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Spatial Statistics Approach for Study of Infant Mortality in Uttar Pradesh, India

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Abstract: Programs can achieve the best results when they have there better coverage in approachable geographical regions. This paper is an attempt to find the high risk zones of infant mortality in Uttar Pradesh using spatial approaches. These zones might help to government to cover wide area to implement the programs related to infant mortality. The approaches are applied using National Family Health Survey-IV (2015-16) data for Uttar Pradesh.

Keywords: Infant Mortality, Spatial Point Process, Scan statistics, National Family Health Survey, Clusters

1 Introduction

According to WHO report, India is among countries which has highest number of infant mortality. There have been several approaches considered to reduce it but it is still high in the Indian context. According to Tlou (2017) it is considered as major public health problem in many developing countries. In order to achieve the millennium development goal 4, for 20 deaths per 100 live births was not being met despite large reduction in child mortality from 1990-2015 (UN 2015), which may caused by effects of so many associated condition.

Estimation of infant mortality has an issue to study because it has wide connection with fertility. And number of births becomes introduction of new medical facilities for the reduction in child mortality leads to the declining in fertility with economic development (Donald, O.Hara (1975) and Schutz (1979)). Ben-porath and Welch (1972) shown that occurrence of death as anticipation that it may also enter into the determination of the desired number of surviving children. In a study of Tiwan, Schultz (1980) found that high infant mortality rates are highly associated with earlier marriages, which may be taken as indirect evidence of replacement type in the same way. Williams (1977), Brass and Barrett (1978) shown by different models that child mortality may lead to high numbers of births for couples. Olson(1980) shows by using linear regression model that it is possible to estimate the extent of direct replacement of children who died by using fertility on child mortality. Wolpin (1984), Hackman and MaCurdy (1980) and surgen (1978) gives the model sequential life cycle and other dynamic models for the study of the relationship between fertility and child mortality.

Change in pattern of fertility due to infant mortality can be hypothesized as an exogenous cause. The pattern of declining mortality and declining fertility can result from exogenous changes the provision of medical services. Only

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with a prior restriction placed upon the preference structure(O'Hara (1975), Rosenwigh and Wolpin (1980), with the use of the exponential model, the study on dynamic regressors, incomplete spells, time dependence, heterogeneity. Salent (1977), Hackman and Borjas (1979), Coppock (1980), Tuma, Hannan and Greenveld (1979), Tuna and Hannon, Flinn and Heckman (1978) gives their study for the dependence of variables in between fertility and child mortality. Olson and Wolpin non-exponential model using dynamic regressors variables. According to Pathak et al. (1991) the estimate of Hill and David (1989) for child mortality for all births which have been taken place in last five years before survey suffers from the problem of underreporting. Several studies with several forms for infant and child mortality had been proposed as by Chauhan (1997), Goldblutt (1989), Heligman and Pollard (1980), Krishna (1993), Lee and Carter (1992), Keyfitz (1997), Pareto Distribution by Arnold (1993), Krishnan (1993), Polya Aeppli Model by Bhuyan and degraties (1999) for a study of the trend of infant and child mortality.

In 1965 Naus proposed the study of an event with the help of recognition of space-time hot spots by locating them on the map and defining with the connected states according to the cluster. He also approached with two problems related to those hot spots. Those problems are givn as

- What would be the risk of occurring the Considered event in cluster?
- What will be mean number of Units of Spatial cluster?

. For the first problem, many extensions have been made by Kulldroff (1995-2000) where he proposed to study on the basis of clusters of regular shape or on the basis which expands it to a large extent in a study of epidemic, health and several endemic scenarios. Kulldroff (1997) discussed the formation of cluster in spatial-temporal zone. In his study he explained that the points patterns in the cluster are homogeneous which may be applied through Poisson or Binomial structure, but the patterns in between clusters may be in homogeneous.

Several studies have been made with the help of space-time for infant mortality in several countries. Alam et al. (2010) used that study to find the patterns of under-five mortality in rural Bangladesh with the help of MATLAB and given a logistic approach to study the effect of several explanatory variables on under-five mortality. Ayle et al. (2013-2016) made the study on childhood mortality study on the basis of spatial distribution in Ethiopia, and several studies have been made on the several parametric and semi parametric models with the help of spatial cluster. Gupta et al. (2016) studied the spatial cluster and risk detection for infant mortality in high focus states of India with the help of Annual Health Survey (2013), and District Level Health Survey-III (2007-08) Data.

