

Polycentric Model/Approach for Greater Chennai Metropolitan Region (GCMR)

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Abstract-Rapid urbanisation is the present day trend everywhere especially in the developing countries. More people are moving towards the Metropolitan cities due to concentration of better livelihood opportunities and higher order infrastructural facilities which leads to overcrowding ill-effects, Environmental degradation and regional imbalance. Polycentric approach is one of the decentralization strategies for discouraging the concentration of activities and functions towards the Metro cities which helps to overcome or to mitigate the ill-effects of overcrowding in a mother city and to bring the overall regional development in a balanced way. It also helps for the development of secondary towns and cities in a region. It reduces various pressures on the mother city. Chennai Metropolitan Area (CMA) is one of such mother city (undergoes various overcrowding issues) which needs polycentric approach. By realising the various urbanisation issues (like overcrowding, Environmental degradation, haphazard, uncontrolled and unplanned growth) prevailing in CMA, Chennai Metropolitan Development Authority (CMDA) suggested a solution of forming Greater Chennai Region (GCR) as a strategy by expanding the boundary of CMA for which Government of Tamil Nadu (GoTN) approved and expanded the boundary of Chennai Metropolitan Area in October 2022. This paper strongly suggests that, mere expansion of Metropolitan area boundary further, will not give a permanent solution for the Urbanisation issue unless reducing immigrants towards CMA by identifying and developing the potential nodes which will act as polycentres/counter magnets to attract migrants towards CMA. From the analysis, it is identified that the influence area of CMA falls beyond the proposed GCR or expanded CMA region. Hence, Greater Chennai Metropolitan Region (GCMR) has been delineated which covers more area than proposed GCR. As a significant outcome of analysis and findings, this paper proposed a Polycentric model for the development of Greater Chennai Metropolitan Region.

Keywords: Chennai Metropolitan Area, Overcrowding ill-effects, Polycentric model, Sphere of Influence, Greater Chennai Metropolitan Region, Potential Urban Nodes.

1. INTRODUCTION

Currently Managing urban growth and Metropolitan cities have become most important challenges especially in India. Due to rapid urbanisation, there exists very high unexpected increase in growth rate of population in cities, which in turn imparts more pressure on infrastructure facilities, job opportunities, land to accommodate them etc. This leads to various issues like increase in land cost, unauthorized settlement, urban sprawl, violation of rules, blockage of water shed areas, More exploitation of natural resources, Traffic congestion and spoiling of eco-sensitive areas in peri-urban.

Polycentric approach for a region is one of the best solution which helps to overcome issues and problems in the core city. Moreover it helps to bring the overall regional development and also for the development of secondary cities and towns in the region. Many megacities are adopting this strategy after undergoing serious sufferings. Initially they were following the strategy of extension of boundaries further and further to mitigate the overcrowding ill-effect in a particular mother city. But it won't be the permanent solution for the overcrowding ill-effects because mere extension of boundaries won't solve the problem unless the potential centres (polycentrism) have been identified and future development have been directed towards the identified centres to attract the future population and investments. The concept of polycentricism can be understood from the following characteristics and from fig. 1.

The characteristics of centres within the region are as follows

- a) Each centre should act independently and should serve the surrounding lower order settlements for facilities and livelihood opportunities.
- b) Spatially balanced distribution of centres.
- c) Centres should not depend on mother centre for facilities and livelihood opportunities. It should be a self contained one and should acts as pulling counter-magnets for the migrants towards the

mother centre and should create the 'live and work' environment.

d) There should not be vast difference between the Mother centre and other centre's catchment area and hierarchy.

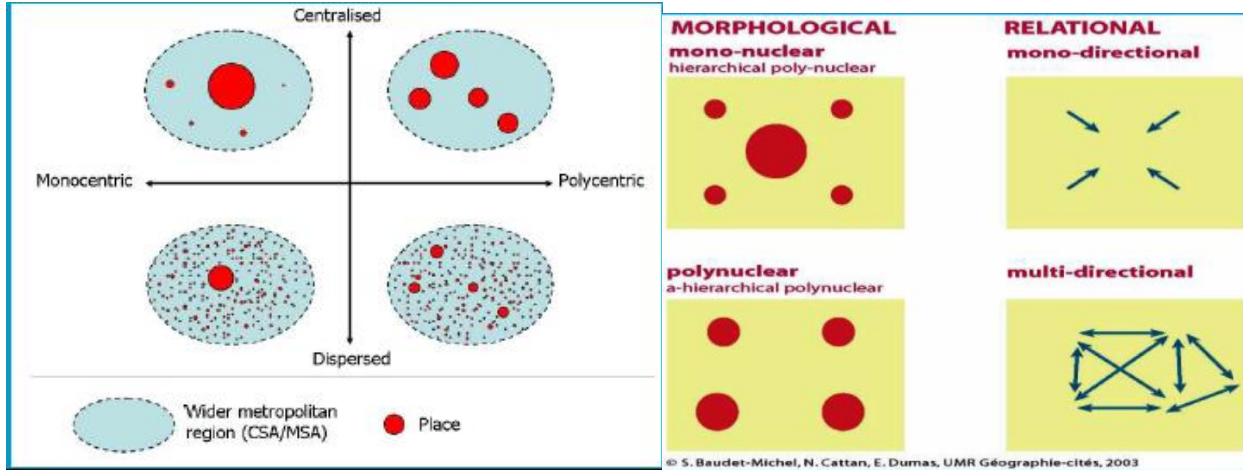
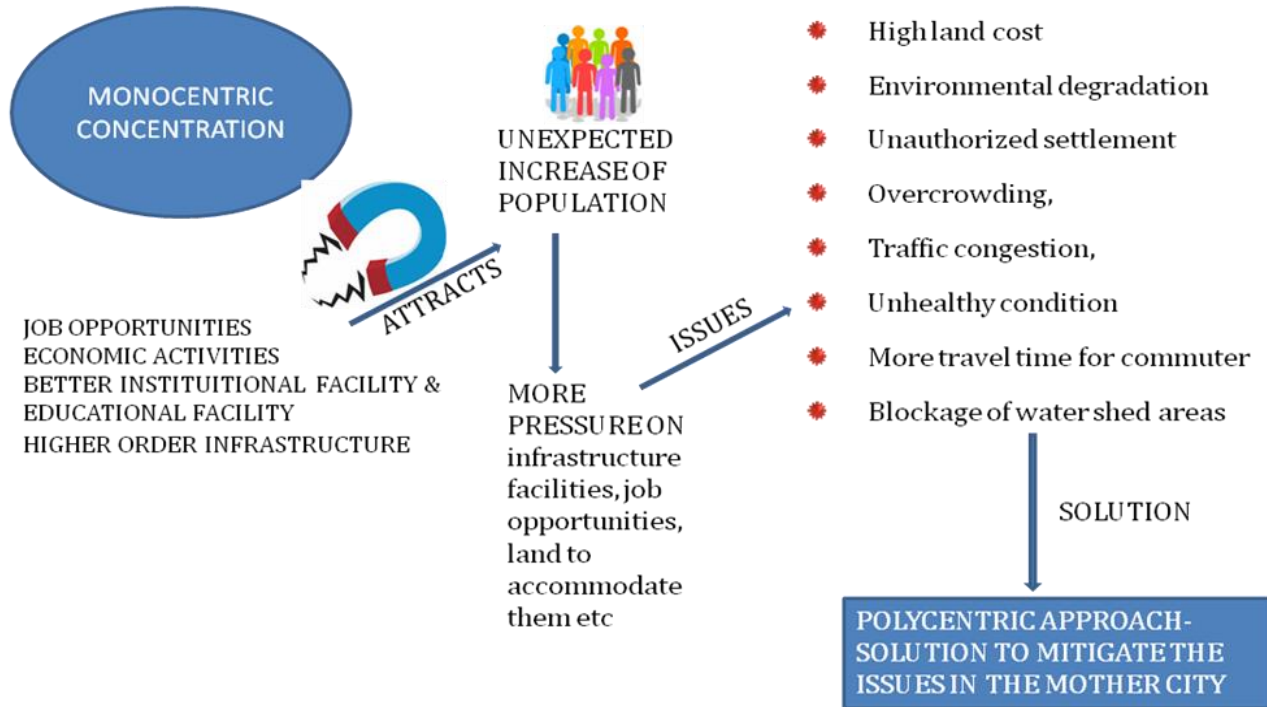


