CHAPTER-XIV

CHAPTER NO : XIV DISEASE DIFFUSION

14.1 Introduction to disease diffusion :

Studies of diseasae diffusion largely utilize the formal geographic diffusion theories in the analysis of disease distribution and dynamics and thus the approach evolved after diffusion had become an important ingredient in geographic research. Such studies also represent a mechanism possibly contributing to the diffusion of disease from a pathogenic point of view. Such an approach is particularly concerned with the influence of the physical environment. Besides this, the spread of disease through a biological population is seen as a spatial process, hence particular attention has been paid to the form of the epidemic wave, to its spread and intensity and to the geographical pathways it follows. Thus, the particular advantage of the disease diffusion approach is that it makes it possible to simultaneaously view time and space in relation to the disease being studied.

Most studies of disease diffusion have concentrated either on the development of highly abstract models of diffusion process or on analyzing past outbreaks of communicable diseases. These have resulted in the identification of many major principles of disease diffusion and processes of diffusion which might have been instrumental in predicting the spread of disease. They also offer a variety of approaches and explanations to problems of

disease diffusion. But they share some common ground which is related with the test of different hypothesis with a view to offer explanations beyond general description resulting from disease mapping.

Here an attempt is made to study diffusion of leprosy in Vadodara district in order to know in which geographical region the process of spread of this disease starts by the dynamics of population and what kind of epidemic wave it generates while spreading.

During the course of survey the history of 177 adult active cases were interviewed, out of which 40% (71 cases) were able to answer as to how they have contracted this disease. Among these 40% , 75% (53 cases) had got this disease within the district and remaning 25% (18 cases) had contracted from the adjoining districts. Among the first group of cases 50% (27 cases) were found to have contracted this disease from other talukas of the district as shown in appendix-13. Besides this 80% of leprosy health workers (HW) and para-medical workers (PMW) had reported, that in their allotted areas, there are certain villages which are constant source of new leprosy cases.

14.2 Process of Diffusion :

As already noted out of total cases (1515) 50% of cases are found in the villages which are located beside rivers or stream

or any other water body. A similar result was found in new leprosy cases (Table-104). Thus the soil of such villages might have slow rate of permeablity and good water holding capacity which along with locally humid condition create the possibility of greater chances of survival of the bacilla in these villages. This could be the possible reason for the new cases emerging from these villages which are located beside rivers, streams or water bodies. From here the process of diffusion starts.

The movement of population within villages of the same talukas or adjoining talukas, of the district and neioughbouring districts, increases the possibility of diffusion of the disease in the entire district. Field survey reveals that majority of the sufferers are either agricultural or casual labourers, living in same environment with similar type of amenities and food habits. Out of total 177 adult active case, 40% (71 cases) had admitted that knowingly or unknowingly they had come in contact with leprosy sufferers at their work place. According to them usually the infected used to hide their sufferings. Thus this concealment, arising out of stigma, had made others face the consequence of the disease.

As is already noted, the most common mode of entry of the leprosy bacilla into the body of the contact person is the inhalation of bacilla laden droplets of nasal secretion of the affect-

ed patient. Besides this, a casual or short contact is sufficient for inhaling bacilla through the respiratory tract and the bacilla then get carried to sites suitable for their multiplication within susceptible persons who had either little or no knowledge of the infectivity of the disease.

There are two possibilities of spreading the disease in the villages. The first is, the infected person living in a village beside a river might have gone to some other place for work or other reasons. The second possibility is that a person from another village or area had visted the suffereres and had thus become exposed to leprosy as shown below in figure 14.1