For the case of second problem the approach of point process can be approached which is defined as a collection of mathematical points randomly located on real line or $n-dimesional$ Euclidean space. The analysis of point pattern data in compact set s where $s \subset \mathbb{R}^n$ (where $n \geq 2$ dimension in space) is termed as Spatial point process. First time this kind modeling was established by Hawks (1972). This process is defined as the n-dimensional extension of a basic stochastic process for points given in space. To establish this process in wide manner studies had been performed by different authors e.g., Daley and Vere-Jones (2003), Daley and Vere-Jones (2008), Moller and Waagepetersen (2004) and Illian et al. (2008). Most of my material comes from Moller and Waagepetersen (2004), Illian et al. (2008), Moller, Syversveen, and Waagepetersen (1998) and Moller and Waagepetersen (2007), Elliott et al. (2000), Van Lasout and Baddeley (2002), Johnson (2010). Significant works had been done by Myllymäki (2016), Illian et al. (2017) to explain the process.

Improvement in infant mortality is not possible only by recognizing important factors to effect it until and unless its prime locations of high risk are not available. Health facilities and programs are also can be achieved rapidly if the locations are connected are easily accessible. This chapter is an attempt to study the prime locations of infant mortality using spatial procedures in Uttar Pradesh. Also, with the answers of the questions on spatial procedures given by Naus (1965). Study approaches are widely discussed in Data and Methodology section.

2 Data and Methodology

2.1 Study Area

Uttar Pradesh State covers a large part of Indian geographical structure, serving the population approximately 17% of the population of based on census of India (2011) with consists of 75 of districts in total of 706 districts in India. This state located in central part of India. Data shows district wise infant death in that geographical structure and locations.

2.2 Study Population

Infant mortality in that structure had been taken into account of Uttar Pradesh with the help of National Family Health Survey-IV (2015-16).

2.3 Study Units

For study, we consider the study units as the district wise infant mortality from National Family health survey-IV (2015-16) data for Uttar Pradesh, Which might be helpful to officials to perform health facilities in widely significant manner of plan implications.

2.4 Risk Determination

For the risk determination of Binomial model we can find window, and thereby the corresponding collection of zones depends on some applications. Some possibilities are,

1.All circular subsets.
2.All circle centered at any of several foci on fixed grid, with a possible upper limit on circle size. (Kulldroff and Nagarwala, 1994)
3.All circle centered at any of several foci on fixed grid, with a possible upper limit on circle size with Fixed size. (Turnbull et al., 1989)
4.All rectangles of a fixed size and shape. (Naus, 1965b)
5.When looking for space-time clusters we could use cylinders, scanning circular geographical areas over variable time intervals.

Thus for spatial processes for the risk study, spatial binomial Likelihood is given as:-

$$L = max\left(\frac{c}{n}\right)^{c}\left(\frac{n-c}{n}\right)^{n-c}\left(\frac{C-c}{N-n}\right)^{C-c}\left(\frac{(N-n)-(C-c)}{N-n}\right)^{(N-n)-(C-c)} \tag{1}$$

where C is total number of cases, c is the observed number of cases within the cluster. n is the total number of Observation within cluster, N is the combined total number observation within the region.

2.5 Size determination

Definition 1(Spatial Point Process). *: A spatial point process is a random pattern of points, Both numbers and location of points are random having following properties:*

1.At most one point of the process is observed at any location.
2.The probability of observing on a point at any predefined location is 0.

3.The probability of observing an infinite number of points in a bounded region is 0.

In terms of sets and measurable function point process can be defined as(Johnson et.al.(2011)):

Definition 2.*Let $n(x)$ denote the cardinality of a subset $x \subseteq S$. If x is not finite, set $n(x) = \infty$. Let $x_B = x \cap B$ for $B \subseteq S$. Now, x is said to be locally finite if $n(x_B) < \infty$ whenever B is bounded.*

Hence, X takes values in the space

$$N_{lf} = \{x \subseteq S : n(x_B) < \infty; \forall \text{bounded} B \subseteq S\}$$

Elements of N_{lf} are called *locally finite point configurations* and will be denoted by $x, y, \cdots$, while $\xi, \eta, \cdots$ will denote singletons in S.
Let's Assume S is a complete, separable metric space (c.s.m.s.) with metric d and equip it with the Borel sigma algebra ß and let $ß_0$ denote the class of bounded Borel sets. Equip N_{lf} with the sigma algebra

$$N_{lf} = \sigma(\{x \varepsilon N - lf : n(x_B) = m\} : B \varepsilon ß_0; m \varepsilon N_0)$$

That is N_{lf} is the smallest sigma algebra generated by the sets

$$\{x \varepsilon N - lf : n(x_B) = m\} : B \varepsilon ß_0; m \varepsilon N_0)$$

where

$$N_0 = N \cup \{0\}$$

. For the case of measurable function point process will defined as:

Definition 3.*A point process X defined on S is a measurable mapping defined on some probability space $(\Omega, \mathbb{F}, \mathbb{P})$ taking values in (N_{lf}, N_{lf}). This mapping induces a distribution P_X of X given by $P_X(F) = P(\{\omega \varepsilon \Omega : X(\omega) \varepsilon F\}$, for $F \varepsilon N_{lf}$. In fact, the measurability of X is equivalent to the number, N(B), of points in $B \varepsilon ß$ being a random variable.*

2.6 Characteristics

There are three characterizations of a point process. That is the distribution of a point process X is completely specified by each characterization. with help of some definitions:

Definition 4.*The family of finite-dimensional distributions of a point process X on c.s.m.s. S is the collection of the joint distributions of $(N(B_1), \cdots N(B_m))$, where $(B_1, \cdots B_m)$ ranges over the bounded borel sets $B_i \subseteq S, i = 1, \cdots, m$ and $m \varepsilon \mathbb{N}$*

Theorem 1(Characteristic-1). *The distribution of a point process X on a c.s.m.s. S is completely determined by its finite-dimensional distributions.*

Definition 5.*A point process on S is called a simple point process if its realizations contain no coincident points. That is $N(\{\xi\}) \varepsilon \{0, 1\}$ almost surely for all $\xi \varepsilon S$.*

Theorem 2(Characteristic-2). *The distribution of a simple point process X on S is uniquely determined by its void probabilities of bounded Borel sets $B \varepsilon ß_0$.(Renyl (1967)).*

Theorem 3(Characteristic-3). *The distribution of a point process X on S is uniquely determined by its generating functional.*

From those characteristics now we proceed for our study, for which assumptions are given as:

2.7 Assumptions

- –For spatial structure, considered real space is of 2 dimension or in $\mathbb{R}^2$
- –W be the region in which spatial point lies as $W \subset \mathbb{R}^2$. and B be the set of cluster points such as $B \subseteq W$
- –$X_1, X_2 \cdots, X_n$ be I.I.D. random points which are uniformly distributed in W with uniform intensity $\beta > 0$.
- –N is defined as N(B)=number of points lies in B defined for each bounded closed set $B \subset \mathbb{R}^2$ and vacancy indicator V as V(B)=1 if N(B)=0, I.e. no points falls in B.
- –λ is defined as $\lambda_{(W)}$ is area of region W.
- –n be the total number of spatial points in region W.
- –For every bounded closed set B the count N(B) has Poisson distribution with mean $\beta\lambda_B$
- –if $B_1, B_2, \cdots B_m$ are disjoint regions, then $N(B_1), \cdots N(B_m)$ are independent.

PDF of each X_i is defined as

$$f(x) = \begin{cases} 1/\lambda_{(W)} & if\ x\varepsilon W \\ 0 & otherwise \end{cases}$$

If x_i's are uniformly distributed then For B in R^2

$$N(B) = \sum_{i=1}^{n} 1 \quad x_i \varepsilon B \tag{2}$$

and

$$V(B) = \min_{i=1}^{n} 1 \quad x_i \notin B \tag{3}$$

So that for $P(N(B) = K)$ we have

$$P(N(B) = k) = \exp(-\beta\lambda_B)\frac{(\beta\lambda_B)^k}{k!} \tag{4}$$

Lemma 1. *Consider a point process with uniform density $\beta > 0$. and for region W with $0 < \lambda_W < \infty$. Given that conditional distribution of N(B) for $B \subseteq W$ is Binomial.*

let $k \leq k \leq n$ then

$$\mathbb{P}(N(B) = k|N(W) = n) = \frac{\mathbb{P}(N(B) = k \cap N(W) = n))}{\mathbb{P}(N(W) = n)}$$
$$= \frac{\mathbb{P}((N(B) = k, N(W|B) = n-k)}{\mathbb{P}(N(W) = n)}$$

By independence Assumption numerator can be written as:-

$$\mathbb{P}(N(B) = k, N(W|B) = n-k) = \mathbb{P}(N(B) = k)\mathbb{P}(N(W|k) = n-k)$$

evaluating numerator and denominator using Poisson assumption we have:-

$$\mathbb{P}(N(B) = k|N(W) = n) = \frac{\exp(-\beta\lambda_B)\frac{(\beta\lambda_B)^k}{k!}\exp(-\beta\lambda_{W|B})\frac{(\beta\lambda_{W|B})^{(n-k)}}{(n-k)!}}{\exp(-\beta\lambda_W)\frac{(\beta\lambda_W)^n}{n!}}$$
$$= \frac{n!}{k!(n-k)!}\left(\frac{\lambda_B}{\lambda_W}\right)^k \left(\frac{\lambda_{w|B}}{\lambda_W}\right)^{n-k}$$
$$=^n C_k p^k (1-p)^{n-k}$$

where $p = \frac{\lambda_B}{\lambda_W}$ Which implies $N(B) \sim B(n, p)$ for $B \subseteq W$
Since final form of process considers binomial form with areal probability p, hence it can be named as Binomial point process.