Fig. 1- Polycentric structure with morphological and relational pattern

CONTEXT IN GENERAL

India's large metropolises are struggling to cope with rapid and unexpected growth of population and the rising demand for urban facilities. All such struggling metropolitan cities when transforming to Megapolis, they start to adopt the strategy of polycentric approach to reduce ill effects of overcrowding and sprawling as depicted in Fig. 2.



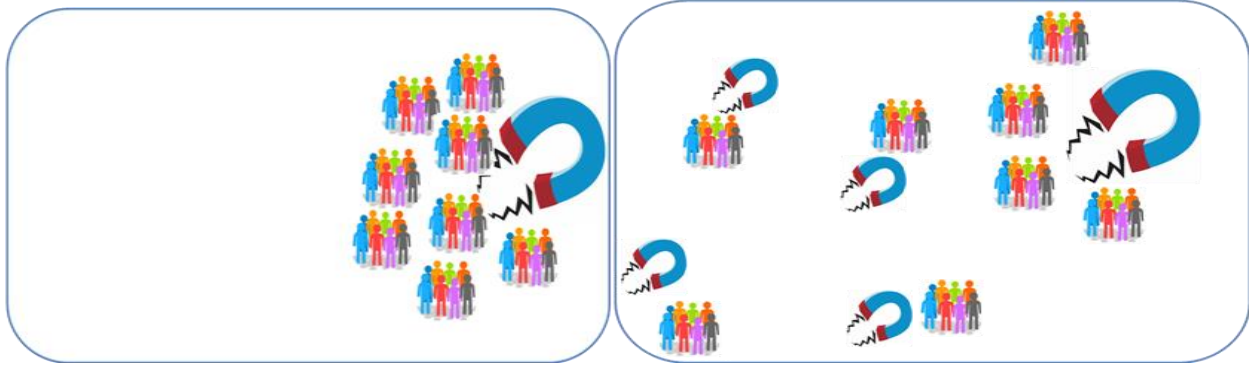


Fig. 2 Need for Polycentric Approach

Proposed Greater Chennai Metropolitan Region (GCMR)

The GCMR earmarked for the Study includes the Greater Chennai Region (GCR) already proposed by the Chennai Metropolitan Development Authority and adjoining Districts of Vellore, Tiruvannamalai and Villupuram. These Districts have been included because they lie within the influence area of Chennai and the outmigration from these included areas to the Chennai Urban Agglomeration is larger. Further, a larger catchment area is required to identify potential nodes and to have meaningful polycentric approach. The GCR suggested by CMDA comprises of whole Districts of Thiruvallur & Kancheepuram, and the Arakkonam Taluk of Vellore District which is about 8800 Sq. Km. (It was later modified in October 2022 and further reduced to 5,904 sq.km) Whereas the total extent of study area-GCMR to propose Polycentric model is 25910 Sq.km.

