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Visual analysis of geospatial habitat suitability model based on inverse distance weighting with paired comparison analysis

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Abstract Geospatial data analytical model is developed in this paper to model the spatial suitability of malaria outbreak in Vellore, Tamil Nadu, India. In general, Disease control strategies are only the spatial information like landscape, weather and climate, but also spatially explicit information like socioeconomic variable, population density, behavior and natural habits of the people. The spatial multi-criteria decision analysis approach combines the multi-criteria decision analysis and geographic information system (GIS) to model the spatially explicit and implicit information and to make a practical decision under different scenarios and different environment. Malaria is one of the emerging diseases worldwide; the cause of malaria is weather & climate condition of the study area. The climate condition is often called as spatially implicit information, traditional decision-making models do not use the spatially implicit information it most often uses spatially explicit information such as socio-economic, natural habits of the people. There is need to develop an integrated approach that consists of spatially implicit and explicit information. The proposed approach is used to identity an effective control strategy that prevents and control of malaria. Inverse Distance Weighting (IDW) is a type of deterministic method used in this paper to assign the weight values based on the neighborhood locations. ArcGIS software is used to develop the geospatial habitat suitability model.

Keywords Visual analysis · Geospatial analytical model · Habitat suitability · Inverse distance weighting · Spatial modeling · Paired comparison analysis

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1 Introduction

Geospatial data analytics play an essential role in prevention and control of various diseases. Geospatial data model consists of landscape, climate and elevation and so on [24, 26, 29]. This type of model is also used to develop the risk maps for the areas which are likely to get more infection compare to other neighboring locations. Image processing is also used to process the geospatial data [17, 20, 26]. In general, image processing methods are widely used in many applications it includes healthcare, restorations and enhancements, movie maker, color code processing, pattern recognition, robot vision and remote sensing. Nowadays, image processing plays a vital role in various applications to make the decisions and solve various issues in day-to-day life. In general, image processing methods have been used in medical fields for disease diagnosis, clinical care and other healthcare services. Image enhancement is widely used to improve the quality of the image generated from various sources. In general, image enhancement methods are also called as image editors. Image processing software's and tools are used to manipulate the images [43]. For example, image enhancement is often used to increase and decrease the contrast of a digitally stored image. Image contrast plays a vital role in extracting important features for decision making in various fields it includes disease diagnosis, change detection, feature selection and pattern mining. Image contrast is considered as an essential key to deciding the image quality. Image contrast is determined by the variation between the brightness and visual color of two different objects [44]. Nowadays, various image enhancement algorithms are developed to change the contrast of an image. Image enhancement is also used to alter the images with advanced filters and feature extraction methods. In other words, the essential role of an image enhancement technique is to modify or alter the existing image for a given task. It is observed that various image enhancement methods are available to modify a digital image without destroying its originality and features. Geospatial data is collected from various satellites and remote sensing software's to analyze the spatial distribution of various features. In this paper, ArcGIS software is used to analyze the geospatial data to model the malaria outbreak.

This paper focused on the responsibility of multi-criteria decision analysis in geographical information systems under multi-attribute decision analysis. Our proposed spatial multi criteria decision analysis (SMCDA) is used to identify a suitable land area for the occurrence of malaria. In addition, the proposed geo-spatial based multi-criteria decision analysis is used to make an effective control strategy for the outbreak of malaria in Vellore, Tamil Nadu, India. Data of malaria were obtained from the Directorate of Health Services, National Informatics Centre, Vellore with the official permission from Director of Health Services, Tamil Nadu. Arc GIS 10.2 is used to model the suitability of malaria in Vellore [15]. Weighted overlay and inverse distance weighting techniques are used to find the suitable land parcels. U.S. National Weather Service has invented a deterministic method called IDW at 1972. Inverse Distance Weighting (IDW) is a type of deterministic method, it assigns the weight values based on the neighborhood location and its values [21]. IDW method is dissimilar to GPR and Kriging approaches. Kriging is a type of interpolation method to model probability distribution based on the mean and covariance. Recently, many researchers from various environments have used Kriging to model the emerging diseases. For example, Olaf Berke et al., (2004) have used Kriging for choropleth disease mapping [3].

In addition to choropleth disease, more number of spreading diseases is spatially correlated to the neighborhood locations. For example, vector-borne and zoonotic diseases occur based on the presence of animal hosts, pathogens and susceptible human populations overlap [36].

The minimum temperature and specific humidity are most often considered as significant parameters to model the swine flu [8]. Similarly, Xiao H et al., 2013 have identified dryness, low wind speed and high-pressure are the significant factors for swine flu outbreak in Changsha, China [45]. In this paper the proposed SMCDA model uses demographic data, weather & climate data and socio economic variables to model the malaria outbreak in Vellore district, Tamil Nadu, India. We conclude that our spatial multi criteria decision making model outperform well for developing decision making rules in public health. Fig 1 represents the traditional decision making process. The structure of the study is described as follows: section 1 and section 2 describe the recent work in habitat suitability model. Section 3 describes the study area and data source. The proposed framework is represented in section 4. Results are discussed in section 5. Finally, section 6 concludes the work.

2 Related work

Multi criteria decision making (MCDM) is used to solve various decision making problems in complex environments. Qualitative and quantitative evaluation criteria's are used in the MCDM model to find the compromise solution to solve any kind of problem. Nowadays, decision making plays a vital role in public health and human life. For example, new emerging diseases such as Ebola and Zika are considered as major issues in human health. In addition, reemerging diseases such as Malaria, Dengue and Chikungunya are also considered as significant problem in all over the world. In recent years, many researchers are used MCDM models to prevent and control of emerging and reemerging diseases [2, 9, 32, 37]. In order to select best alternative from multiple alternatives with various criteria's, the following MCDM models are widely used such as Grey System Theory (GST), Analytic Goal Programming (GP), Network Process (ANP), Multi-Attribute Value Theory (MAVT), Analytic Hierarchy Process (AHP), Data Envelopment Analysis (DEA) and many others. Thomas L. Saaty has originally developed AHP model to solve composite decision making problems. In general, AHP often used to formulate a decision in contractor prequalification [1].
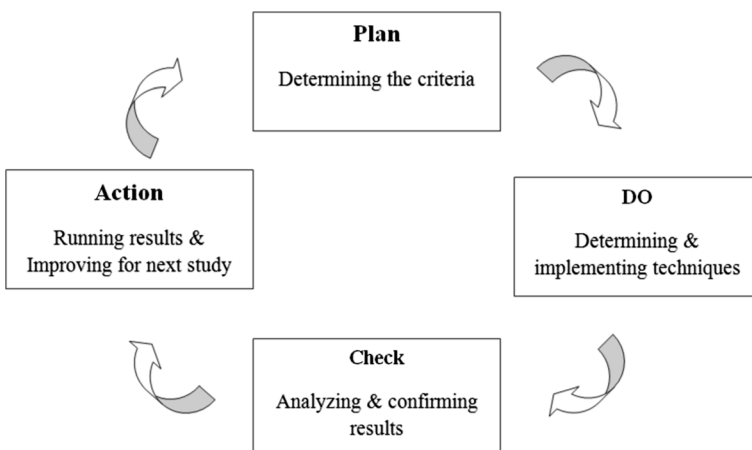
Fig. 1 Traditional decision making process