2.8 Notations

– Study region W= Uttar Pradesh.
– n =total number of districts in Uttar Pradesh.
– B_j is defined as the set of districts lies in a cluster.
– λ_{B_j} defined the area of j^{th} cluster in region

Considering these now we approach to Results section.

3 Results

From using the data of National Family Health survey-IV (2015-16) we get our results such as:-

3.1 Clusters

3.1.1 Cluster-1

Cluster-1 consists with 2 districts of Uttar Pradesh. First district is Sitapur with around 27% of its infant died, who are born in last 12 months. Second district is Maharajganj with 13% infants died, who are born in last 12 months. From table 7 we found that total number of infant born in this cluster are 216 in which 49 infants are died in past 12 months.

3.1.2 Cluster-2

Cluster-2 consists with 8 districts of Uttar Pradesh. First district is Mahoba with more than 10% of its infant died, who are born in last 12 months. Second district is Banda with 10% infants died, who are born in last 12 months. Third district is Chitrakoot with around 14% of its infant died, who are born in last 12 months. Fourth district is Jalaun with more than 15% infants died, who are born in last 12 months. Fifth district is Fatehpur with around 8% of its infant died, who are born in last 12 months. Sixth district is Kanpur Nagar with 7% infants died, who are born in last 12 months. Seventh district is Jhansi with around 15% of its infant died, who are born in last 12 months. Eighth district is Auraiya with 5.4% infants died, who are born in last 12 months. From table 7 we found that total number of infant born in this cluster are 645 in which 68 infants are died in past 12 months.

3.1.3 Cluster-3

Cluster-3 consists with 9 districts of Uttar Pradesh. First district is Farrukhabad with more than 18% of its infant died, who are born in last 12 months. Second district is Eath with 19% infants died, who are born in last 12 months. Third district is Kanshiran Nagar with around 21% of its infant died, who are born in last 12 months. Fourth district is Mainpuri with more than 18% infants died, who are born in last 12 months. Fifth district is Firozabad with around 15% of its infant died, who are born in last 12 months. Sixth district is Mahamaya Nagar with 16% infants died, who are born in last 12 months. Seventh district is Budaun with around 18% of its infant died, who are born in last 12 months. Eighth district is Allahabad with 14% infants died, who are born in last 12 months. Ninth district is Agra with more than 16% of its infant died, who are born in last 12 months. From table 7 we found that total number of infant born in this cluster are 1158 in which 199 infants are died in past 12 months.

3.1.4 Cluster-4

Cluster-4 consists with 14 districts of Uttar Pradesh. First district is Pratapgarh with more than 8% of its infant died, who are born in last 12 months. Second district is Basti with 11% infants died, who are born in last 12 months. Third district is Ambedkar Nagar with around 9% of its infant died, who are born in last 12 months. Fourth district is Sant Ravidas Nagar (Bhadohi) with more than 9% infants died, who are born in last 12 months. Fifth district is Varanasi with around 12% of its infant died, who are born in last 12 months. Sixth district is Ghazipur with 16% infants died, who are born in last 12 months. Seventh district is Mau with around 15% of its infant died, who are born in last 12 months. Eighth district is Ballia with 10% infants died, who are born in last 12 months. Ninth district is Azamgarh with more than 10% of its infant died, who are born in last 12 months. Tenth district is Jaunpur with 16.5% infants died, who are born in last 12 months. Eleventh district is Deoria with around 12% of its infant died, who are born in last 12 months. Twelfth district is Mirzapur with more than 16% infants died, who are born in last 12 months. Thirteenth district is Sonbhadra with around 11% of its infant died, who are born in last 12 months. Fourteenth district is Sant Kabir Nagar with 7% infants died, who are born in last 12 months. From table 7 we found that total number of infant born in this cluster are 1374 in which 172 infants are died in past 12 months.

3.1.5 Cluster-5

Cluster-5 consists with 6 districts of Uttar Pradesh. First district is Bareilly with more than 12% of its infant died, who are born in last 12 months. Second district is Rampur with 10% infants died, who are born in last 12 months. Third district is Moradabad with around 14% of its infant died, who are born in last 12 months. Fourth district is Chandausi with more than 10% infants died, who are born in last 12 months. Fifth district is Jyotiba Phule Nagar with around 14% of its infant died, who are born in last 12 months. Sixth district is Pilibhit with 8% infants died, who are born in last 12 months. From table 7 we found that total number of infant born in this cluster are 777 in which 96 infants are died in past 12 months.