Fig.3(a) and 3(b) shows the map of the GCR/Expanded CMA, the Study Area

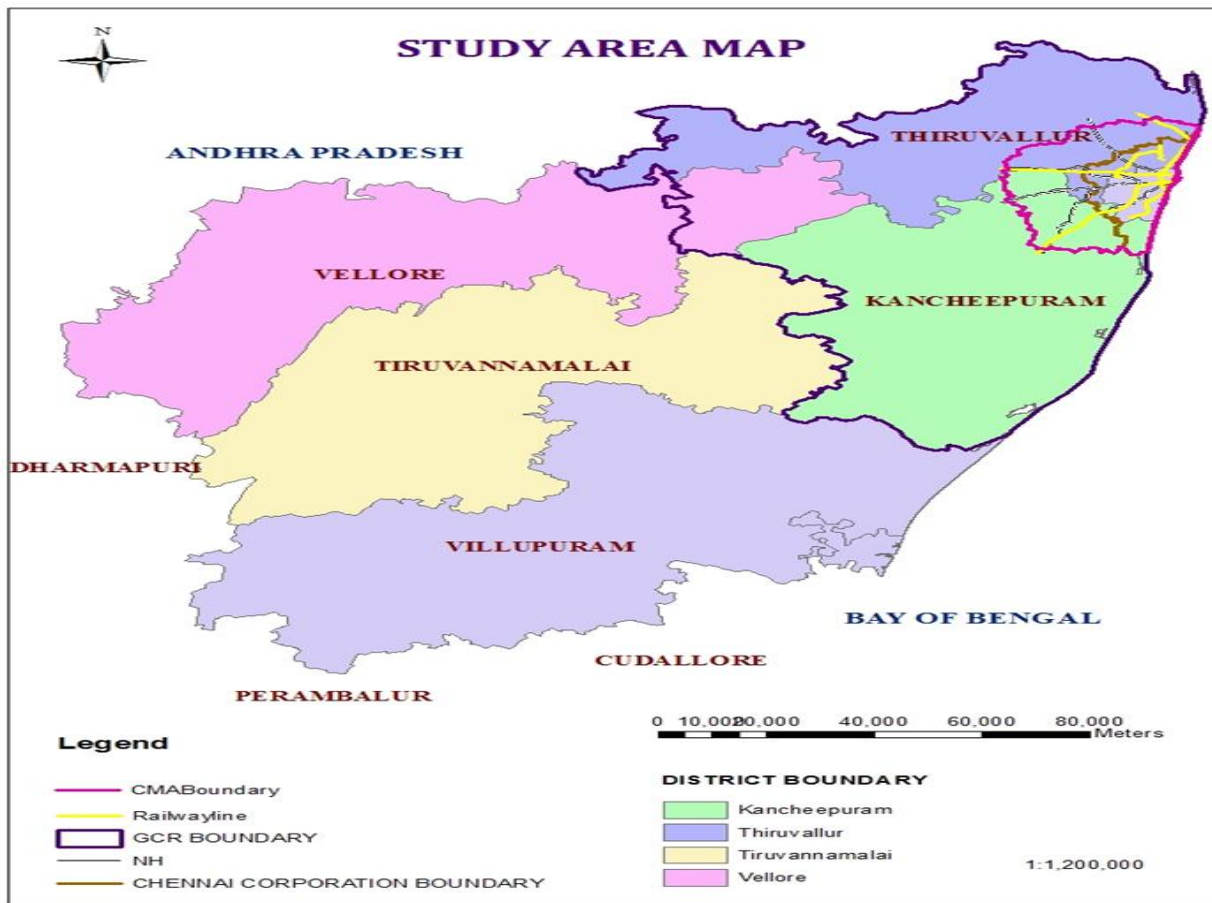
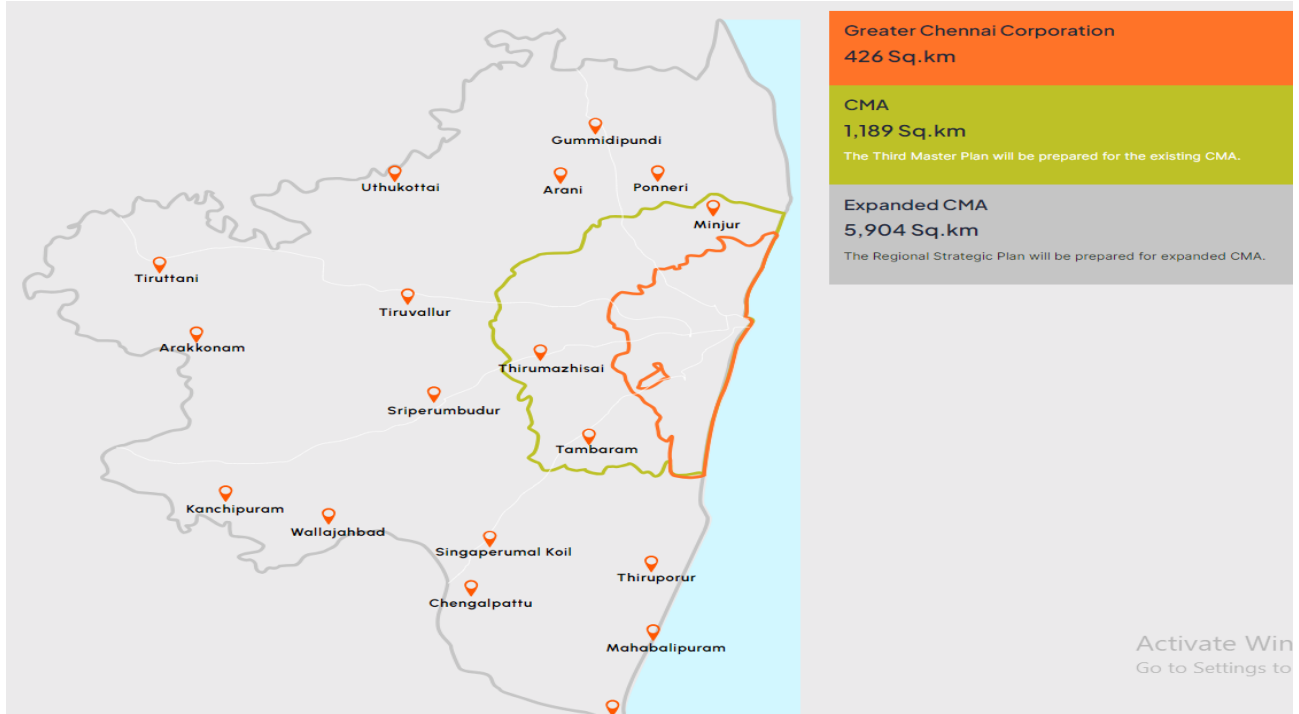


Fig. 3 (a) Greater Chennai Region and Study area



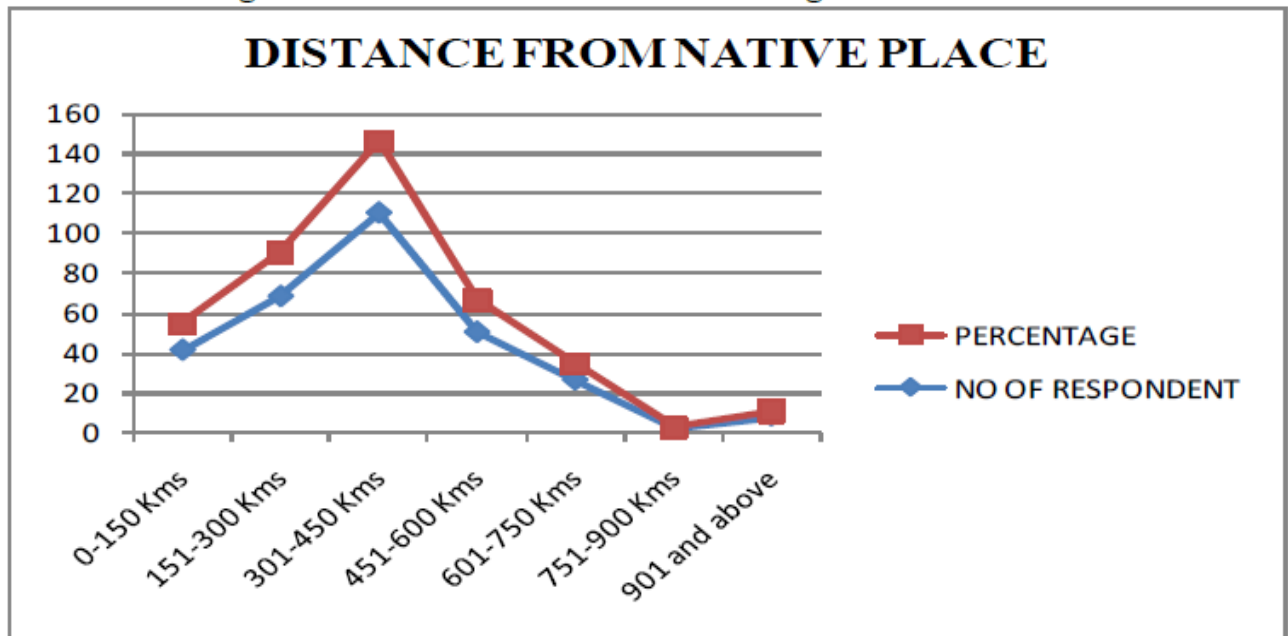
Source: CMDA website

Fig. 3 (b) Expanded Chennai Metropolitan Area (Modified GCR)

Table 1- Migration pattern of districts in the Study Area towards CMA

DISTRICT	INMIGRATION	OUTMIGRATION	NETMIGRATION
THIRUVALUR	598176	52406	545770
KANCHEEPURAM	417894	139641	278253
VELLORE	130897	180004	-49107
TIRUVANNAMALAI	59958	139293	-79335
VILLUPURAM	113443	160823	-47380

(Source: "PATTERNS OF INTERNAL MIGRATION", Research article)



(Source:“Rural To Urban Migration in an Indian Metropolis-case study Chennai)

Fig. 4- Distance and percentage of migrants to Chennai

It is inferred from the Table 1, that the Vellore, Tiruvannamalai and Villupuram districts show negative net migration. So, they need counter magnets within to retain out migrants. From Fig 4, it is clear that the migrants towards Chennai is more from the towns which are located within 300-500 km range which covers in our study area considered as catchment area to identify potential urban nodes.

