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Research Article

Malaria Prevalence in Forest and Nonforest Areas of Kokrajhar District of Assam

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An analysis of malaria prevalence and its trends in Kokrajhar district of Assam over the last ten years starting from 2001 to 2010 shows that the occurrence of malaria in the forest area is significantly higher than in the nonforest area ($\chi^2 = 7819.87, P < .0001$). The transmission of malaria parasite takes place through only two Plasmodium species of *P. falciparum* (PF) and *P. vivax* (PV) in both the forest and nonforest areas of the district, and the prevalence of *P. falciparum* has been found higher. The annual blood examination rate (ABER) is relatively lower in forest area than the nonforest area while annual parasite incidence (API) of the former was much higher. Nearly one-third of the population of the district is under high risk of being affected. The malaria API and forest cover of the district during the period are negatively correlated with a coefficient of −0.57. Special measures are necessary to contain the transmission of malaria in forest area.

1. Introduction

Forest malaria has been so deep rooted that it has resisted the international community's efforts for total eradication of malaria. The forests, being the reservoir of malarial disease, have been facilitating extensive malarial transmission, and the challenge is so great that even the World Health Organization had to abandon its goal of total eradication of malaria in 1969 and start the current global campaign "Rollback Malaria" [1]. Controlling malaria in forest areas has remained a challenge in many parts of Asia and South America [2]. In central Vietnam higher percentage of malarial attack takes place in forest area [3] and the same is the case in different parts of India also—higher malaria incidence in forest areas than in nonforest areas [4–6]. The northeastern part of India, to which the state of Assam belongs, is one of the regions having higher annual parasite incidence (>5) [7].

The National Vector Born Disease Control Programme (NVBDCP) of the country identifies Kokrajhar as one of the eight malaria endemic districts in the state of Assam. It has contributed more than 6% of malaria cases in the last five years from 2006 to 2010 to the state malaria cases. A major part of the district is covered by forests where the inhabitants are mainly tribal people, the *Bodos* and the *Adivasis*, with some migratory population of Nepalese origin. The socio-economic condition of villagers is poor and the people solely depend on paddy cultivation and the collection of forest products. The villages inside the forests are scattered, thinly populated, and backward in communication. These villages are difficult to approach and remain inaccessible by road during rainy season, which is pick period of malaria in the district.

The geographical area of the district is 3169 sq km and is bounded by 89°46′ to 90°38′ east longitudes and 26°19′ to 26°54′ north latitudes. The district has a contiguous forest area in its northern part while the southern part is a non-forest plain intensively cultivated with paddy. The present estimated area under reserved forests of the district is roughly 1,163 sq km, which is about 37% of the total geographical area of the district. In an approximate population of 905,764 of the district, scheduled tribes constitute 33.67% of the population and 36.09% of the people are below the poverty line [8].

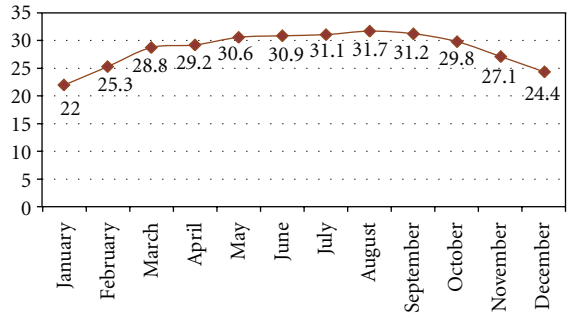

Figure 1: Monthly mean temperature. Source: District Agricultural Office, Kokrajhar.

Endemic diseases have been prevalent in the district for a long time [9]. Kala-azar, an endemic disease, used to sweep through the district killing thousands of people in the twenties of the 20th Century [9]. Though Kala-azar was prevalent in the past in the district, it no longer exists now and other vector-borne diseases are also very rare. But malaria remains to be endemic in the district and creates havoc among the masses.

The district has a moderate variation of temperature from 22°C to 32°C, January and August being the coldest and the hottest months, respectively (Figure 1, respective standard deviations of monthly mean temperatures are 1.0, 1.5, 1.7, 1.6, 1.1, 0.7, 1.2, 1.2, 1.1, 1.2, 1.4, and 2.1). The district has got a high annual rainfall of 18626 mm and a high humidity of 73.5 on average [10]. These together build up a favorable condition for transmission of malaria that subsists in the district throughout the year. For this reason malaria disease occurs in the district throughout the year, the monsoon season, from May to September, being the pick period of the disease [11].