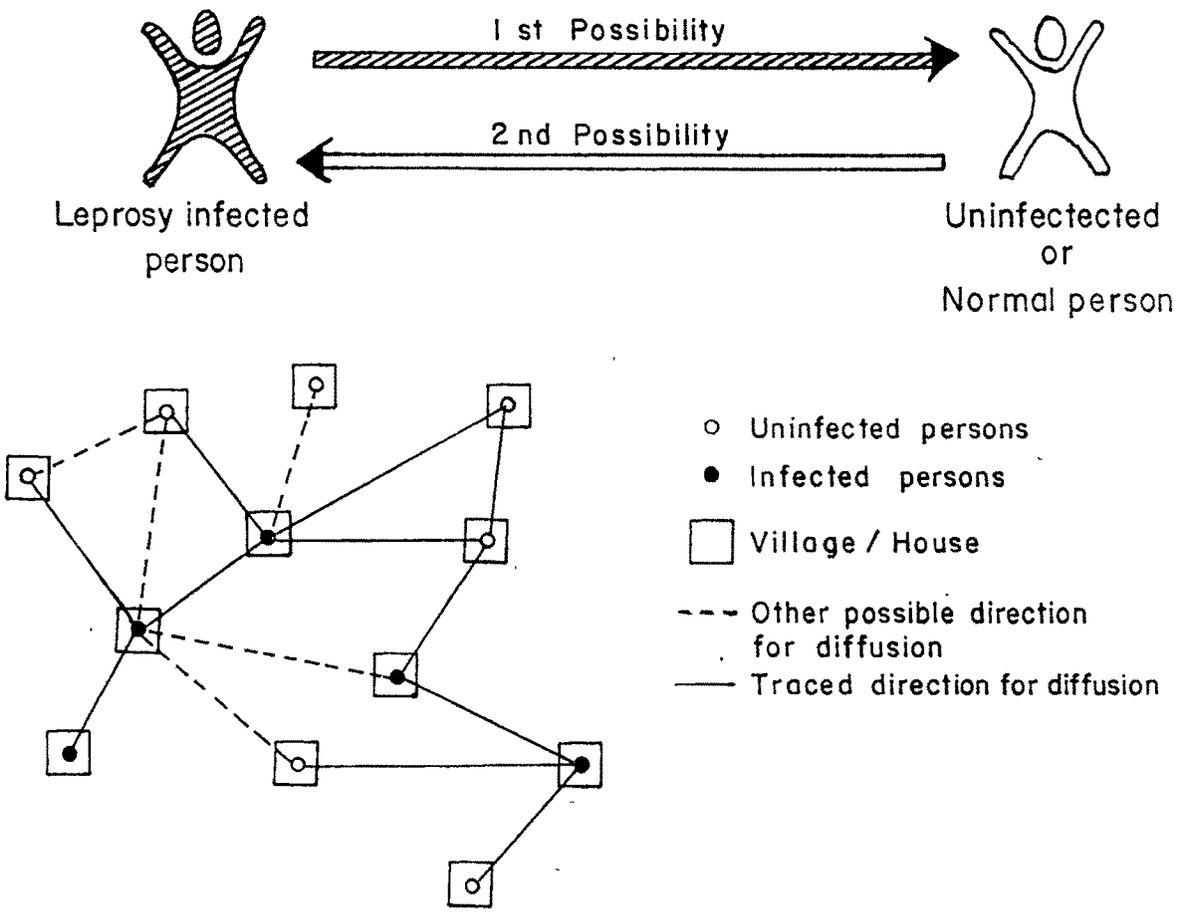

Figure 14.1: The process of spreading of the disease.

The progressive waveform (fig-12.6) prepared from the information shown in Appendix-13, shows the haphazard movement of the population having this disease. Thus the diffusion of this disease is basically through contact diffusion that takes place in a haphazard manner. This accounts for the widespread and scattered distribution of the disease throughout the district as shown in figure 12.6.

According to National Leprosy Eradication Programme (NLEP) out of every five leprosy cases one leprosy case is found to be infectious, i.e.,

Total cases	Infected cases
5	1
10	2
15	3
.	.
.	.
.	.
5n	n

Thus 5n number of leprosy cases is able to produce 'n' number of infected leprosy cases. Thus the intensity with which the infected number of leprosy cases are produced or diffused due to the population dynamics, shows arithematic progression (1,2,3,4,.... n).

Considering both possible routes, i.e., either the infected person is moving towards group of non-infected persons or vice versa, with many possible directions of diffusion, it appears