PARAMETERS CONSIDERED FOR SELECTION OF POTENTIAL URBAN NODES WITHIN THE REGION FOR THE PURPOSE OF DECENTRALISATION

Following parameters have been selected based on literature review and data availability to identify potential urban nodes.

- a) Administrative status (A1)
- b) Population size (A2)
- c) Population growth rate (A3)
- d) Population density (A4)
- e) Work participation rate (A5)
- f) Non- Agricultural workers (A6)
- g) No. of Industries (A7)
- h) Industrial workforce (A8)
- i) Total receipt (A9)
- j) Proximity to railway station (A10)
- k) Road length per 1000 population (A11)
- l) No. of colleges (A12)
- m) No. of beds facilities in hospital (A13)
- n) No. of banks (A14)
- o) Proximity to Industrial Estate, Large & Medium scale Industries (A15)

Methodology to identify Potential Nodes:
Cumulative Functional Index technique has been adopted for determining the growth performance of

centres. This technique is regarded as one of the most rationale method to identify the functional and growth performance of the settlements in a given region.

Step 1: As a first step, the actual values of each indicator against each settlement have to be tabulated.

Step 2: The comparative assessment of Performance Index can be arrived at by using the following formula.

$$P.I = \frac{N - Min}{Max - Min} \times 100$$

Where, N = Observed value of each indicator against each settlement

Min = Minimum value of the selected indicator

Max = Maximum value of the selected indicator

P.I = Performance Index

Step 3: Construct a table and list all Performance Index values for all the settlements.

Step 4: Add all the values for a given settlement and arrive at a Cumulative Functional Index (CFI) value. Repeat the exercise for all the settlements. Rank them accordingly to know the comparative level of growth performance.

ANALYSIS PROCESS AND RESULT

The settlements with the population size greater than 20,000 have been selected for the analysis. Totally there are 102 such settlements within the Study Region. The method used to find the potential centres of the region is based on Cumulative functional index analysis which gives score and ranking for centres

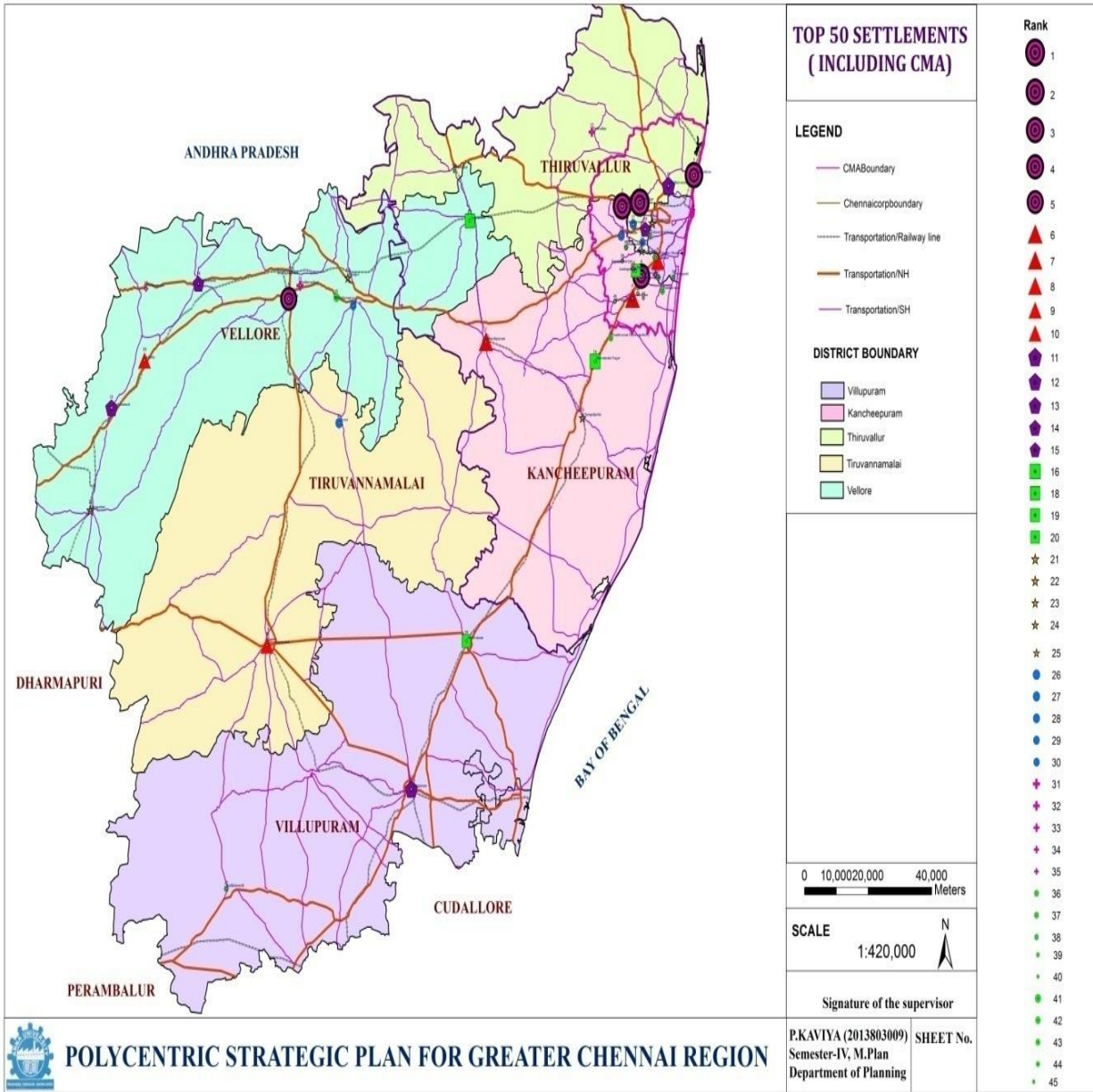


Fig. 5- Top 50 settlements including CMA within the region.

In the initial analysis, among all the top fifty settlements, twenty five settlements are concentrated within Chennai Metropolitan Area (CMA) as shown in figure 5.

This is an index for glaring regional imbalance. So in the polycentric model, Chennai metropolitan area has been considered as core centre in first hierarchy and the centres outside CMA and within the region has been considered for identification of centres for the polycentric model as given in Table 2. The

identification and development of those centres (outside CMA) will act as attracting magnet for the migrants and commuters towards CMA and also helps to bring the overall balanced regional development. The sphere of influence has been calculated for the entire top Twenty five centres based on the centrality score calculation technique. Then the polycentric model was arrived based on scoring, spatial distribution and influence area served by the centres.

