primary health centre (PHC)	Primary health sub centre (PHS)	Secondary School (S)	Senior Secondary school (SS)	Veterinary hospital (VH)	Degree college of arts ,science & commerce (ASC)	Community health centre (CHC)	Vocational training school (ITI)	Pre-Primary school (PP)	Polytechnic (Pl)	Engineering college(EC)	Medical college (MC)	Management institute (MI)	Non-formal training centre (NFTC)	Special school for disabled (SSD)	Maternity and child welfare centre (MCW)	T.B. clinic (TBC)	Hospital-allopathic (HA)	Hospital-alternative medicine (HO)	Dispensary (D)	Family welfare centre (FWC)	Total Settlement Weightage
1	1	Vandapillaisa	255	3850	678	2	1	1	02	0.4	2	2	0.4	0.4	0.4	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	11.80
2	2	Palampuram	748	2022	472	3	1	2	02	0.4	1	0.4	0.4	0.4	0.4	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	11.20
3	3	Chinnbhada	408	1600	399	4	0.1	0.2	1	1	0.4	0.1	0.4	0.4	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	9.70
4	16	Tahasu	204	836	170	4	0.1	0.2	04	1	0.2	0.2	0.4	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	8.50
5	9	Chenpi	538	1051	253	2	1	1	02	0.2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	8.40
6	20	Tethuru	270	757	163	3	0.1	1	02	1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	8.10
7	10	Saraldagada	108	1008	264	2	1	0.4	02	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	8.00
8	6	Gumchi	692	1290	255	2	0.1	1	1	1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	7.90
9	5	Kathalalligada	249	1321	193	2	1	1	02	0.4	1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	7.80
10	4	Mah Nagaram	387	1462	382	3	1	0.2	02	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	7.20
11	12	Varra	282	935	192	3	1	0.1	02	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	7.10
12	23	Pappulavalsa	481	611	142	1	1	0.2	02	0.4	0.2	0.4	0.4	0.4	0.4	0.4	0.2	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.70
13	17	Pulalalu	341	702	190	2	1	0.2	04	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.40
14	27	Rasajikoh	558	506	118	2	1	0.2	04	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.40
15	19	Sankaranatta	150	701	188	2	0.1	1	1	0.1	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.40
16	11	Panirangini	307	975	226	2	0.2	0.2	1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.20
17	18	Nandigudi	400	701	172	2	1	0.2	02	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.20
18	24	Vanthanaru	611	601	132	2	1	0.2	02	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.20
19	21	Doorapalle	443	681	141	2	0.1	1	1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.20
20	8	Ruski	357	1003	208	1	0.1	1	1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.00
21	15	Jananguda	320	902	208	1	1	1	02	0.4	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.60
22	13	Gaggada	363	930	209	1	1	02	04	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.50
23	26	Suringada	384	506	121	1	1	1	01	0.4	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.50
24	14	Mahagaiga	178	907	222	1	1	0.2	02	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.20
25	25	Boshada	330	587	145	1	0.2	0.2	1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.20
26	7	Madgada	174	1213	278	1	0.2	0.1	1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.10
27	22	Kinnangada	191	670	162	1	1	0.2	04	0.4	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.00
	Total Infrastructural Weightage					53.00	18.30	16.00	12.50	11.10	10.90	6.90	5.90	5.70	5.70	5.70	5.50	5.30	3.00	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	

Figure 3: Chart showing list of 27 Rural Settlements subjected to variation in the ranking system comprehending to its infrastructural weightage and demographic dividend as well.
Source: Author

Settlements having lower population rank but higher infrastructural weightage (Figure 3)
Settlements having higher population rank but lower infrastructural weightage (Figure 3)