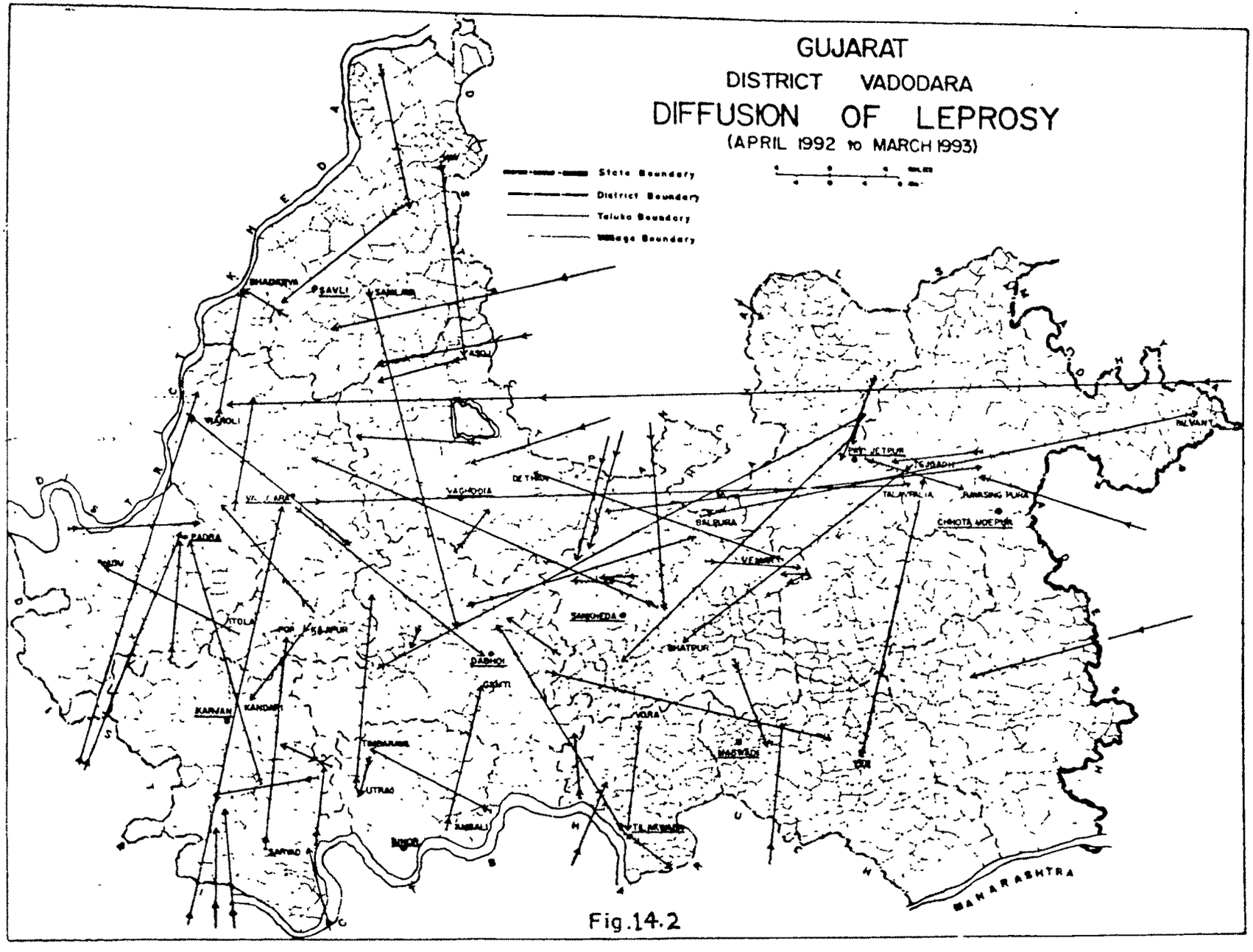
GUJARAT
DISTRICT VADODARA
DIFFUSION OF LEPROSY
(APRIL 1992 to MARCH 1993)
State Boundary
District Boundary
Taluka Boundary
Village Boundary
BHADKEVA
SAVLI
SANKHEDA
BALBURA
CHHOTA UDEPUR
JUNASING PURA
PADRA
KARJAN
KANDARI
BHATPUR
VORA
MAHARASHTRA

Fig.14.2

that every infected case is able to produce at least two leprosy cases. Thus the process of diffusion will take place as $2,4,8,12,\ldots\ldots 2^n$, (Where n = 1,2,3,... n) with the intensity of geometric progression.

Applying NLEP criteria to the above geometric progresssion the results obtained are :

Total cases	Infected cases	
2	-	
4	-	
8	1	(neglegable)
16	3	
32	6	
64	12	
.	.	
.	.	
.	.	
2^n	$3/2(2^n)$	

Thus 2^n number of total leprosy cases will be able to produce at least $3/2\ (2^n)$ infectious leprosy cases.

But apart from disease diffusion process originating from within the house, village, taluka and from neioughbouring district, a parallel elimination process (NLEP) will also be very active for the control of the disease. Hence seeing the diffusion and control process of the disease, one would like to know about the future prediction of the occurence of the disease with in the district.

14.3 Future Prediction Model :

Analysis of last eleven years' data of leprosy as shown in table 14.1 was utilised for predicting the future trend of disease occurrence in the district.

Table 14.1 : Information of some parameters of leprosy in Vadodara district.

Years (X)	New cases detected during the year (Y_1)	During the current year Left 1	Died 2	RFT 3	Deleted 4	Total cases 5 (Y_2)	Total number of existing deformed cases at the of the year. Grade-1 6	Grade-2 7	Total 8
1982-83	1877	413	184	704	0	1306	NA	NA	NA
1983-84	2173	434	164	1301	0	1899	NA	NA	NA
1984-85	2763	1060	247	1172	2	2481	1036	2081	3117
1985-86	2200	429	182	3446	23	4080	1169	2169	3338
1986-87	2457	394	126	7183	9	7712	1289	2214	3503
1987-88	1747	159	76	3409	86	3730	1366	2235	3601
1988-89	1818	65	33	2184	70	2352	1462	2225	3687
1989-90	1636	67	24	1973	28	2092	1572	2235	3807
1990-91	1545	78	14	1611	9	1712	1657	2257	3914
1991-92	1410	60	11	1422	1	1494	1752	2264	4016
1992-93	1349	55	26	1427	36	1544	1848	2272	4120

Source : District Leprosy Office, Vadodara.