3.1.6 Cluster-6

Cluster-6 consists with 5 districts of Uttar Pradesh. First district is Kheri with more than 17% of its infant died, who are born in last 12 months. Second district is Shrawasti with 16% infants died, who are born in last 12 months. Third district is Shajahanpur with around 18% of its infant died, who are born in last 12 months. Fourth district is Hardoi with more than 15% infants died, who are born in last 12 months. Fifth district is Bahraich with around 16% of its infant died, who are born in last 12 months. From table 7 we found that total number of infant born in this cluster are 569 in which 98 infants were died in past 12 months. Now we move our study towards risk scenario of infant deaths in clusters.

3.2 Relative Risk of Infant death

From the table 7 we get that the relative risk of death in clusters-1 of cases with respect to control is 1.610 with corresponding p-value 0.200 and log likelihood 5.523. For cluster-2 we find with respect to cases relative risk is 0.720 with p value 0.484 and log likelihood 4.449. For cluster-3 we get relative risk with respect to controls for cases we get 1.240 with p-value 0.516 and log likelihood 4.270. When we take cluster-4 we get the relative risk of cases is 0.850 with respect to controls with p value 0.984 and log likelihood 2.319. For Cluster-5 the relative risk of death is 0.820 for cases with respect to controls on p value 0.996 and log likelihood 2.064. at last in cluster-6 we get the 1.220 value of relative risk for cases with respect to controls with p value 0.996 and log likelihood 1.972. Now we go for number of average points in the clusters are given in study.

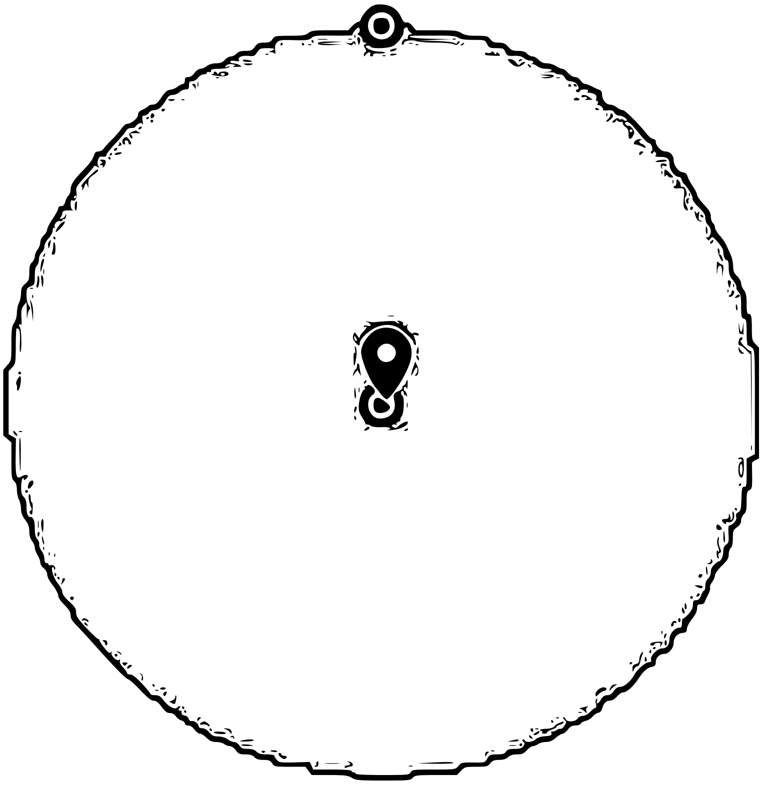

Fig. 1: Cluster-1

3.3 Size of Clusters

Table 8 Shows that mean and observed number of points in each cluster with areal probability of a point lies in clusters. In case of cluster-1 we get total number of points(n) is 75, areal probability(p) is 0.036, average number of points($N(\bar{B})$) is 2.679 and observed number of points$N(B)$ are 2. For Cluster-2 we get $n, p, N(\bar{B}), N(B)$ are 75, 0.114,8.515,8 respectively. In case of cluster-3 we get n is 75, p is 0.118, $N(\bar{B})$ is 8.966 and $N(B)$ are 9. For Cluster-4 we get $n, p, N(\bar{B}), N(B)$ are 75, 0.176, 13.218, 14 respectively. In case of cluster-5 we get n is 75, p is 0.076 $N(\bar{B})$ is 5.697 and $N(B)$ is 6. For Cluster-6 we get $n, p, N(\bar{B}), N(B)$ are 75,0.103, 7.714, 5 respectively. Through it we move to Conclusions.