ANP works as similar to AHP but the difference is AHP always form a hierarchy with an end whereas ANP often forms a network [22]. DEA is often used to monitor various functions of an organization. For example, DEA is used recently to schedule and monitor the bridge maintenance functions [35]. Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is used to make a better decision based on the geometric distance between the events [40]. In addition, Grey System Theory (GST) is also considered as an effective solution and it is developed based on the differential equations to evaluate decisions. Recently, hybrid decision-making model is developed based on the above mentioned MCDM models [14]. Opricovic has originally developed VIKOR (VIsekriterijumska optimizacija iKOmpromisno Resenje) MCDM method to identify compromise solution from various contradictory criteria's [34]. VIKOR method identifies the individual regret values and compromises solution to achieve better decision [42]. Nowadays, there is a need to develop a decision-making model that process and solve uncertainty, especially in biology and medicine. In general, disease diagnosis and epidemiological analysis have a high level of uncertainty and ambiguity [4]. For example, various diseases may have the different impact on different people. In addition, due to the level of immunization every individual may feel different symptoms for the same disease. This variation would degrade the performance of disease diagnosis based on symptoms [18, 19, 28]. AHP method is used in this paper to solve imprecision and uncertainty problems in decision making. Figure 2 represents the classification of decision making and number of publications in each type.

Spatial Multi-criteria decision analysis (SMCDA) approach combines the Multi-criteria decision analysis (MCDA) and geographic information system (GIS) to model the spatially explicit and implicit information and to make an effective decision under different scenarios and different environment. SMCDA is widely used in many application it include vector born and air born diseases [13, 25, 27], not only disease modeling but also land suitability modeling for hillside development [6, 30, 31, 41], flood monitoring [46], Moose modeling [11], wild goat (*Capra aegagrus*) modeling in a mountainous arid area [39], United state rivers modeling [12], Asian elephant [38], walleye modeling in the Sandusky River [10] and Grassland bird [16].
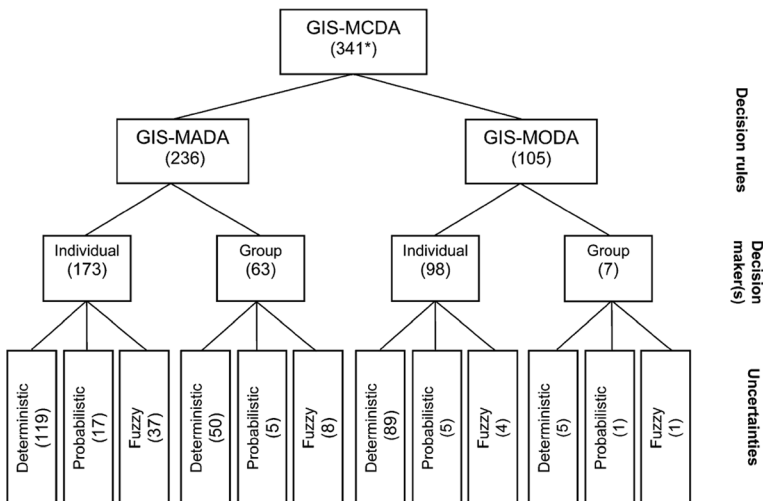

Fig. 2 Classification of decision making and number of publications in each type

3 Data source and study area

The climatic conditions for each block in Vellore district is collected from the Vellore agriculture department. Malaria incidence data is collected from National Informatics Center (NIC), India. Table 1 depicts the climatic and number of infected people for each block in Vellore district. Figure 3 depicts the raster file for the number of infected (malaria) individuals from August 2009 to July 2010 in the study area of Vellore district; it is the one of the states in Tamil Nadu, India. Figure 4 represents the weather data used in the proposed geo-spatial analytical framework.

4 Proposed framework

The Geo-spatial data model is used to model the disease prevalence and spatial concentration of disease risk, which is not given any absolute solution for the decision makers to control the disease. Disease control strategies must be considered not only the spatial information like landscape, weather and climate, but also spatially explicit information like socioeconomic variable, population density, behavior and natural habits of the people. There is need to develop an integrated approach that consists of spatially implicit and explicit information to identity an effective control strategy that prevents and control of emerging infectious disease in a traditional world.

Decision making is a set of organized procedures used to analyze the complex problems in any environment. In order to visualize the suitable area to get malaria, the proposed geospatial analytical framework is used with IDW method. Proposed geospatial analytical framework is represented in Fig. 5. Multi-criteria decision analysis is a decision-making framework that allows the policy makers to make an effective decision with qualitatively and quantitatively. There is a need to develop an efficient decision-making system that controls the spreading diseases. Malaria is one of the emerging diseases worldwide; the root cause of malaria is weather & climate condition of the study area. The climate condition is often called as spatially implicit information, traditional decision-making models do not use the spatially implicit

Table 1 Rank assignment based on significant variables

Variable	Definition	P Value	Initial Rank
A2	Age 21–40	0.010	1
TP	Temperature	0.011	2
A3	Age > 40	0.022	3
WS	Wind speed	0.023	4
PD	Pop Density	0.042	5
RF	Rainfall	0.055	6
HM	Humidity	0.063	7
A1	Age < 20	0.075	8
SM	Smoking	0.078	9
AL	Alcoholic	0.088	10
DB	Diabetics	0.134	11
WZ	Wheezing	0.231	12