The National Rural Health Mission (NRHM), a scheme of Government of India that aims at providing valuable healthcare services to rural households all over the country, is giving special attention to the eighteen health backward states of the country, among which Assam is also one. It was launched in 2005 for a period of seven years (2005–2012). Effort has been made through this program to ensure effective healthcare, especially to the poor and vulnerable sections of the society. One of the key components of the National Rural Health Mission is to provide every village in the country with a trained female community health activist called an accredited social health activist (ASHA), who is selected from the village itself and given responsibility to look after the village. The Kokrajhar District National Rural Health Mission was formed in the year 2006, and it started functioning from 2007. It is trying its best to contain malaria in the district along with tackling other health issues.

2. Objective

The study has been taken up to analyze the malaria situation in forest area and nonforest area of the district. There is example of more prevalence of malaria in forest area than nonforest area in different parts of India [4–6, 12]. In the event that such a distinguishing situation prevails in the two areas of the district, a comparative study would be helpful in adopting effective policy and essential measures separately for forest area and nonforest area in the district for containment of malaria.

3. Materials and Methods

The entire district has been divided into four medical blocks: Kachugaon, Gossaigaon, Dotma, and Balajan; they are called block public health centres (BPHC). Almost the whole part of Kachugaon block primary health centre lies within forest area and parts of Dotma and Balajan Block PHCs also fall within forest area (Figure 2). In the forest area parts of Dotma and Balajan BPHCs the population is thin and there is no key health-care set-up in these parts. As such, for analysis of prevalence of malaria disease in forest area, the situation in Kachugaon BPHC may be considered to reflect the malaria situation in forest area of the district.

Henceforth, the term *forest area* will stand for *Kachugaon BPHC* and *nonforest area* will stand for clubbed area of *Gossaigaon, Dotma,* and *Balajan* BPHCs. A figure that stands for nonforest area will represent the *mean of the respective three figures* of the associated three BPHCs.

For the trend analysis the secondary data on epidemiological situation reports supplied by National Vector Borne Disease Control Programme (NVBDCP), Kokrajhar district, for the period 2001–2010, has been considered and malaria indicators for different years have been calculated for all the four medical blocks. Then the mean of the indicators of the three BPHCs—Gossaigaon, Dotma and Balajan—are found out and assigned as indicator of the nonforest area. BPHC wise population was also supplied by the same office from their annual survey. For the state figures, the epidemiological situation report of NVBDCP, Assam, has been considered.

4. Statistical Methods and Appliances

All data were entered in the datasheet of Microsoft Excel of 2007 version and figures have been prepared from it. Statistical tests, such as chi-square and t-test, have been performed with the help of VassarStats: Website for Statistical Computation: http://faculty.vassar.edu/lowry/VassarStats.html and MedCalc Statistical Software.

5. Results

5.1. Malaria Cases. During the epidemiological report study period 2001–2010 a total of 1,061,495 blood slides from four BPHCs (Kachugaon 197,195, others 864,300) were examined for malaria cases and out of this 66,526 slides were tested positive (Kachugaon 23,484, others 43,042). Based on the assigned definition of forest and nonforest areas, there were 23,484 cases of malaria in the forest area and 14,347 in the nonforest area out of 485,295 blood slides (forest 197,195, nonforest 288,100) examined for malaria cases, showing