Table 2- Top 50 settlements (Excluding CMA) with Functional index score

District	Name of the settlement	CUMULATIVE FUNCTIONAL INDEX	RANK
VELLORE	Vellore	729.14	1
KANCHIPURAM	Kancheepuram	596.07	2
TIRUVANNAMALAI	Tiruvannamalai	574.00	3
VILLUPURAM	Viluppuram	535.15	4
VELLORE	Gudiyatham	528.93	5
KANCHIPURAM	Maraimalainagar	470.62	6
KANCHIPURAM	Chengalpattu	411.07	7
VELLORE	Vaniyambadi	409.79	8
VELLORE	Arakonam	399.10	9
VELLORE	Ambur	393.21	10
VELLORE	Tirupathur	372.51	11
VELLORE	Walajapet	365.09	12
VELLORE	Ranipettai	360.89	13
VILLUPURAM	Tindivanam	351.48	14
KANCHIPURAM	Urapakkam	307.68	15
VELLORE	Arcot	306.65	16
THIRUVALLUR	Tiruttani	306.61	17
TIRUVANNAMALAI	Arani	303.72	18
THIRUVALLUR	Thiruvallur	301.37	19
KANCHIPURAM	Nandivaram - Guduvancheri	295.11	20
VILLUPURAM	Kallakurichi	291.80	21
VELLORE	Dharapadavedu	289.67	22
KANCHIPURAM	Maduranthakam	272.04	23
VELLORE	Sathuvachari	266.14	24
KANCHIPURAM	Mangadu	258.88	25
KANCHIPURAM	Sevilimedu	256.92	26
VILLUPURAM	Chinnasalem	255.88	27
KANCHIPURAM	Kundrathur	255.11	28
VELLORE	Pernampattu	251.05	29
VELLORE	Jolarpet	249.11	30
KANCHIPURAM	Sriperumbudur	243.21	31
THIRUVALLUR	Minjur	241.90	32
THIRUVALLUR	Ponneri	239.78	33
TIRUVANNAMALAI	Tiruvethipuram	235.61	34
VELLORE	Sholingur	234.28	35
TIRUVANNAMALAI	Vandavasi	232.40	36
TIRUVANNAMALAI	Polur	230.62	37
VELLORE	Melvisharam	230.40	38
THIRUVALLUR	Vengathur	223.81	39
VELLORE	Palavansathu	215.39	40
VELLORE	Allapuram	206.38	41
VILLUPURAM	Kottakuppam	204.32	42
VELLORE	Katpadi	202.98	43
KANCHIPURAM	Polichalur	200.63	44
VILLUPURAM	Tirukkoyilur	196.30	45
VILLUPURAM	Ulundurpettai	196.28	46
VELLORE	Pallikonda	194.55	47
KANCHIPURAM	Tirukalukundram	189.19	48
THIRUVALLUR	Pothatturpettai	173.37	49
KANCHIPURAM	Uthiramerur	170.21	50

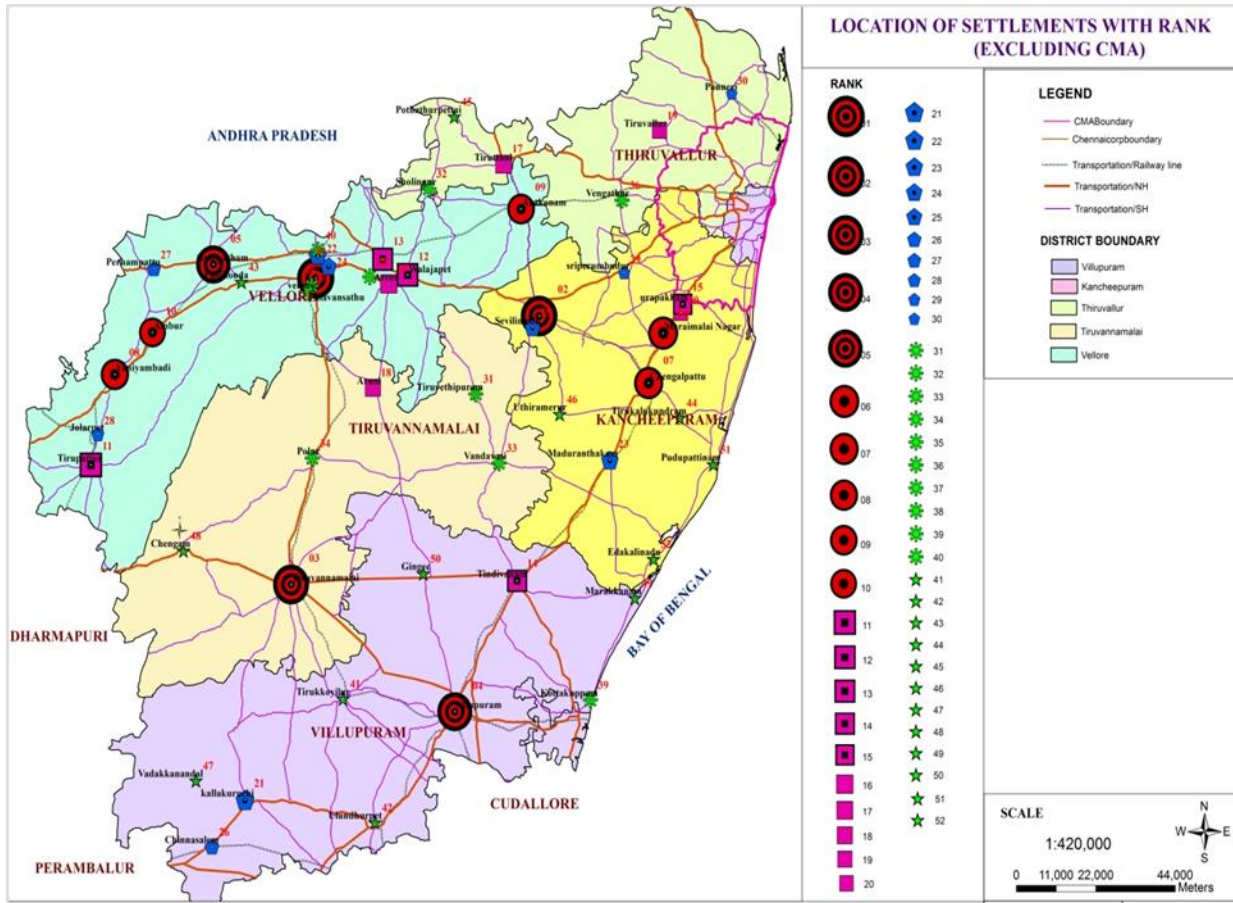


Figure-6 Location of settlements with ranking (excluding CMA)

Refer Figure-6 to view the location of top 50 settlements excluding CMA based on functional index scoring and observe the line chart in Figure-7 to know the top 20 settlements where there is sudden decrease from vellore to other centres which shows the potentiality of vellore centre.