Weights w is calculated by, weights $w = \frac{Variable\ rank\ total}{Total\ rank}$
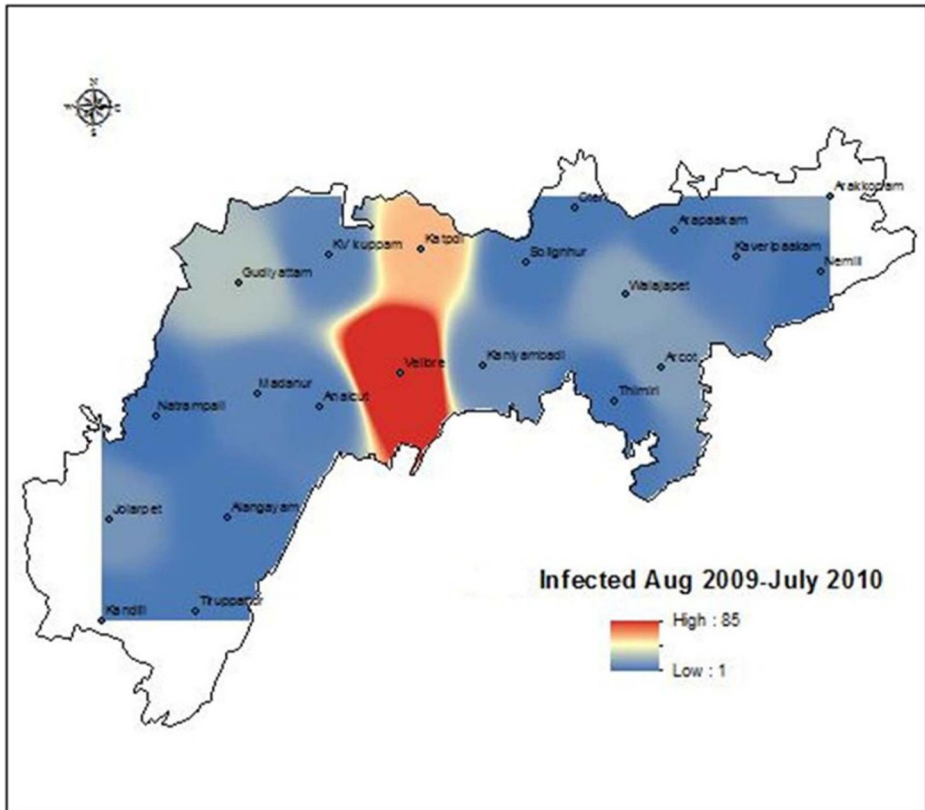
Fig. 3 Malaria incidence data from August 2009–July 2010

information it most often uses spatially explicit information such as socioeconomic, natural habits of the people. A geographic information system (GIS) is an emerging technology worldwide that mainly focused on gathering, storing, manipulating, managing and analyzing all types of geographic data (weather & climate). Geographical

FID	Shape *	NAME_3	Infected	Population	MaxTemp	MinTemp	MaxHum	MinHum	WindSpeed	RainFall
0	Polygon	Nemili	1	70983	28.9	24.35	68.87	64.98	7	123
1	Polygon	Thimiri	1	65459	35.27	24.32	68.87	64.65	6	125
2	Polygon	Katpdi	32	83065	29.2	29.2	66.34	61.12	7	239
3	Polygon	Tiruppattur	2	99845	31.23	23.9	68.46	64.32	7	156
4	Polygon	Natrampali	1	47631	31	24.11	68.46	64.34	5	135
5	Polygon	Vellore	85	180083	29.32	20.12	67.26	61.03	8	254
6	Polygon	Walajapet	10	105704	28.22	20.34	67.24	61.24	6	225
7	Polygon	Kandili	2	66515	28.12	22.87	67.32	63.74	6	158
8	Polygon	Jolarpet	7	85585	33.54	21.32	67.81	62.56	6	207
9	Polygon	Alangayam	2	104768	28.23	23.33	66.54	64.32	7	163
10	Polygon	Madanur	4	96068	27.4	22.12	67.22	63.56	8	194
11	Polygon	Gudiyattam	15	125312	31.23	20.33	67.34	61.21	6	229
12	Polygon	KV kuppam	4	59153	30.1	22.13	67.21	63.21	8	197
13	Polygon	Solignhur	2	67482	28.3	23.76	66.34	64.21	7	168
14	Polygon	Oteri	2	54634	26.34	22.45	66.27	64.32	8	177
15	Polygon	Anaicut	3	72578	27.34	22.87	67.28	63.45	7	185
16	Polygon	Kaniyambadi	6	54975	28.34	20.98	67.23	62.32	7	204
17	Polygon	Arcot	9	89309	29.34	21.33	66.7	62.38	5	215
18	Polygon	Arapaakam	2	34523	28.3	20.56	66.48	64.31	6	179
19	Polygon	Kaveripaakam	3	79913	28.3	21.34	66.32	62.98	6	189
20	Polygon	Arakkonam	9	80117	28.34	20.56	66.83	61.45	6	217

Fig. 4 Weather data
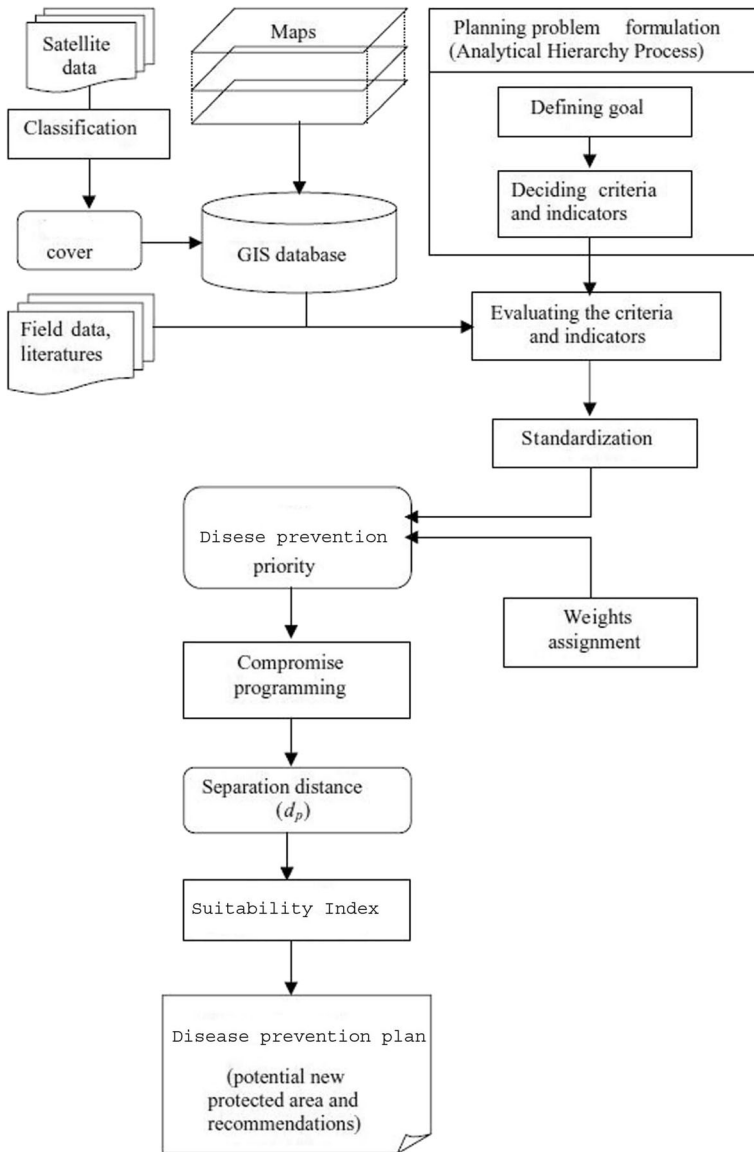
Fig. 5 Proposed geospatial analytical framework