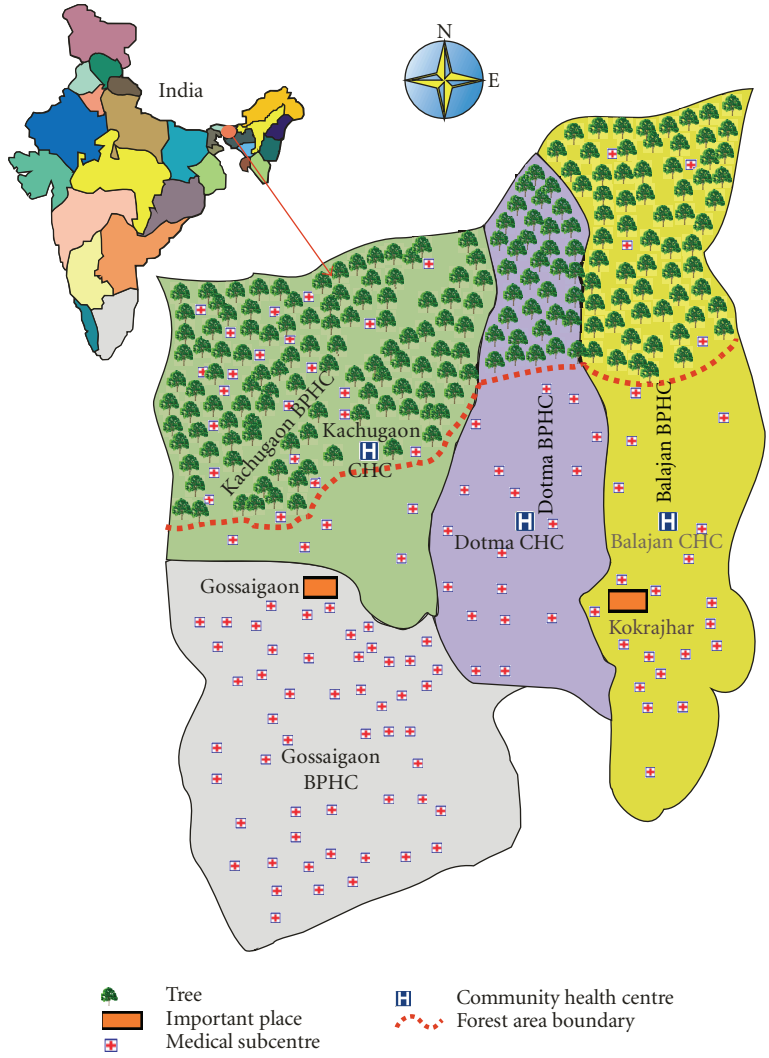

Figure 2: Medical blocks of Kokrajhar district.

significantly higher malaria prevalence in the forest area ($\chi^2 = 7819.87$, $P < .0001$).

5.2. Annual Blood Examination Rate. During the period Kachugaon BPHC recorded much lower ABER than the other three BPHCs lying in nonforest area, the mean ABER of forest and nonforest areas being, respectively, 10 ± 5.83 and 11 ± 3.85. Up to 2007 the ABER of forest area was lower than the respective ABER of nonforest area. From 2008 onwards forest area has been provided a higher cover of ABER in comparison to nonforest area (Figure 3). Although the coverage had been up and down, ABER in both forest and nonforest areas of the district was increasing and has crossed the figure 10 (Table 1), which has been recommended by World Health Organization.

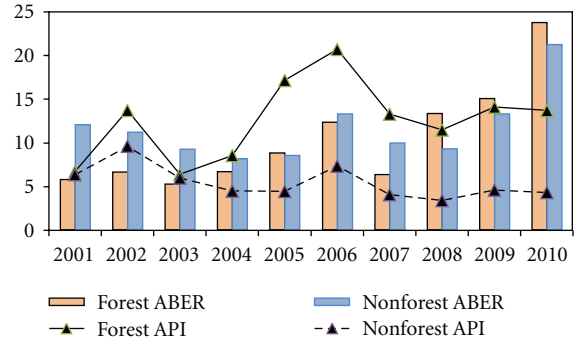

Figure 3: ABER and API of forest and nonforest areas.

5.3. Annual Parasite Incidence. Contrary to ABER coverage situation, Kachugaon BPHC has recorded much higher API than other three BPHCs of the district since 2004 and the API of forest area had been all time higher than the API of the whole district during the whole period, suggesting that malaria parasite transmission is significantly higher in the forest area than the nonforest area ($P = .0002$, $t = 4.61$; $df = 18$; Figure 4). The API of the forest malaria varied from 6.41 (in 2003) to 20.71 (in 2006) while the range of

Table 1: Block wise API and ABER.