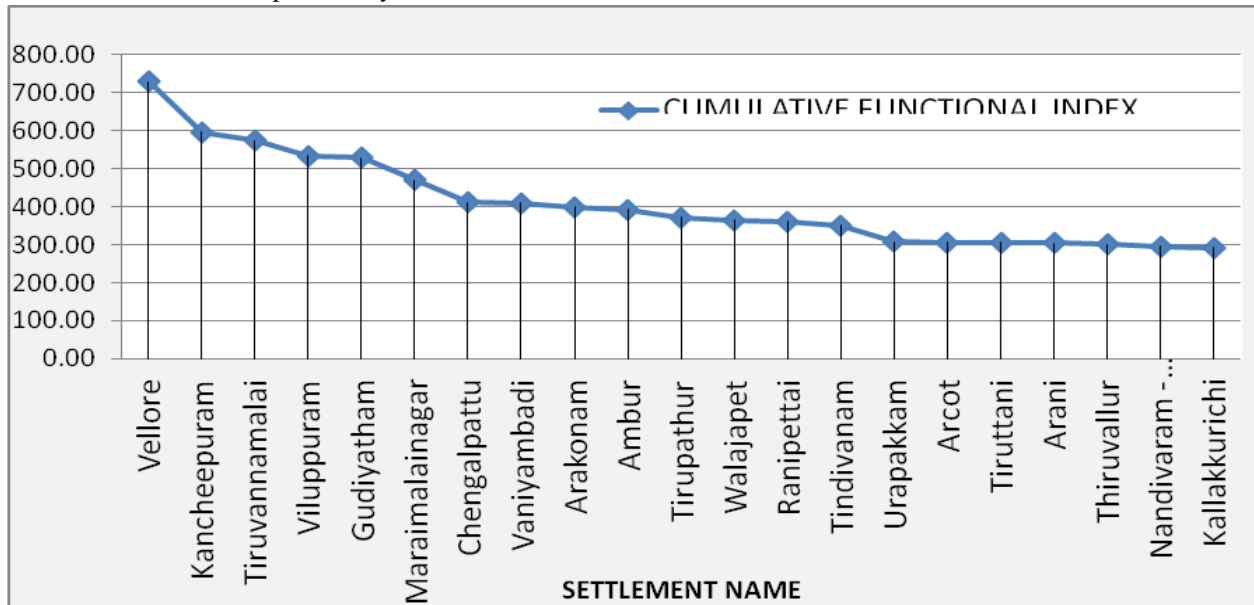


Figure-7 Top 20 settlements based on functional importance scoring

METHOD AND RESULTS TO CALCULATE THE SPHERE OF INFLUENCE FOR THE IDENTIFIED SETTLEMENTS BASED ON CENTRALITY SCORE

The zone of influence of each town of hierarchical order has been delineated using modified quantitative technique devised by V.L.S. Prakash Rao (Lokhande and Pawar 2004) referred in the literature by Mr.Julfikar ALI which are as follows:

$$S.I. = TCA/C$$

$$R = \sqrt{(TCA/c)}$$

Where, S.I. = Sphere of Influence of central place (sq. km.), TC = Total Centrality score of central place, A =

Total area (sq. km) of the study region, C = Total centrality score of all central places, and R = Radius of circle indicating the sphere of influence (km.)

For calculating the centrality score the parameters considered are Proximity to Industrial estates and large and medium scale industries (A15) and utilities and services (A12, A13, A14). Refer Figure- 8 to know the location of industrial estates and large and medium scale industries within the region and also its influence rings from 5 km to 30 km range. The settlements fall within the rings have been scored based on its proximity which are shown in table 3. The top 20 settlements are scored based on the scoring in table 3.

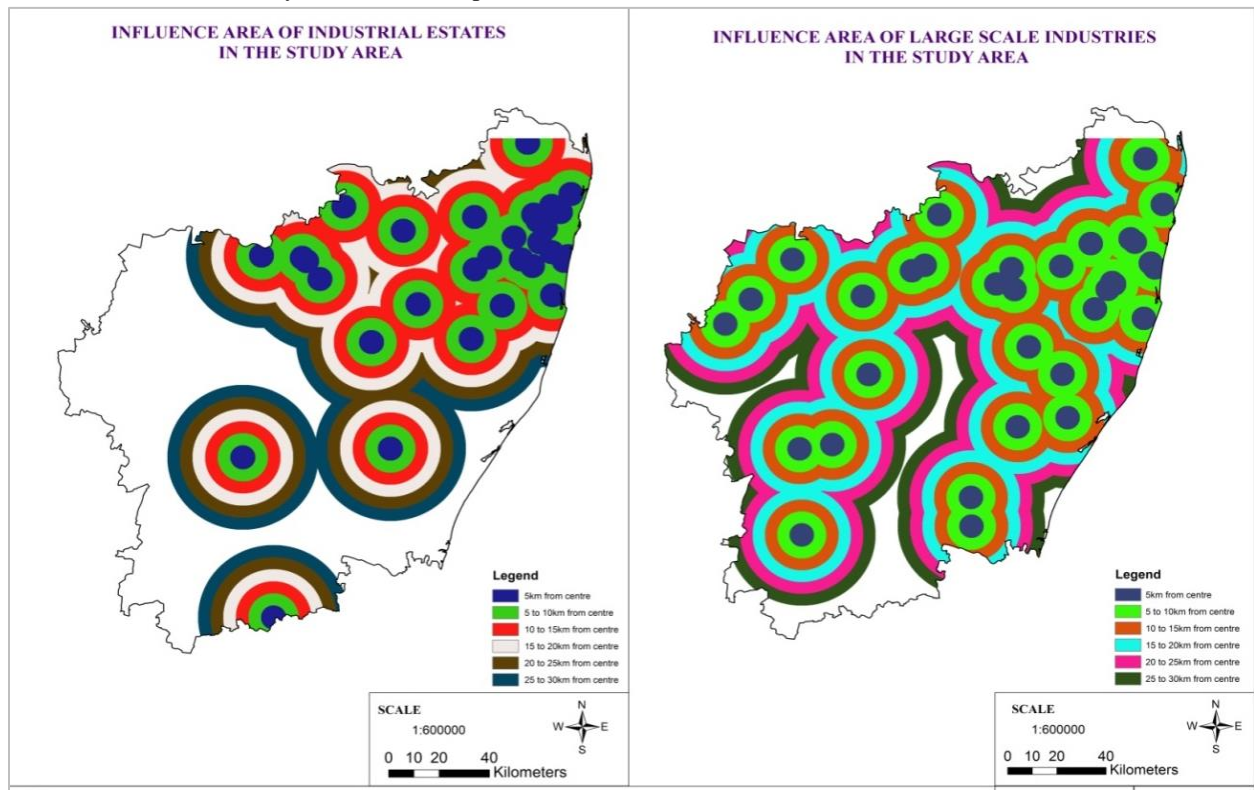


Figure 8- Influence ring of Industrial estate and Large & medium scale industries

Scoring for the top 25 settlements has been based on proximity to Industrial estates and large & medium scale industries for calculation of P.I value for A15.