Information Systems (GIS) is used to map and visualize the epidemic spread in a particular location. In recent years, a number of technologies has developed to find the suitable areas for the occurrence of emerging epidemic diseases. Remote Sensing and Geographical Information Systems (GIS) are the familiar techniques used to map the epidemic spread and spatial modeling of emerging diseases.

Spatial statistics and spatial autoregressive algorithms use spatial weight matrix to find the relationship between the neighborhood locations. Figure 6 represents an example of contiguity matrix. The spatial location and its weight matrix are shown in Fig. 7.
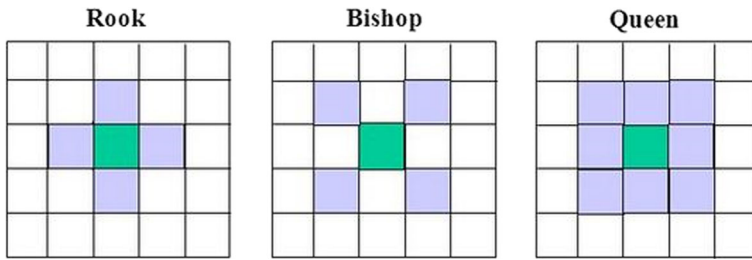
Fig. 6 Contiguity matrix

The standardized weight matrix W^* for the Fig. 6 can be represented as follows,

$$W^* = \begin{bmatrix} 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 1/2 & 1/2 & 0 & 0 \\ 1/3 & 0 & 1/3 & 1/3 & 0 \\ 1/3 & 1/3 & 0 & 1/3 & 0 \\ 0 & 1/3 & 1/3 & 0 & 1/3 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0.5 & 0.5 & 0 & 0 \\ 0.33 & 0 & 0.33 & 0.33 & 0 \\ 0.33 & 0.33 & 0 & 0.33 & 0 \\ 0 & 0.33 & 0.33 & 0 & 0.33 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix}$$

5 Result and discussion

5.1 Weight calculation based on Paired comparison analysis (PCA)

Weights are used to rank the significant parameters to get malaria. The initial weights are calculated using paired comparison analysis. The paired comparison analysis is significantly used to rank the parameters when choices are quite different from one another. In addition, paired comparison analysis is also used when decision criteria's are subjective. Paired Comparison Analysis is an effective solution when decision options are relative to one another. Thus the proposed geospatial based analytical framework uses Paired Comparison Analysis to compute the initial rank. The calculated rank is depicted in Table 1. It is observed that temperature plays a major role among the population aged above 40 and 20–40 respectively. In addition, wind speed, rainfall and population density are also impact more on malaria transmission. Paired comparison and calculated weights are tabulated in Tables 2 and 3 respectively.

5.2 Weighted overlay analysis

Figure 8 represents the raster images of various climatic conditions such as maximum and minimum temperature and humidity, rainfall, wind speed and demographical variables of malaria outbreak in
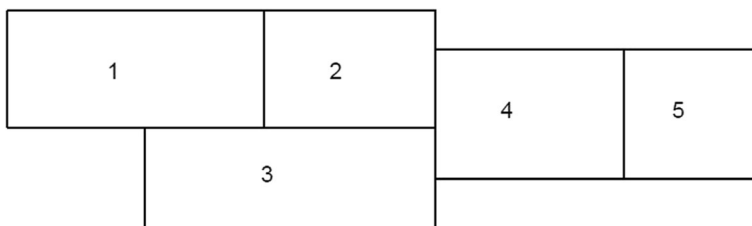

Fig. 7 Example spatial location

Table 2 Paired wise comparison

	TP	HM	WS	RF	PD	A1	A2	A3	SM	AL	DB	WZ
TP		TP,5	TP,2	TP,4	TP,3	TP,6	A2,1	TP,1	TP,7	TP,8	TP,9	TP,10
HM			WS,3	RF,1	PD,2	HM,1	A2,4	A3,5	HM,2	HM,3	HM,4	HM,5
WS				WS,2	WS,1	WS,5	A1,4	A3,1	WS,4	WS,5	WS,6	WS,7
RF					PD,1	RF,2	A2,5	A3,3	RF,3	RF,4	RF,5	RF,6
PD						PD,3	A2,5	A3,3	PD,4	PD,5	PD,6	PD,7
A1							A2,7	A3,5	A1,1	A1,2	A1,3	A1,4
A2								A2,2	A2,8	A2,9	A2,10	A2,11
A3									A3,6	A3,7	A3,8	A3,9
SM										SM,1	SM,2	SM,3
AL											AL,1	AL,2
DB												DB,1
WZ												

Vellore, Tamil Nadu, India. Table 3 depicts the influence of various parameters to model the malaria outbreak. The results generated from Table 3 states that population and rainfalls have the highest influence on malaria outbreak. The influence parameters are used to develop the habitat suitability model for malaria in Vellore, Tamil Nadu, India. Figure 8 represents the raster images of climatic conditions like maximum and minimum of temperature and humidity, rainfall, wind speed. The raster images also contain population, demographical data of malaria in Vellore district. Figure 9 represents a habitat suitability model for malaria in Vellore, Tamil Nadu, India.