Year	API					ABER				
	Kachugaon	Gossaigaon	Dotma	Balajan	District	Kachugaon	Gossaigaon	Dotma	Balajan	District
2001	6.73	9.26	4.79	6.05	6.43	5.76	17.58	9.88	11.21	11.16
2002	13.73	15.81	3.31	9.43	10.20	6.59	16.08	8.43	10.56	10.49
2003	6.41	12.64	2.97	3.68	6.08	5.19	12.30	6.43	8.72	8.32
2004	8.57	8.47	2.37	3.26	5.38	6.63	10.15	7.05	7.41	7.78
2005	17.17	6.43	1.84	4.56	7.18	8.78	8.92	7.51	8.68	8.55
2006	20.71	8.33	5.91	7.47	10.18	12.29	16.54	12.59	11.74	13.05
2007	13.30	1.91	5.04	4.86	6.08	6.31	10.12	8.54	10.37	9.12
2008	11.49	2.71	3.09	3.95	5.18	13.30	11.36	10.61	7.49	10.13
2009	14.10	5.09	2.34	5.59	6.90	15.01	16.61	14.20	9.67	13.65
2010	13.71	3.70	3.64	5.34	6.55	23.68	22.89	24.15	17.82	21.76

Table 2: Malaria indicators of forest and nonforest areas.

Year	Forest area						Nonforest area					
	BSE	API	SPR	PF	SFR	PV	BSE	API	SPR	PF	SFR	PV
2001	9859	6.73	11.68	1018	10.33	134	43351	6.38	5.31	1,856	4.28	446
2002	11885	13.73	20.85	1949	16.40	529	40782	9.62	8.65	2,677	6.56	851
2003	9053	6.41	12.34	904	9.99	213	19038	5.99	6.52	966	5.08	275
2004	11639	8.57	12.91	1370	11.77	133	17338	4.51	5.57	698	4.03	267
2005	15600	17.17	19.54	2586	16.58	463	18480	4.46	5.26	770	4.16	202
2006	22261	20.71	16.85	2531	11.37	1220	29820	7.36	5.55	1,343	4.50	313
2007	11935	13.30	21.08	1234	10.34	1282	22584	4.09	4.13	830	3.68	104
2008	25708	11.49	8.64	1298	5.05	922	21316	3.42	3.70	696	3.27	93
2009	30750	14.10	9.40	1923	6.25	966	28540	4.62	3.50	883	3.10	115
2010	48505	13.71	5.79	2079	4.29	730	46850	4.34	2.05	774	1.65	188

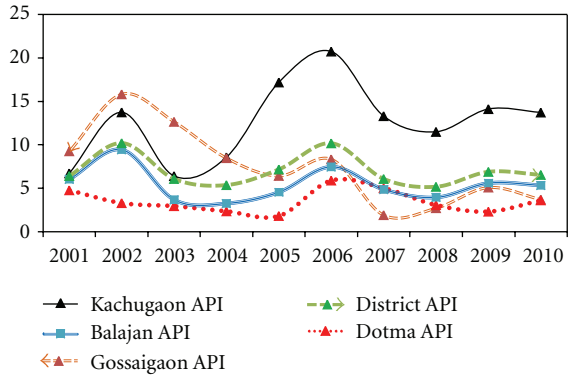

Figure 4: BPHC wise API.

nonforest malaria API was 3.42–9.62. The API of nonforest was highest during 2002 while it was lowest during 2008. There is a low-significant decreasing trend of API in both the areas ($\chi^2 = 2.746$, $df = 1$, $P = .0975$ for forest and $\chi^2 = 3.019$, $df = 1$, $P = .0823$ for nonforest).

It is noteworthy that during the period the API of the whole district had been varying in the form of a harmonic motion with varying amplitudes. It used to increase for some years and then took to decrease for some years, repeating the same process. During 2001–2006 the amplitude of the harmonic motion was approximately 2.51, while in the later part the amplitude has been decreasing and thus the path of API was transformed into a damped harmonic motion (Figure 5). Of course, the API of forest malaria was more fluctuating than that of nonforest area and had set a new trend line after 2006, which lies below the earlier trend line for the period 2001–2006. The API of forest area had remained always much above the API of nonforest area during the period and the malaria scenario in the district is being characterized by the malaria scenario of the forest area (Table 2).