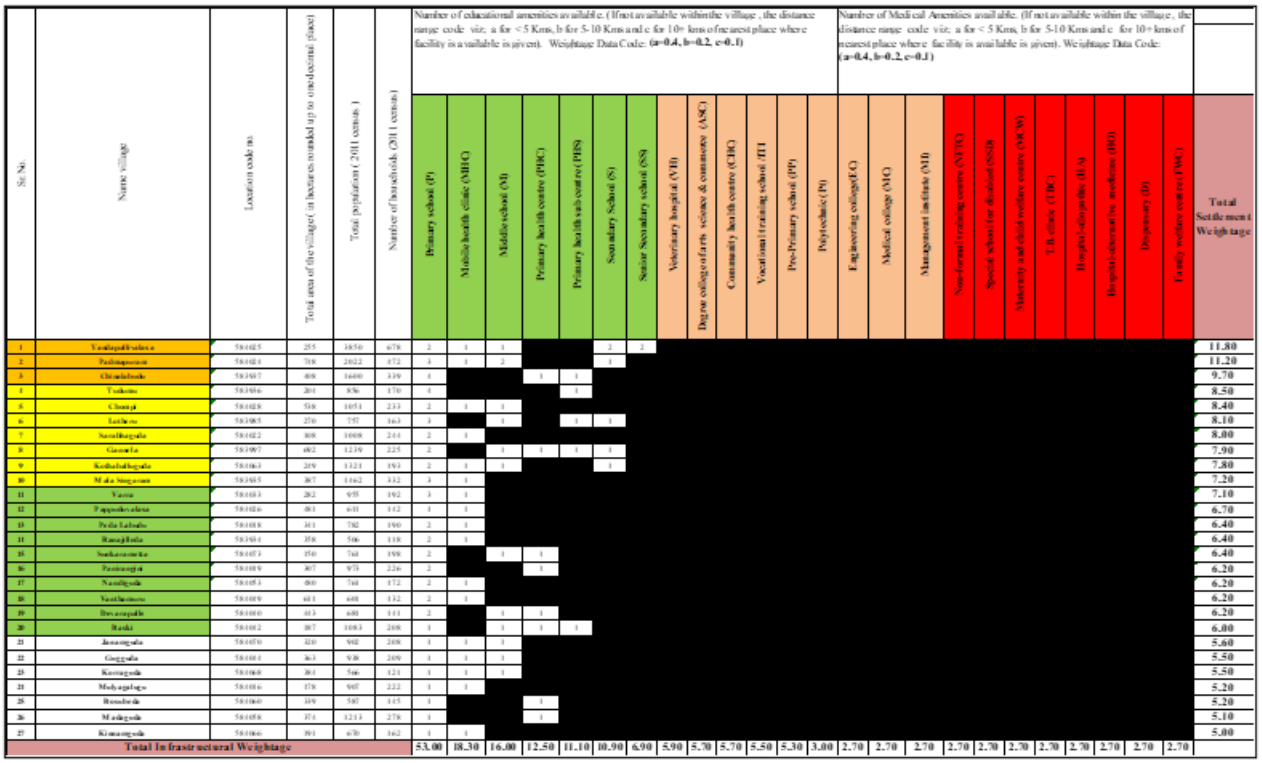

Figure 4: Chart showing the distribution pattern of the social infrastructure all across the selected 27 rural settlements.
Source: Author