5.3 Habitat suitability model based on inverse distance weighting (IDW)

Habitat suitability model is used to identify the land parcels where the malaria outbreak is more likely to happen. Inverse Distance Weighting (IDW) and Weighted Overlay functions are primarily used to find the most suitable spatial locations for the occurrence of the malaria epidemic [23, 47]. Interpolation refers to the property of a point j, P_j, depend upon the measured values for each locations j. Interpolating methods are used analyze the randomly distributed data in the geospatial environment. Interpolating methods are classified as the global method and local method [5, 33]. Global methods use known values to find the unknown value whereas in local methods the unknown value is identified based on the specified number of nearest neighbors [7].

Table 3 Weight calculation

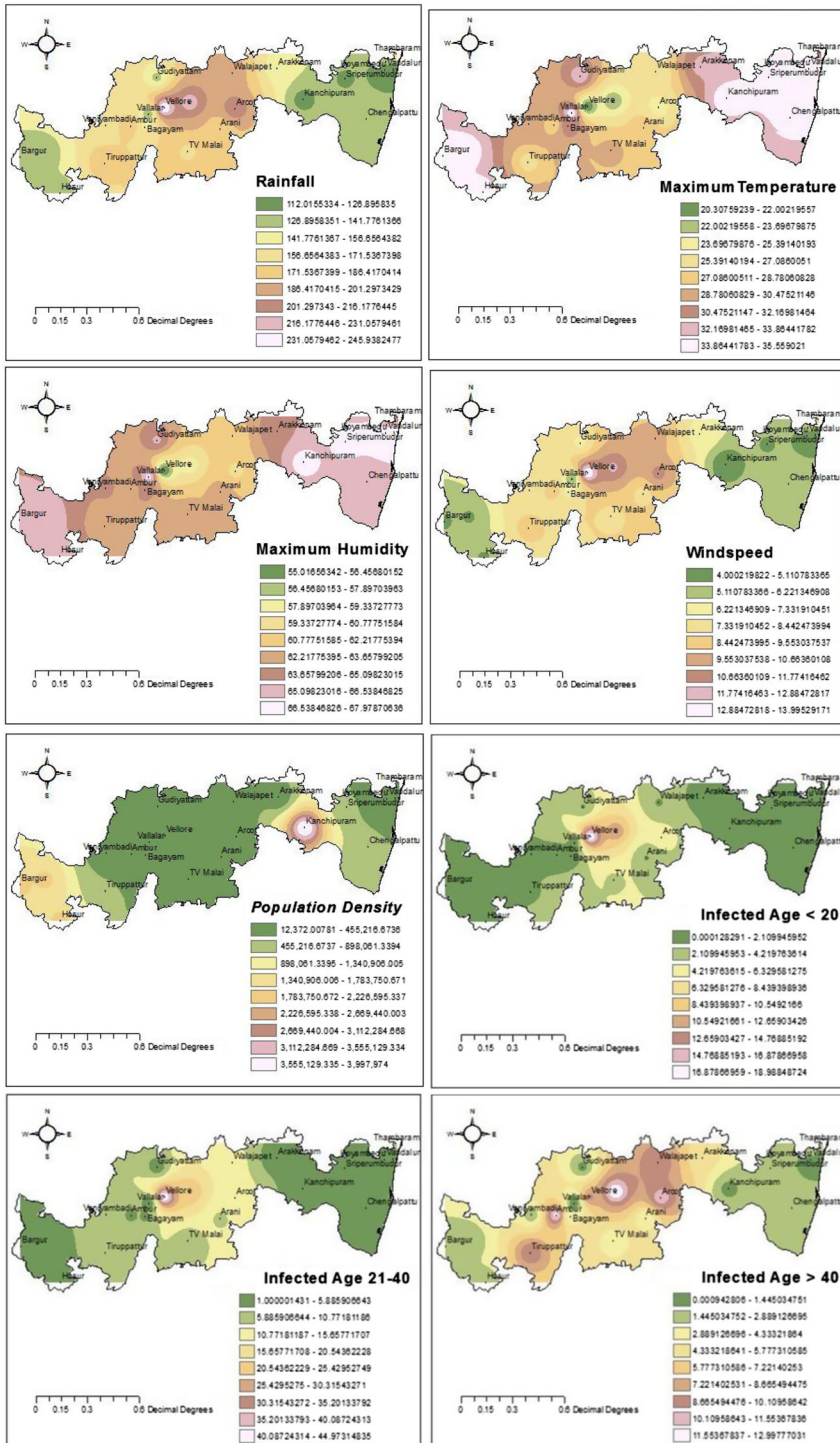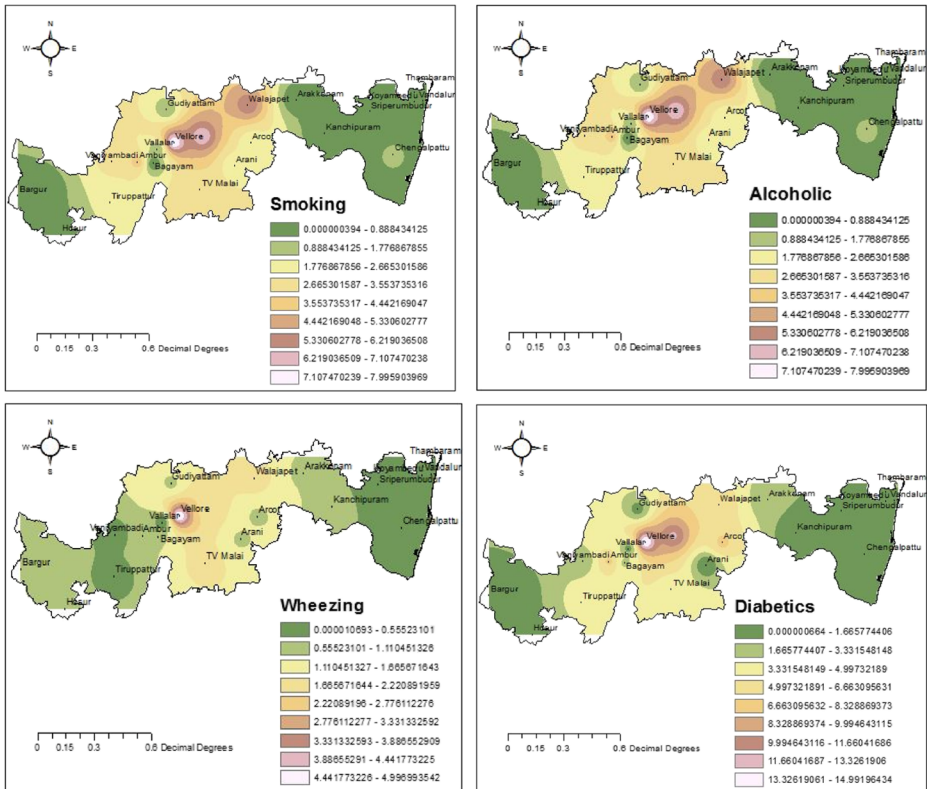| Variable	Definition	Variable Rank Total	Percentage	Weights w
TP	Temperature	54	19.2%	0.92
HM	Humidity	15	5.3%	0.05
WS	Rainfall	33	11.7%	0.11
RF	Wind speed	21	7.4%	0.07
PD	Pop Density	28	9.9%	0.09
A1	Age < 20	10	3.5%	0.03
A2	Age 21–40	62	22%	0.22
A3	Age > 40	48	17%	0.17
SM	Smoking	6	2.1%	0.02
AL	Alcoholic	3	1%	0.11
DB	Wheezing	1	0.3%	0.03
WZ	Diabetics	0	0%	0.01
Total rank		281		