5.4. Prevalence of Disease. There was higher prevalence of malaria disease in the forest area than nonforest area during the period ($P < .0001$, $t = 4.93$; $df = 18$). The mean SPR of forest area was 14 ± 5.4 during the period, the highest and lowest rates being in the years 2007 and 2010, while the mean SPR of nonforest area stood as 5 ± 1.82, the years of highest and lowest rates being 2002 and 2010. The SPR of forest area kept on fluctuating in between the range of 11.68–21.08 during 2001–2007, the mean prevalence during the period being 16 ± 4.14. But since 2008 the forest SPR had acquired a fast declining trend and the mean prevalence in the last three

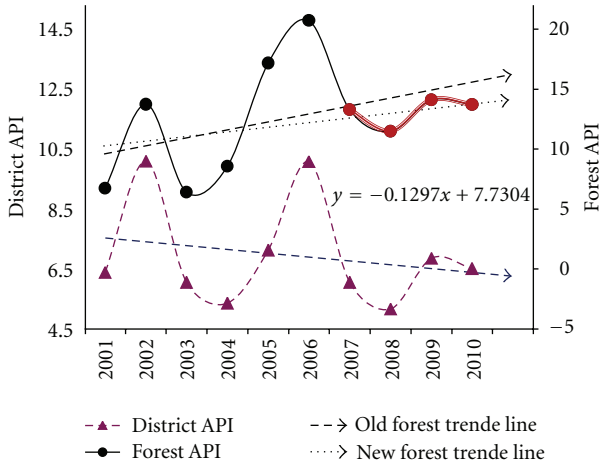

Figure 5: Trends of district and forest API.

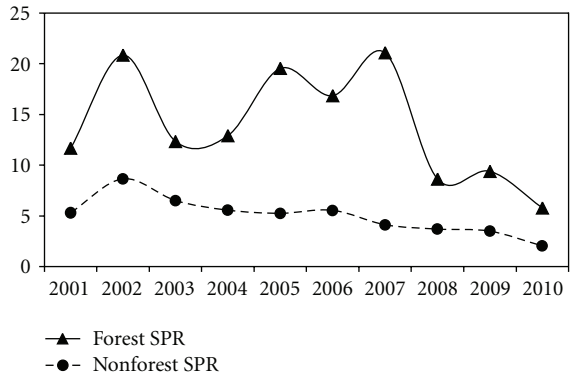

Figure 6: SPR of forest and nonforest areas.

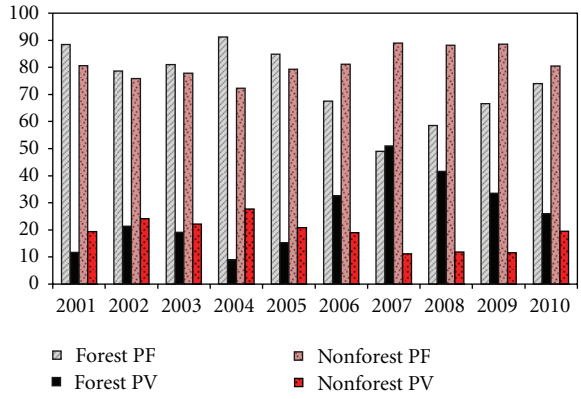

Figure 7: PF and PV of forest and nonforest areas.

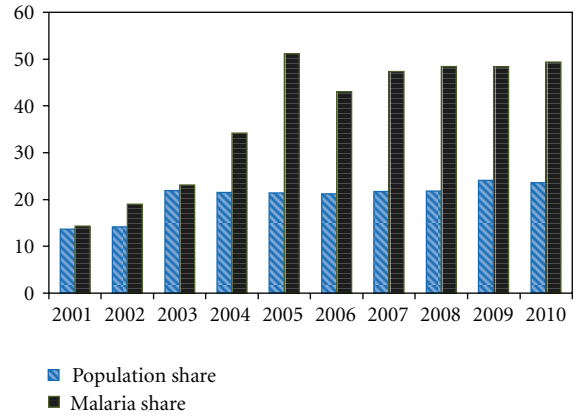

Figure 8: Population share versus malaria share of forest area.

years from 2008 to 2010 stood at 8 ± 1.9. On the other hand, the SPR of nonforest area attained its maximum during the year 2002 and after that it took to decline almost steadily and during the last three years of the period the mean prevalence was 3 ± 0.9 (Figure 6). There is a notable declining trend in the SPR of both the areas ($\chi^2 = 7.891$, $df = 1$, $P = .005$ for forest and $\chi^2 = 6.959$, $df = 1$, $P = .008$ for nonforest).