Table 3 - Scoring based on proximity to Industrial estate and Large & medium scale industries

Location of settlements within (km)	Score
0-5	60
5-10	50
10-15	40
15-20	30
20-25	20
25-30	10

Total area of study region

27099

Sq.km

Total centrality score of all centres

1906.5

Table 4 -Centrality score and sphere of influence of centres

S.No	District	Name of the settlement	P.I (A12)	P.I (A13)	P.I (A14)	UTILITIES AND SERVICES	PROXIMITY TO I.E & LM	P.I(A15)	TOTAL CENTRALITY SCORE	S.I	RADIUS
1	CHENNAI	CHENNAI	100.0	100.4	100.00	300.4	100	80	380.4	5591.52	75
2	VELLORE	Vellore	1.5	17.1	6.09	24.7	90	70	94.7	1391.73	37
3	KANCHIPURAM	Kancheepuram	2.3	5.9	2.55	10.7	110	90	100.7	1480.52	38
4	TIRUVANNAMALA	Tiruvannamalai	6.8	2.2	2.55	11.6	110	90	101.6	1493.3	39
5	VILLUPURAM	Viluppuram	3.8	3.6	3.93	11.3	50	30	41.3	607.609	25
6	VELLORE	Gudiyatham	0.8	1.0	1.77	3.6	70	50	53.6	787.444	28
7	KANCHIPURAM	Maraimalainagar	6.8	0.1	0.39	7.3	120	100	107.3	1577.07	40
8	KANCHIPURAM	Chengalpattu	3.0	4.2	1.18	8.4	100	80	88.4	1298.8	36
9	VELLORE	Vaniyambadi	4.5	0.9	1.38	6.8	60	40	46.8	688.229	26
10	VELLORE	Araonam	6.8	0.6	0.98	8.4	90	70	78.4	1152.34	34
11	VELLORE	Ambur	1.5	1.9	1.38	4.7	60	40	44.7	657.638	26
12	VELLORE	Tirupathur	2.3	1.0	1.57	4.8	20	0	4.8	70.6974	8
13	VELLORE	Walajapet	1.5	0.7	0.20	2.4	120	100	102.4	1504.99	39
14	VELLORE	Ranipettai	1.5	1.8	0.79	4.1	110	90	94.1	1383.33	37
15	VILLUPURAM	Tindivanam	3.0	1.3	1.38	5.7	100	80	85.7	1259.83	35
16	KANCHIPURAM	Urapakkam	1.5	0.0	0.00	1.6	110	90	91.6	1345.77	37
17	VELLORE	Arcot	1.5	0.7	0.98	3.2	120	100	103.2	1516.3	39
18	THIRUVALLUR	Tiruttani	2.3	0.3	0.59	3.1	60	40	43.1	634.167	25
19	TIRUVANNAMALA	Arani	0.8	0.7	1.38	2.8	40	20	22.8	335.379	18
20	THIRUVALLUR	Thiruvallur	0.0	0.4	0.98	1.4	60	40	41.4	608.073	25
21	KANCHIPURAM	Nandivaram -	1.5	0.0	0.00	1.5	110	90	91.5	1345.18	37
22	VILLUPURAM	Kallakurichi	1.5	2.2	1.38	5.1	40	20	25.1	368.388	19

Refer table 4 to know the centrality score, Sphere of influence and influence radius for top 20 settlements.

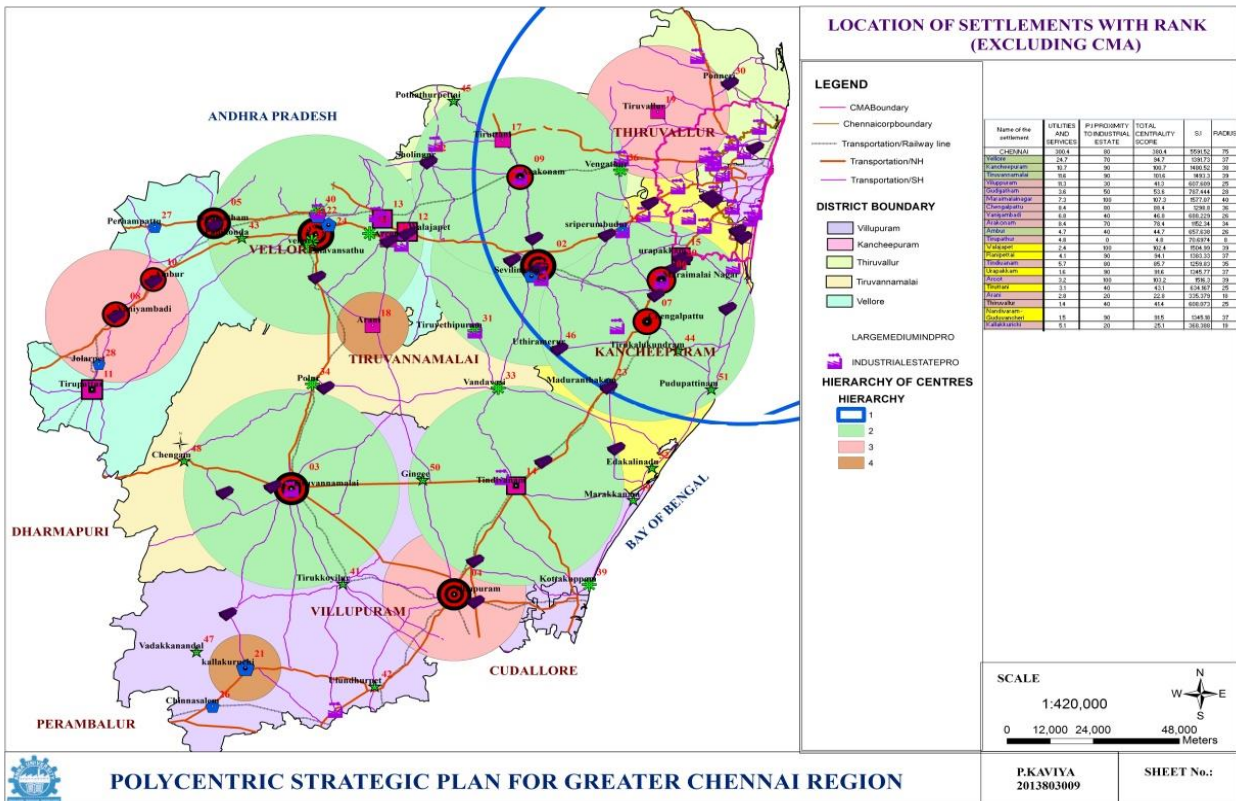


Figure 9- Polycentric Model for the region IDENTIFIED POLYCENTRES WITH SCORES AND FINDINGS

Based on the rank, spatial distribution of settlement and sphere of influence, with the aim of serving the entire region following settlements has been identified as centres of the polycentric model for the region listed in table 5 and shown in Fig. 9.

Table 5: Identified Poly-centres of the model and their scoring

Settlement name	Total Functional importance score (P.I A1+...A15)	Rank	Centrality score (P.I A12+...A15)	Influence radius (Km)
Vellore	799.14	1	94.7	37
Kanchipuram	686.07	2	100.7	38
Tiruvannamalai	664.00	3	101.6	39
Villupuram	565.15	4	41.3	25
Chengalpattu	491.07	7	88.4	36
Arakonam	469.10	8	78.4	34
Vaniyambadi	449.79	9	46.8	26
Tindivanam	431.40	14	85.7	35
Tiruvallur	361.37	19	41.4	25
Kallakurichi	331.80	18	25.1	19
Arani	323.72	21	22.8	18

Some settlements with lower scores such as Kallakurichi, Arani, Tindivanam and Tiruvallur have been selected as proposed nodes of polycentric model to have spatially balanced distribution of centres and to have overall balanced regional development, Fig.9 shows the hierarchy of identified potential Urban Nodes for the GCMR.