Achieved Ranking	Sr. No.	Name village	Total area of the village (in hectares rounded up to one decimal place)	Total population (2011 census)	Number of households (2011 census)	Primary school (P)	Mobile health clinic (MHC)	Middle school (M)	Primary health centre (PHC)	Primary health sub centre (PHS)	Secondary School (S)	Senior Secondary school (SS)	Veterinary hospital (VH)	Degree college of arts science & commerce (ASC)	Community health centre (CHC)	Vocational training school (ITI)	Pre-Primary school (PP)	Polytechnic (Pt)	Engineering college(EC)	Medical college (MC)	Management institute (MI)	Non-formal training centre (NFTC)	Special school for disabled (SSD)	Maternity and child welfare centre (MCW)	T.B. clinic (TBC)	Hospital-allopathic (HA)	Hospital-alternative medicine (HO)	Dispensary (D)	Family welfare centre (FWC)	Total Settlement Weightage
1	1	Vandapallibalava	255	1850	678	2	1	1	0.2	0.4	2	2	0.4	0.4	0.4	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	11.80
2	2	Padmapuram	748	2022	472	3	1	2	0.2	0.4	1	0.4	0.4	0.4	0.4	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	11.20
3	3	Chimalabada	408	1600	339	4	0.1	0.2	1	1	0.4	0.1	0.4	0.4	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	9.70
4	16	Tadarasu	204	856	170	4	0.1	0.2	0.4	1	0.2	0.2	0.4	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	8.50
5	9	Chengil	538	1051	233	2	1	1	0.2	0.2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	8.40
6	20	Lotheru	270	787	163	3	0.1	1	0.2	1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	8.10
7	10	Suralthagada	108	1008	244	2	1	0.4	0.2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	8.00
8	6	Gaveda	692	1239	225	2	0.1	1	1	1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	7.90
9	5	Kothabillagada	249	1321	193	2	1	1	0.2	0.4	1	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	7.80
10	4	Mala Singavaram	387	1462	332	3	1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	7.20
11	12	Varra	282	955	192	3	1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	7.10
12	23	Pappadorulava	481	611	142	1	1	0.2	0.2	0.4	0.2	0.4	0.4	0.4	0.4	0.2	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.70
13	17	Peda Lahuda	341	782	190	2	1	0.2	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.40
14	27	Ramajilleda	358	506	118	2	1	0.2	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.40
15	19	Sunkaramotta	150	761	198	2	0.1	1	1	0.1	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.40
16	11	Pantrangini	307	973	226	2	0.2	0.2	1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.20
17	18	Nandigada	480	761	172	2	1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.20
18	24	Vanthamaru	611	601	132	2	1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.20
19	21	Devaragallo	443	661	141	2	0.1	1	1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.20
20	8	Bavikl	187	1083	208	1	0.1	1	1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.00
21	15	Janamgada	320	902	208	1	1	1	0.2	0.4	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.60
22	13	Gaggada	365	958	209	1	1	1	0.2	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.50
23	26	Korragada	384	566	121	1	1	1	0.1	0.4	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.50
24	14	Mahyagalaga	178	907	222	1	1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.20
25	25	Bavuluda	339	587	145	1	0.2	0.2	1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.20
26	7	Madagada	374	1213	278	1	0.2	0.1	1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.10
27	22	Kimmangada	191	670	162	1	1	0.2	0.4	0.4	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.00
	Total Infrastructural Weightage					53.00	18.30	16.00	12.50	11.10	10.90	6.90	5.90	5.70	5.70	5.50	5.30	3.00	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	

Figure 4: Chart showing final raking of settlements order and distribution of social infrastructural facility with weightage factor or mark of relevance allocation to each infrastructural entity.
Source: Author

The application of the scalogram model successfully established the functional hierarchy of the 27 settlements within Araku Valley Mandal by evaluating the distribution of educational and healthcare infrastructure. The analysis

demonstrates considerable spatial variation in the availability of social infrastructure, indicating that public services are concentrated in only a limited number of settlements while many villages continue to depend on these centres for higher-order facilities. Such disparities highlight the importance of adopting a balanced regional planning approach for equitable infrastructure development.

The analysis identified Yandapallivalasa as the highest-ranked settlement, achieving the maximum composite weightage of approximately 11.8, thereby emerging as the principal service centre within the mandal. The settlement exhibits the greatest concentration and diversity of educational and healthcare facilities, indicating its capability to provide services not only to its resident population but also to surrounding villages. Padmapuram, with a composite score of approximately 11.2, ranked second and similarly functions as an important secondary growth centre supporting regional service delivery. The upper-ranked settlements collectively possess comparatively better educational institutions, primary healthcare facilities, and supporting public services, making them functionally more influential within the regional settlement network.