5.5. Malaria High-Risk Area. The average SPR of forest area for the last three consecutive years 2008, 2009, and 2010 is 7.9%, which is greater than 5%. So based on the criteria of Malaria Action Programme of the country [13, 14], the entire forest area may be placed under high-risk-area category. Contrary to this, the nonforest area may be considered outside high-risk area as the SPR of the last three consecutive years is less than 5%.

5.6. Dominant Malaria Species. PF species had dominated the PV species in both forest and nonforest areas ($P = .0002$, $t = 4.37$; $df = 18$ for forest and $P = .0004$, $t = 3.98$; $df = 18$ for nonforest) of the district more or less the whole period (Figure 7). During the year 2007 only the PV cases exceeded the PF cases in the forest area, after that PV cases are declining in the area. The mean ratio of PF and PV cases in the forest area during the period was 74 : 26 while in the nonforest area it was 81 : 19, and for the whole district it was 77 : 23. The SFR of forest area kept on fluctuating from 2001 to 2005 with a mean rate of 13 ± 3.24, and then took to climb down gradually and in 2010 it had recorded the lowest value of 4.29. Contrary to this, the SFR of nonforest area took to decline right from 2002 almost steadily from the maximum figure 6.56 and in 2010 it recorded its lowest value of 1.65.

5.7. Population Share versus Malaria Share of Forest Area People. The forest area population has been bearing excessive share of malaria cases during the period. The malaria share of the forest area to the district is much higher than the corresponding population share. There is an increasing trend of this inconsistency of malaria and population shares. During 2001 the two shares were almost equal, but during 2010 it has risen up to greater than 2 : 1. During the whole period of study 19.88% population of the district residing in forest area were bearing 35.25% of the malaria occurred in the district (Figure 8).

5.8. District Malaria from the Perspective of State Malaria. When the malaria scenario of the district during the period 2001–2009 is compared with that of the state it is seen that

Table 3: Slide collection by ASHA during 2007–2010. Source: District NRHM Office, Kokrajhar.

Name of block PHC	No. of slides collected	No of patients treated	Percentage of positivity
Balajan	3967	3398	85.66
Dotma	2756	2264	82.15
Kachugaon	4678	4323	92.41
Gossaigaon	3840	2957	77.01
Total	15241	12942	84.92
Monthly average slide collection: 332 nos.			
Percentage of positivity: 84.92			

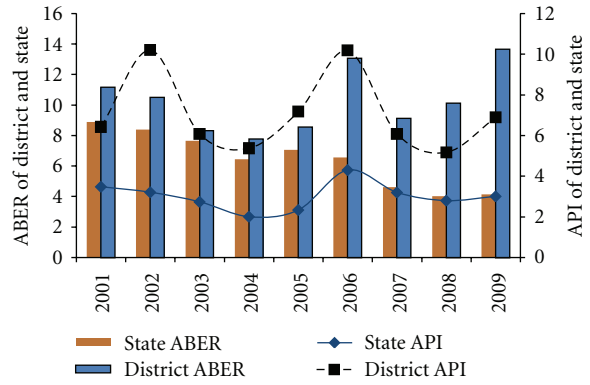

Figure 9: ABER and API of state and district.

for the last nine years the district has got all time higher API than the state. Every year the API of the district happens to be almost twice the API of the state. There is no trend of change of this situation. But it is encouraging that the district is maintaining all time higher ABER than the state (Figure 9).

5.9. Malaria Treatment through ASHA. ASHAs of NRHM are rendering services in the remote forest areas of the district in treating malaria. Blood slides are being collected by them from suspected patients for examination of the presence of malaria parasite, sent to clinics through multipurpose workers (MPW), and then necessary follow-up measures are taken if the slide is found positive. On average, ASHAs are collecting 332 slides per month in the district for malaria tests, of which 84.92% have been found positive (Table 3). Kachugaon BPHC tops the percentage of positivity with a figure of 92.41. Furthermore, NRHM has been providing malaria treatment to the people of medically backward areas of the district through mobile medical services. Annually, on average, 215 medical camps are being held in the district by Mobile Medical Unit of NRHM and on average 30,700 people are being treated annually through these camps.