Table 1: Cluster-1

District	Survived	Died	Population
Sitapur	70(72.917)	26(27.083)	96
Mahrajganj	97(80.833)	23(19.167)	120

Table 2: Cluster-2

District	Survived	Died	Population
Mahoba	70(89.744)	8(10.256)	78
Banda	62(89.855)	7(10.145)	69
Chitrakoot	101(86.325)	16(13.675)	117
Jalaun	43(84.314)	8(15.686)	51
Fatehpur	43(91.489)	4(8.511)	47
Kanpur Nagar	78(92.857)	6(7.143)	84
Jhansi	111(88.095)	15(11.905)	126
Auraiya	69(94.521)	4(5.479)	73

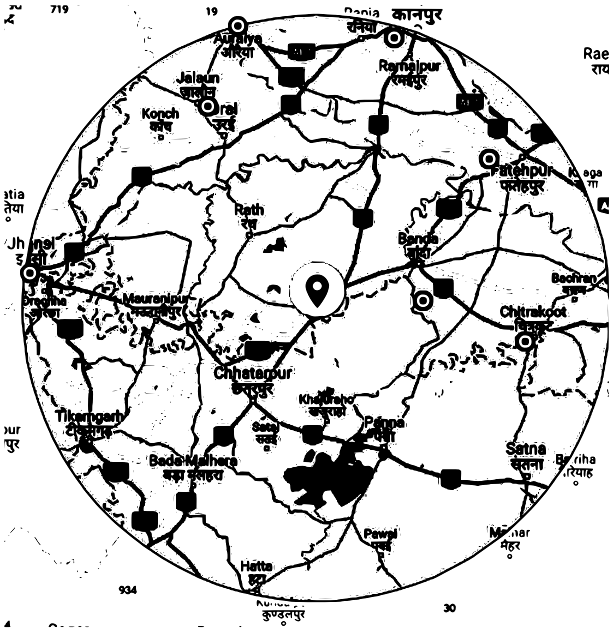

Fig. 2: Cluster-2

Table 3: Cluster-3

District	Survived	Died	Population
Farrukhabad	85(81.731)	19(18.269)	104
Etah	86(80.374)	21(19.626)	107
Kanshiram Nagar	94(78.992)	25(21.008)	119
Mainpuri	85(81.731)	19(18.269)	104
Firozabad	163(85.340)	28(14.650)	191
Mahamaya Nagar	84(84.000)	16(16.000)	100
Budaun	116(81.690)	26(18.310)	142
Allahabad	74(87.056)	12(13.954)	86
Agra	172(83.902)	33(16.098)	205

Table 4: Cluster-4

District	Survived	Died	Population
Pratapgarh	57(91.935)	5(8.065)	62
Basti	93(88.571)	12(11.429)	105
Ambedkar Nagar	69(90.789)	7(9.211)	76
Sant Ravidas Nagar (Bhadohi)	101(90.179)	11(9.821)	112
Varanasi	138(87.342)	20(12.658)	158
Ghazipur	77(83.696)	15(16.304)	92
Mau	85(85.859)	14(14.141)	99
Ballia	86(89.583)	10(10.417)	96
Azamgarh	83(89.247)	10(10.753)	93
Jaunpur	86(83.495)	17(16.505)	103
Deoria	72(87.805)	10(12.195)	82
Mirzapur	89(83.962)	17(16.038)	106
Sonbhadra	83(89.247)	10(10.753)	93
Sant Kabir Nagar	83(83.567)	14(14.433)	97

Table 5: Cluster-5

District	Survived	Died	Population
Bareilly	131(87.333)	19(12.667)	150
Rampur	82(89.130)	10(10.870)	92
Moradabad	169(86.224)	27(13.776)	196
Chandausi	106(89.831)	12(10.169)	118
Jyotiba Phule Nagar	90(85.714)	15(14.286)	105
Pilibhit	106(91.379)	10(8.621)	116

Table 6: Cluster-6

District	Survived	Died	Population
Kheri	74(82.759)	15(17.241)	89
Shrawasti	120(83.146)	25(16.854)	145
Shahjahanpur	95(81.897)	21(18.103)	116
Hardoi	74(82.222)	16(17.778)	90
Bahraich	108(83.721)	21(16.279)	129