New cases and total cases deducted during the year were done by using regression of new cases (Y_1) and total deducted cases (Y_2) on years (X) in order to predict the future scenario of the disease leprosy in the Vadodara district,

Let X = Years

Y_1 = New cases detected during the year.

Y_2 = Total cases deducted during the year.

n = 11

Table 14.2 : Calculation for new leprosy cases emerging and total deduction, of cases by using regression line.

Years	X	X^2	Y_1	XY_1	Y_2	XY_2
1982-83	-5	25	1877	-9385	1306	-6530
1983-84	-4	16	2173	-8692	1899	-7596
1984-85	-3	9	2763	-8289	2181	-7443
1985-86	-2	4	2200	-4400	4080	-8160
1986-87	-1	1	2457	-2457	7712	-7712
1987-88	0	0	1747	0	3730	0
1988-89	1	1	1818	1818	2352	2352
1989-90	2	4	1636	3272	2092	4184
1990-91	3	9	1545	4635	1712	5136
1991-92	4	16	1410	5640	1494	5976
1992-93	5	25	1349	6745	1544	7720
Total	0	110	20975	-11113	30402	-12073

Now putting the values of the above table in equation 1 and 2 we get

For new Cases : $\Sigma Y_1 = na_1 + b_1\Sigma X$ .....(1)

$20975 = 11a_1 + b_1 x\ 0$

$a_1 = 20975/11$

$a_1 = 1906.82 = 1907.$

$\Sigma XY_1 = a_1\Sigma X + b_1\Sigma X^2$ ....(2)

$-11113 = 1906.82 \times 0 + b_1 110$

$b_1 = -11113/110$

$b_1 = -101.03 = -101.$

For Total Deducted cases : $\Sigma Y_2 = na_2 + b_2\Sigma X$ ...(1)

$30402 = 11a_2 + b_2 x\ 0$

$a_2 = 30402/11$

$a_2 = 2763.81 = 2764.$

$\Sigma XY_2 = a_2\Sigma X + b_2\Sigma X^2$ ...(2)

$-12073 = 11 \times 0 + b110$

$b_2 = -12073/110$

$b_2 = -109.76 = 110.$

Now putting the value of 'a' and 'b' in the equation of regression line we get

$Y_1 = a_1 + b_1X$ $\qquad$ $Y_2 = a_2 + b_2x$

$Y_1 = 1907 - 101x$ ....(3) $\qquad$ $Y_2 = 2764 - 110x$ ....(4)

Now putting the onward value of x = 6,7,8.... for the relative years 1993-94, 1994-95, etc., in the equation (3) and (4), the corrosponding number of new cases occurring and total number leprosy cases deducted per year will be obtained as shown in table : 14.3

Table 14.3 : Future scenario of emergence of leprosy new cases and total deduction of cases of the Vadodara district.

For the value of (x)	The corros ponding year	Total number of new cases emer- in the coming years. (Y_1)	Total number of cases to be deducted in the coming years. (Y_2)
6	1993-94	1301	2104
7	1994-95	1200	1994
8	1995-96	1099	1884
9	1996-97	988	1774
10	1997-98	896	1664
11	1998-99	795	1554
12	1999-2000	694	1444
13	2000-2001	593	1334
14	2001-2002	492	1224
15	2002-2003	391	1114
16	2003-2004	290	1004
17	2004-2005	189	894
18	2005-2006	88	784
19	2006-2007	-	674
20	2007-2008	-	564
21	2008-2009	-	454
22	2009-2010	-	344
23	2010-2011	-	234
24	2011-2012	-	124
25	2012-2013	-	14

If the control programme runs smoothly as it is now, the emergence of new cases is expected to stop by the end of 2006-2007. Besides this, the expected duration for the number of leprosy cases deducted due to cases release from treatment (RFT)

and by other reasons (Died + Left + deleted due to other reasons) will be by the end of 2013-14. Thus the deduction of cases will persist for atleast 7 years after the eradication of new cases.

Further, there will be acute problem of deformed cases (Table-14.1). Thus more initiative must be taken from now onward in NLEP in order to tackle deformity cases or RFT cases requiring surgery.