Fig. 8 Raster images

Fig. 8 (continued)

Inverse Distance Weighting is used to find the property at each location, it is given by

$$P_j = \frac{\sum_{k=1}^{n} P_k / D_{jk}^m}{\sum_{k=1}^{n} 1 / D_{jk}^m}$$

W

Pj	Property at location j.
Pk	Property at sampled location k.
Dij	Distance between J to K.
n	Number of sampled location.
m	Inverse distance weighting power.

here,

5.4 Reclassification

Reclassification is used to classify or change the old raster values to alternative values. Reclassification is also used to classify many input raster values to the desired values within
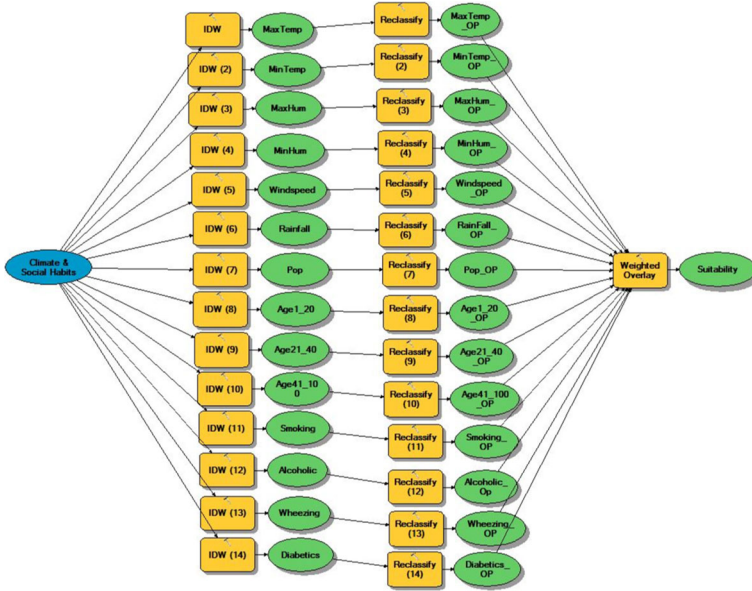
Fig. 9 Habitat suitability model

the range. Reclassification always applied to the entire cell within a zone. The resultant habitat suitability model developed with the help of inverse distance weighting and paired comparison analysis is represented in Fig. 10. ArcGIS 10.2 software is primarily used to develop the habitat suitability model for malaria in Vellore, Tamil Nadu, India. As shown in Fig. 10, there is high suitability index present in the Vellore and its neighborhood locations like Alangayam, Madanur, Gudiyatham, Solignghur, Walajapet, Arakonam. Some areas are less suitability index like Kandili, Jolarpet, Thimiri, Nemili, Natrampali. The geospatial results generated from the proposed habitat suitability model is used for the government to take better decisions against the spread of malaria in Vellore, Tamil Nadu, India. Figures 11 and 12 represent the malaria incidence based on male and female, and various locations respectively. Figure 14 represents the significance of malaria incidence based on population density and rainfall. Figure 13 represents the prediction of malaria incidence based on various independent variables such as Age 21–40, Temperature, Age > 40, Wind speed, Pop Density, Rainfall, Humidity, Age < 20, Smoking, Alcoholic, Diabetics and Wheezing. Table 4 depicts the suitability index count for the habitat suitability model. Tables 5 and 6 represent the influence of various parameters on malaria.

6 Conclusion

Spatial habitat suitability model is developed based on the climatic conditions and social habits of the people who are living in Vellore, Tamil Nadu, India. Inverse Distance Weighting (IDW) function and weighted overlay function are used to predict the suitable locations that most likely affect by malaria. In general, the geospatial data model is used to model the disease prevalence and spatial concentration of disease risk, which is not given any absolute solution
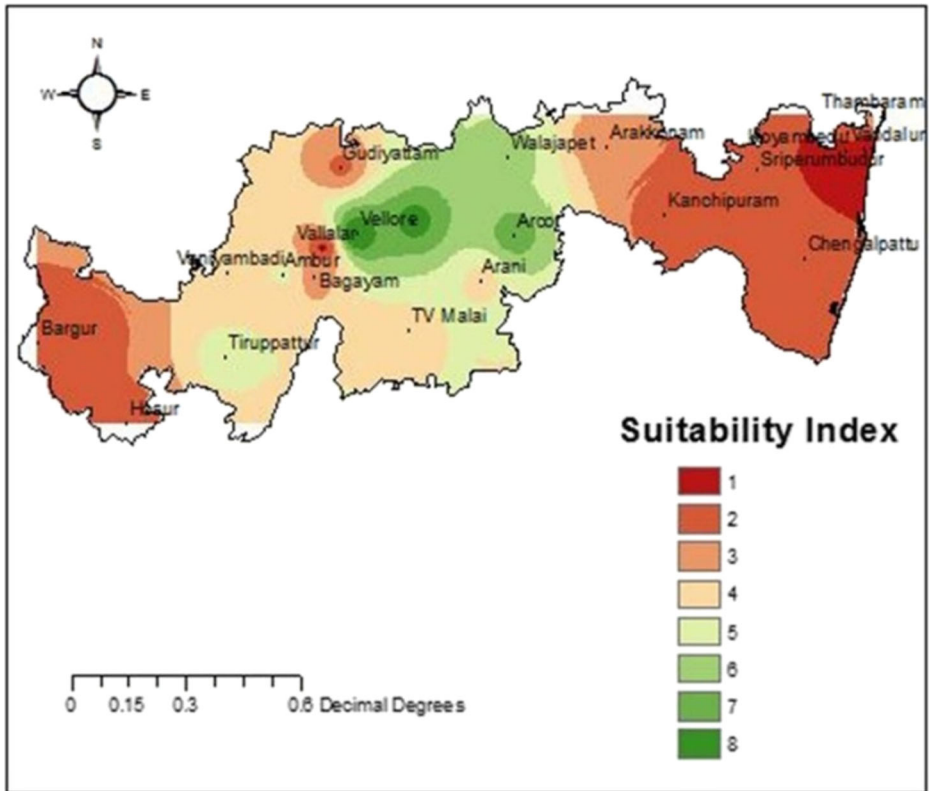
Fig. 10 Geo-locations suitable for malaria outbreak