HIERARCHY OF CENTRES BASED ON INFLUENCE RADIUS

Based on the radius of influence ring, the settlements have been classified under four hierarchies as shown in table 6 and figure 10. The influence radius based on centrality score i.e utilities and services, Proximity to Industrial estates and large scale industries

Table 6- Hierarchy of centres based on Influence ring

Hierarchy of Settlement	Influence radius (Km)	Settlement name
1 st order	75	Chennai
2 nd order	30-40	Vellore, Kancheepuram, Arakonam, Chengalpattu, Tiruvannamalai and Tindivanam
3 rd order	20-30	Vaniyambadi, Villupuram and Tiruvallur
4 th order	10-20	Kallakurichi and Arani

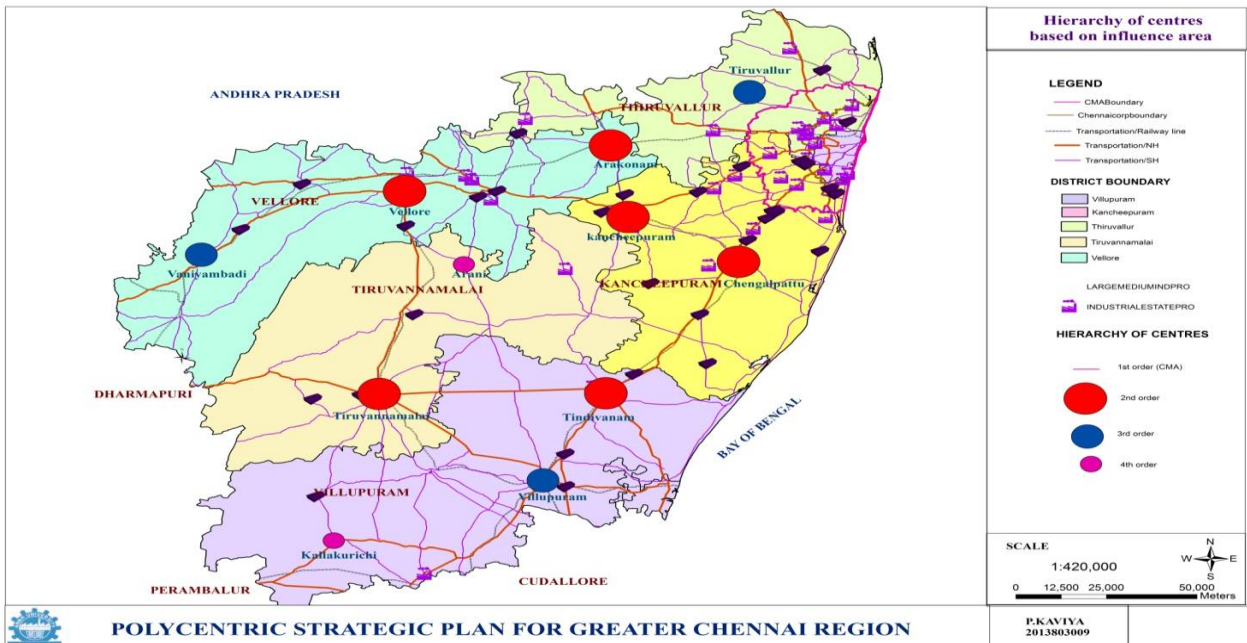


Fig. 10 Hierarchy of centres based on influence area

Since there is vast variation between the 1st hierarchy (CMA) and other hierarchy centres, overcrowding ill-effect happens in CMA. Hence all the identified 2nd order centres need some strategies, policies and proposals for up gradation to act as a pulling magnet for the migrants towards CMA and to bring the overall regional development. Especially proposed nodes need induced development through strategies and proposals for up gradation. Then only the Polycentric

model will be a successful one which brings overall regional development.

HIERARCHY OF SETTLEMENTS BASED ON FUNCTIONAL IMPORTANCE SCORING

Based on the Functional Importance score, the selected centres of polycentric model has been classified under four hierarchical order shown in table 7. It is based on all the fifteen parameters considered.

Table 7- Hierarchy of centres based on functional importance scoring

Hierarchy of Settlement	Functional Score range	Settlement name
1 st order	750-900	Vellore
2 nd order	600-750	Kanchipuram, Tiruvannamalai
3 rd order	450-600	Villupuram, Chengalpattu, Arakonam, Vaniyambadi,
4 th order	300-450	Tindivanam, Tiruvallur, Kallakurichi, Arani

Table 7 shows that, functionally there exists unbalanced distribution of centres in the region. So, there is a need to analyse the Potential of the centres and to strengthen the centres through strategies, Policies and Proposals.

GENERAL POLICY FRAMEWORK FOR A SUCCESSFUL MODEL

Following policies and strategies are necessary to make the model successful one to serve the overall regional development:

- a) Constitution of Regional Development Authority
- b) Formulation of policy framework for Regional Economic promotion, Livelihood enhancement activities in the identified centres through the analysis of available potentiality and suitability of the centres.
- c) Preparation of Master plan and detailed development plan for the development of identified centres by the respective Planning Authorities.
- d) Up-gradation of physical and social infrastructure in the nodes through detailed analysis of nodes

CONCLUSION

Chennai is the one of the Mega City in India, which needs more focus on regional aspect, as like other Megacities. Even though many regional level projects and plans like satellite town formulation, Outer ring road, Industrial parks etc have been proposed and implemented, still Chenna is facing the overcrowding issues which evident the fact that mere expansion of cities and related proposals will not resolve the issue such as over concentration of population, haphazard developments and activities in the region. Majority of

investment for urban development in Tamil Nadu is pumped into Chennai for development of economic and social infrastructure such as transportation, housing, sanitation and water supply and employment generation. Consequently, the skewed pattern of investment has a counterproductive effect in the sense it attracts more migrants into the City. Therefore, the right strategy is to make investments in the identified potential urban nodes and to freeze any more development within the core City and City expansion area. This is precisely what has been proposed in the present study of polycentric approach for decentralization of the City. The proposed Greater Chennai Region by the Chennai Metropolitan Development Authority includes only Kancheepuram and Thiruvallur Districts, which already forms part of the Chennai Metropolitan Area. Therefore, the GCMR proposed by the study embracing three more adjoining districts such as Vellore, Tiruvannamalai and Villupuram would better facilitate the balance pattern of the Region.

In addition to above discussed Polycentric proposal for GCMR, the successful completion and implementation of ongoing projects & proposals such as ‘Regional Plan preparation for eight regions across Tamil Nadu’ by Tamil Nadu Government & formation of regional planning authorities for the same and industrial park development in many spots across Tamil Nadu would definitely create more counter magnets and helps to arrest migrants towards Chennai

region and leads to have balanced development across Tamil Nadu.

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