Table 7: Relative Risk and Log Likelihood of Infant Mortality in Clusters

Clusters No.	Population	Cases	Relative Risk	Log Likelihood	p-Value
1	216	49	1.610	5.523	0.200
2	645	68	0.720	4.449	0.484
3	1158	199	1.240	4.270	0.516
4	1374	172	0.850	2.319	0.984
5	777	93	0.820	2.064	0.996
6	569	98	1.220	1.972	0.996

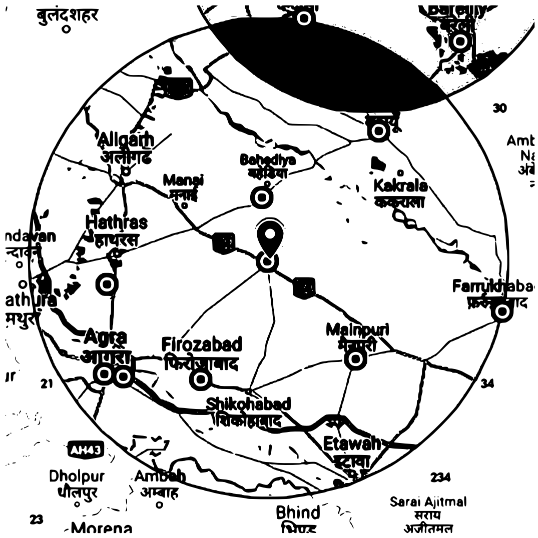

Fig. 3: Cluster-3

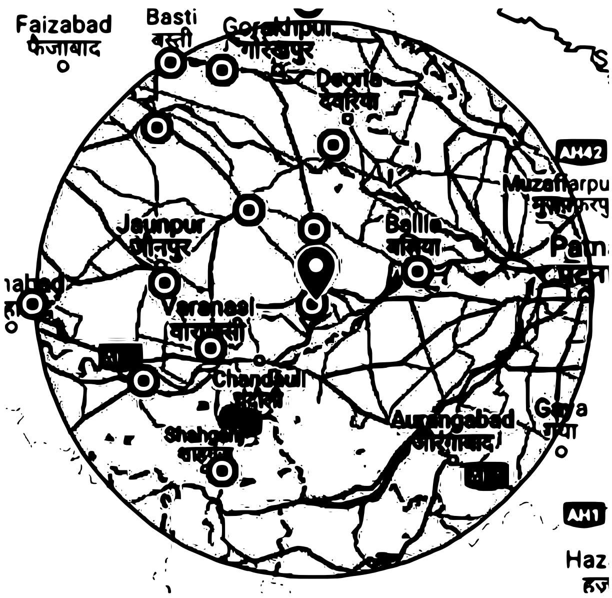

Fig. 4: Cluster-4

4 Discussions and Conclusions

A thorough visualization of results says that in Uttar Pradesh for study of infant mortality we found six clusters on the basis of National Family Health Survey-IV (2015-16) data. First one is in northern region of Uttar Pradesh, Second is with Chitrakoot and Jhansi division districts. Third cluster is of Agra, Allahabad and Mainpuri devision. Fourth cluster is of Azamgarh, Gorakhpur, Mirzapur and Varanasi division. Fifth cluster have districts of Bareilly and Moradabad devision.