for the decision makers to control the disease. Disease control strategies must be considered not only the spatial information like landscape, weather and climate, but also spatially explicit
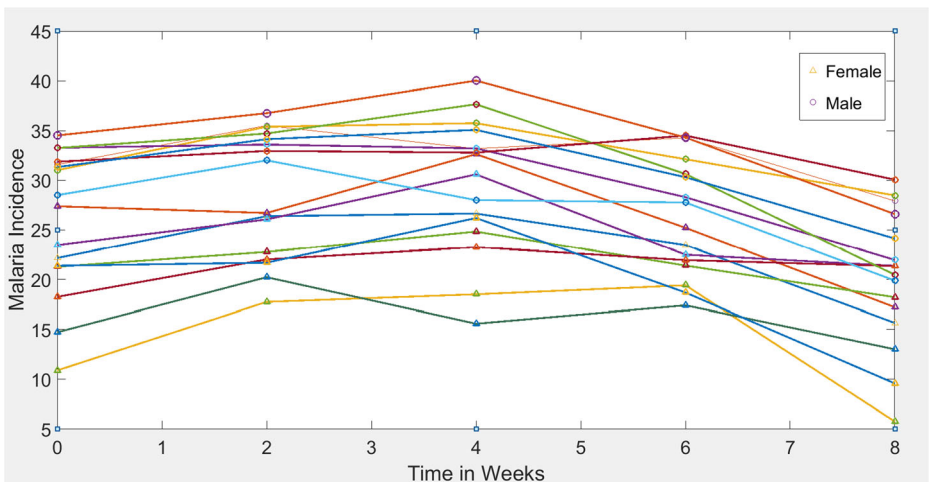

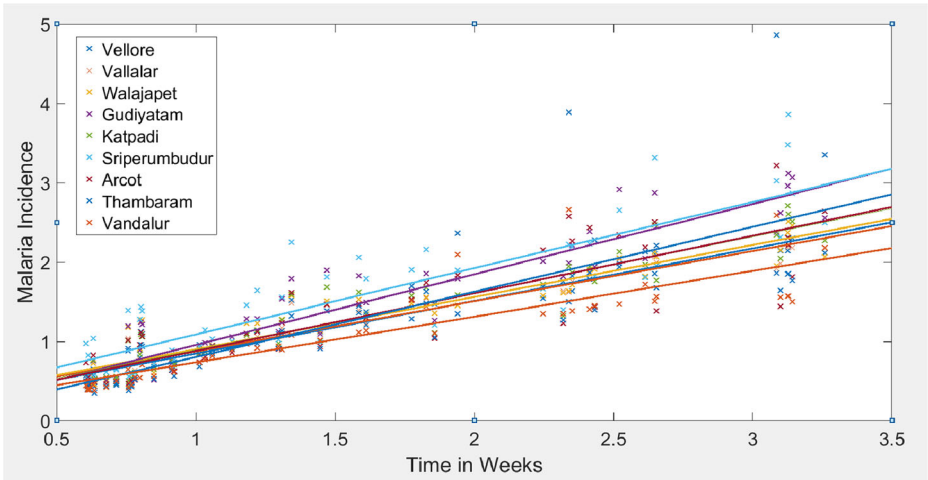**Fig. 11** Malaria incidence based on male and female

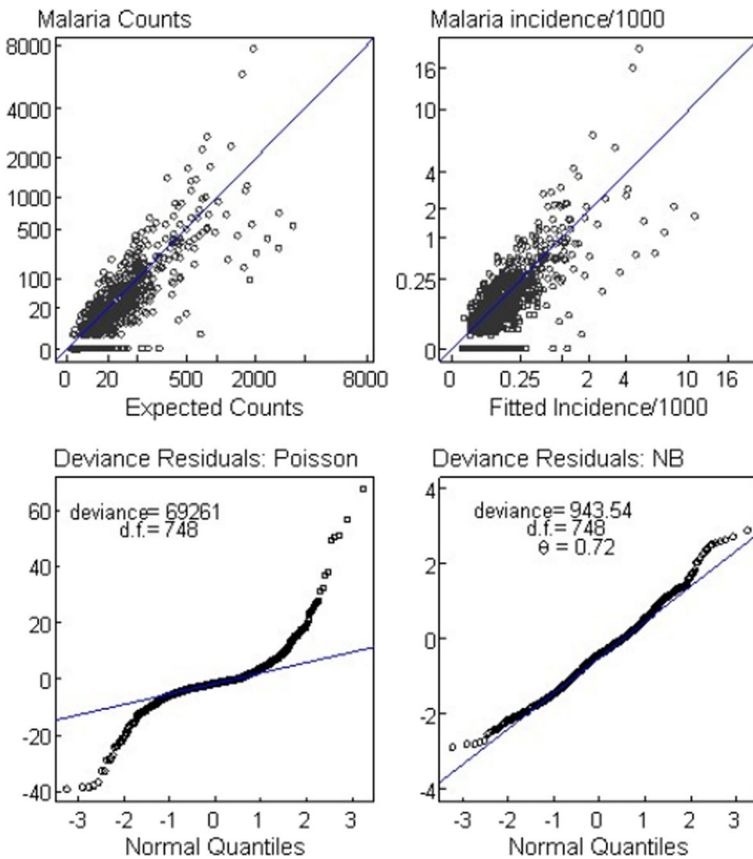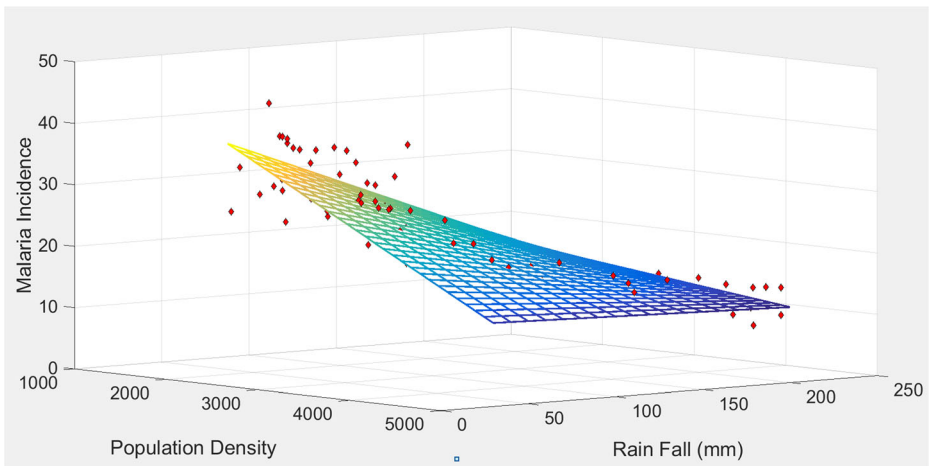Fig. 12 Malaria incidence on various locations