Settlements occupying intermediate positions in the hierarchy generally possess essential facilities such as primary schools, middle schools, primary healthcare institutions, and basic community services. Although these settlements adequately cater to local populations, they remain dependent on higher-order centres for specialized educational institutions, advanced healthcare services, and technical education. This pattern reflects a typical hierarchical distribution of services commonly observed in developing regions, where higher-order facilities remain spatially concentrated due to financial, demographic, and administrative considerations. The lower-ranked settlements, including Bosubeda, Madaguda, and Kinnamguda, recorded composite weightages ranging between approximately 5.0 and 5.2, indicating comparatively limited availability of social infrastructure. These settlements largely contain only basic educational facilities and minimal healthcare services while lacking higher-order institutions capable of supporting broader regional populations. Their dependence on upper-order settlements increases travel distance, service accessibility challenges, and socio-economic disparities, particularly for vulnerable populations residing in geographically remote areas.

The settlement hierarchy obtained through the scalogram analysis clearly demonstrates that infrastructure development within Araku Valley Mandal remains spatially uneven. While a few settlements have evolved as dominant service centres, numerous villages continue to experience deficiencies in education, healthcare, and associated public services. Such concentration of infrastructure contributes to increased pressure on higher-ranked settlements while simultaneously limiting development opportunities in peripheral villages.

From a regional planning perspective, these findings provide valuable guidance for infrastructure prioritization. Future investments should focus on strengthening intermediate settlements by introducing secondary educational institutions, community health centres, vocational training facilities, and improved public transport connectivity. Rather than concentrating additional investments exclusively in already developed centres, planners should adopt a decentralized approach that enhances the service capacity of strategically located intermediate settlements. Such interventions would reduce regional disparities, improve accessibility for surrounding rural populations, and create a more balanced settlement structure.

References

[1] Ahmad, S., Balaban, O., Doll, C. N. H., & Dreyfus, M. (2013). Delhi revisited. *Cities*, *31*, 641–653. https://doi.org/10.1016/j.cities.2012.12.006
[2] Blanco Pastor, A., Canniffe, E., & Rosa Jiménez, C. J. (2023). Learning from Letchworth and Welwyn Garden City: Garden cities' policies for the development of existing settlements in the contemporary world. *Land Use Policy*, *132*. https://doi.org/10.1016/j.landusepol.2023.106759
[3] Deb, S., & Okulicz-Kozaryn, A. (2023). Exploring the association of urbanisation and subjective well-being in India. *Cities*, *132*. https://doi.org/10.1016/j.cities.2022.104068
[4] Kumar Routray, J. (1993). *Urban and Regional Planning Practice in India* in* (Vol. 17, Issue 3).
[5] Maparu, T. S., & Mazumder, T. N. (2021). Investigating causality between transport infrastructure and urbanization: A state-level study of India (1991–2011). *Transport Policy*, *113*, 46–55. https://doi.org/10.1016/j.tranpol.2020.03.008
[6] Schneider, A., Chang, C., & Paulsen, K. (2015). The changing spatial form of cities in Western China. *Landscape and Urban Planning*, *135*, 40–61. https://doi.org/10.1016/j.landurbplan.2014.11.005
[7] Shaw, A., & Satish, M. K. (2007). Metropolitan restructuring in post-liberalized India: Separating the global and the local. *Cities*, *24*(2), 148–163. https://doi.org/10.1016/j.cities.2006.02.001
[8] Tian, Y., & Mao, Q. (2022). The effect of regional integration on urban sprawl in urban agglomeration areas: A case study of the Yangtze River Delta, China. *Habitat International*, *130*. https://doi.org/10.1016/j.habitatint.2022.102695
[9] Annapurna, S., & Satish, M. K. (n.d.). *2. Metropolitan Restructuring in Post Liberalized India*.
[10] Friedmann, J. (1967). Book Review: Regional Development Policy : A Case Study of Venezuela by J. Friedmann, M.I.T. Press, 1966, pp. 279, 64/-. *Urban Studies*, *4*(3), 309–311. https://doi.org/10.1080/00420986720080601
[11] UN Habitat, & 2020. (n.d.). *World Cities Report 2020*.
[12] UNHabitat. (n.d.). *INTERNATIONAL GUIDELINES ON URBAN AND TERRITORIAL PLANNING*.