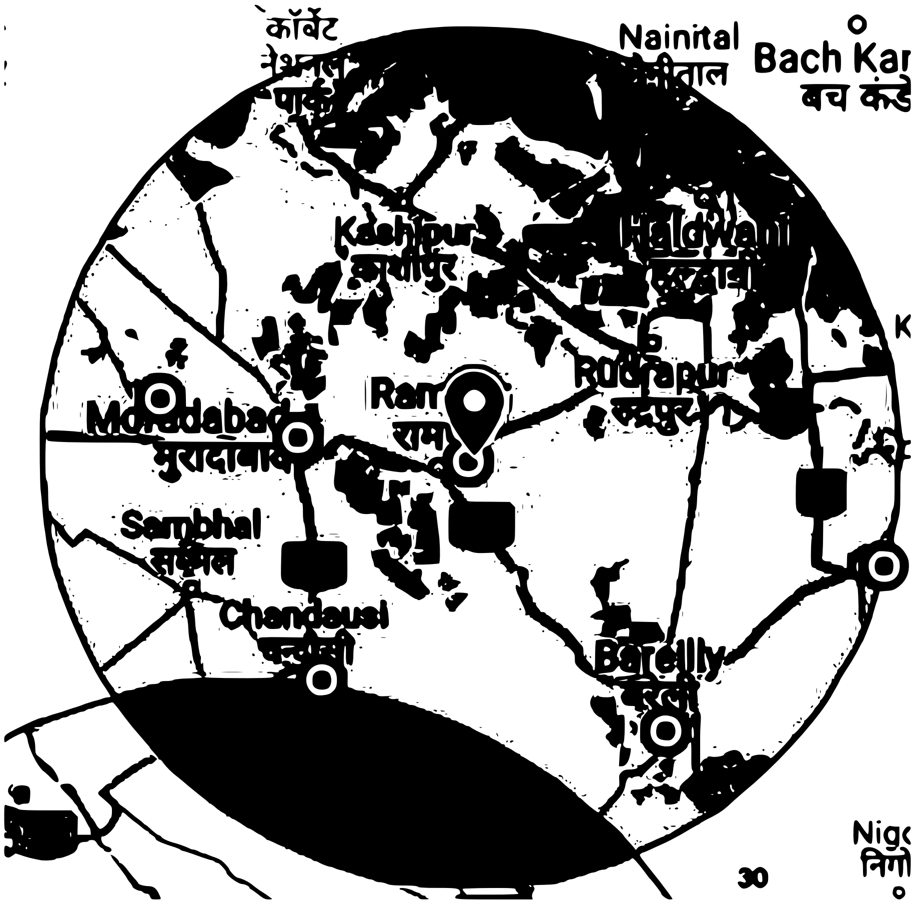

Fig. 5: Cluster-5

Table 8: Average and Observed No. of Points in Cluster

No. of Districts(UP)	Area of Clusters(SQ. KM)	$N(B)$	S.D.(NB)	Observed(N(B))
75	8691	2.679	1.607	2
75	27620	8.515	2.747	8
75	29085	8.966	2.810	9
75	42875	13.218	3.300	14
75	18480	5.697	2.294	6
75	25022	7.714	2.631	5

The districts in sixth cluster are of regions near Lucknow. Risk scenario shows that risk of infant mortality with respect to surviving infants is higher in first, Second and sixth cluster. While in third, fourth and fifth clusters risk of infant mortality with respect to surviving children is lower.

When the study of size estimation of clusters made through spatial point process we found that for each clusters the size follows binomial distribution with areal probabilities. For size study we found that all of clusters, average size of clusters

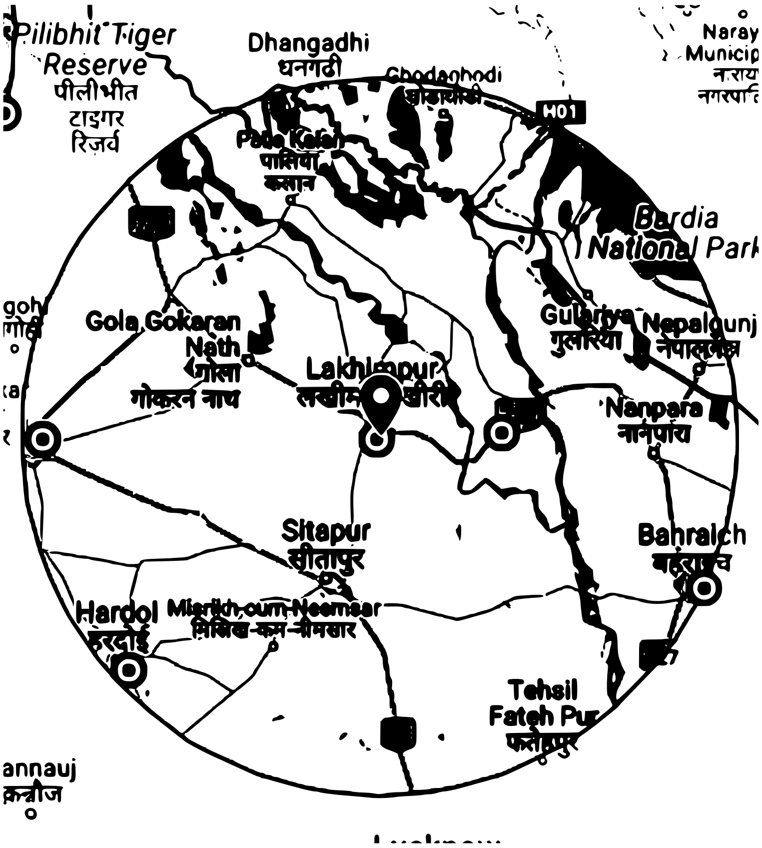

Fig. 6: Cluster-6

are approximately similar to the number of districts in clusters except cluster six. Due to that we can say that for spatial study of infant mortality these clusters are considerably useful and better approach towards any planning implications.

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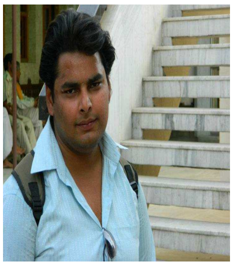

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