Fig. 13 Prediction of malaria incidence

Fig. 14 Malaria incidence based on population density and rainfall

information like socioeconomic variable, population density, behavior and natural habits of the people. There is need to develop an integrated approach that consists of spatially implicit and explicit information to identity an effective control strategy that prevents and control of emerging infectious disease in a traditional world. Decision making is a set of organized procedures used to analyze the complex problems in an organization. Multi-criteria decision analysis is a decision-making framework that allows the policy makers to make an effective decision with qualitatively and quantitatively. There is a need to develop an efficient decision making system that controls the spreading diseases. Malaria is one of the emerging diseases worldwide; the root cause of malaria is weather & climate condition of the study area. The climate condition is often called as spatially implicit information, traditional decision making models does not use the spatially implicit information it most often uses spatially explicit information such as socio economic, natural habits of the people. Spatial Multi-criteria decision analysis (SMCDA) approach combines the Multi-criteria decision analysis and geographic information system (GIS) to model the spatially explicit and implicit information and to make an effective decision under different scenarios and different environment. In this paper, geo-spatial based multi-criteria decision analysis approach is developed to model the malaria outbreak. The future work of this manuscript is to develop various habitat suitability model for emerging diseases.

Table 4 Suitability Index

Suitability Index	Count
1	3002
2	29,186
3	11,134
4	24,768
5	13,229
6	10,619
7	3696
8	1058

Table 5 Various parameters influence on malaria (1)

LID	NAME	TP	HM	WS	RF	PD
	Weights	0.92	0.05	0.11	0.07	0.09
0	Kelambakkam	24.12	65.96	8	75	45.332
1	Thambaram	20.76	54.23	9	85	174.4
2	Koyambedu	35.56	64.98	4	56	129.34
3	Vandalur	32.65	64.85	9	76	43.54
4	Krishnagiri	25.02	66.34	7	71	56.44
5	Chengalpattu	24.12	65.96	8	75	45.332
6	Kanchipuram	35.23	63.23	5	62	65.54
7	Sriperumbudur	35.23	57.04	6	65	78.43
8	Arani	28.43	63.12	9	79	22.1
9	TV Malai	29.45	63.34	9	81	43.54
10	Arakkonam	32.65	64.85	9	76	43.54
11	Arcot	24.3	60.4	11	105	89.34
12	Gudiyattam	33.56	55.34	8	74	75.43
13	Tiruppattur	26.2	62.34	9	89	89.44
14	Ambur	27.3	52.76	10	83	67.232
15	Katpadi	22.3	58.57	12	112	112.34
16	Walajapet	25.4	61.34	11	95	124.23
17	Vaniyambadi	20.23	65.87	9	84	34.2
18	Bagayam	22.12	53.32	8	75	34.23
19	Vellore	20.3	65.01	13	124	143.221
20	Vallalar	35.1	64.98	7	68	121.23
21	Hosur	35.023	65.34	7	72	65.33

Table 6 Various parameters influence on malaria (2)LID

	NAME	A1	A2	A3	SM	AL	WZ	DB	Total
	Weights	0.03	0.22	0.17	0.02	0.1	0.03	0	—
0	Kelambakkam	2	2	2	1	0	0	1	34.55828
1	Thambaram	2	9	2	0	2	0	2	47.0267
2	Koyambedu	1	1	0	0	0	0	0	52.2148
3	Vandalur	1	5	2	0	2	1	2	45.2091
4	Krishnagiri	1	2	2	0	0	1	0	37.995
5	Chengalpattu	2	2	2	1	0	0	1	36.55828
6	Kanchipuram	0	1	1	0	0	1	0	46.7817
7	Sriperumbudur	0	1	2	0	0	0	1	48.0923
8	Arani	2	6	1	2	3	1	0	39.7406
9	TV Malai	4	7	3	3	2	2	4	43.3296
10	Arakkonam	1	5	2	0	2	1	2	45.2091
11	Arcot	5	15	1	2	4	1	7	46.0666
12	Gudiyattam	2	3	0	1	1	1	1	47.3609
13	Tiruppattur	2	10	3	2	1	0	4	45.4006
14	Ambur	9	8	1	4	2	1	7	43.22488
15	Katpadi	0	25	0	7	8	2	12	49.2151
16	Walajapet	2	10	5	6	5	2	6	49.2657
17	Vaniyambadi	1	8	1	3	3	0	2	34.1731
18	Bagayam	0	5	2	0	1	1	3	33.7971
19	Vellore	10	25	10	8	9	5	15	53.63639
20	Vallalar	1	2	0	1	2	0	1	52.6717
21	Hosur	1	2	1	0	0	1	0	47.84786

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