6. Discussion

It has been observed that in the early years of the study period forest area was paid less attention in comparison to nonforest area in containing malaria, as a result of which ABER of forest area remained lower than that of nonforest area.

For an improved malaria situation a high ABER should be followed by a low API, but in the district a high ABER is being followed by a high API, indicating alarming malaria situation in the district, although there is a slightly declining trend.

Prevalence of malaria in the forest area was almost twice the prevalence in nonforest area, and sometimes even greater, every year during the period. Malaria in the forest area of the district took to decline after 2007 only while malaria in nonforest area started to decline, much earlier, after 2002. It is an encouraging indication that the SPR of both the areas remained below 10 during the last three years from 2008 to 2010, and in 2010 the SPR of both areas have attained their lowest levels.

The result of the present analysis corroborates the finding of National Institute of Malaria Research (of India) that in the forest areas inhabited by ethnic tribes, P. Falciparum proportion is 30–90% [7]. But the outcome of this analysis is not in conformity with the findings of Singh et al. that mention PF species to be dominant in forest area of Mandla district of Madhya Pradesh in India while the nonforest area of the state was dominated by PV species [12]; rather in the case of Kokrajhar district, both the forest and nonforest areas are dominated by PF species. Singh et al. observed replacement of dominant PV malaria species by PF in Central India [15]. In Kokrajhar district, although there is no such clear trend of shifting of situation from higher to lower prevalence of PF species in both forest and nonforest areas, there is a great tendency of replacing PF by PV in forest area. During the period 2004–2007, there was a significant decline in PF cases in forest area ($\chi^2 = 52.603$, $df = 1$, $P < .0001$), when PV cases slightly exceeded PF cases in 2007. But after that PV cases took to decline steadily in the area again.

A convincingly strong association of malaria prevalence in the forest and nonforest areas of the district dose not exist, the correlation coefficient of the two prevalence being 0.63. The highest prevalence in the forest area occurred in the year 2007, while the same occurred in the nonforest area in 2002.

It has been observed that the process of deforestation sometimes plays a role of adverse effect on the health status of people [16]. The survival, density, and distribution of malaria mosquitoes are dramatically influenced by small changes in environmental conditions such as temperature, humidity, and the availability of suitable breeding sites; deforestation provides these favorable changes through water logging to these mosquitoes [16] . Deforestation might have

Table 4: Epidemiologic situation of malaria in four blocks of Kokrajhar district during the period 2001–2010.

Name of BPHC	Year	Population	BSE	POS	PV	PF	ABER	SPR	PF%	API
Kachugaon	2001	171,278	9859	1152	134	1018	5.76	11.68	88.37	6.73
	2002	180,471	11885	2478	529	1949	6.59	20.85	78.65	13.73
	2003	174,276	9053	1117	213	904	5.19	12.34	80.93	6.41
	2004	175,422	11639	1503	133	1370	6.63	12.91	91.15	8.57
	2005	177,615	15600	3049	463	2586	8.78	19.54	84.81	17.17
	2006	181,100	22261	3751	1220	2531	12.29	16.85	67.48	20.71
	2007	189,218	11935	2516	1282	1234	6.31	21.08	49.05	13.30
	2008	193,225	25708	2220	922	1298	13.30	8.64	58.47	11.49
	2009	204,840	30750	2889	966	1923	15.01	9.40	66.56	14.10
	2010	204850	48505	2809	730	2079	23.68	5.79	74.01	13.71
Gossaigaon	2001	166,274	29227	1539	486	1053	17.58	5.27	68.42	9.26
	2002	166,587	26786	2634	870	1764	16.08	9.83	66.97	15.81
	2003	171,543	21099	2169	522	1647	12.30	10.28	75.93	12.64
	2004	178,234	18085	1509	490	1019	10.15	8.34	67.53	8.47
	2005	175,400	15650	1127	323	804	8.92	7.20	71.34	6.43
	2006	185,674	30706	1547	348	1199	16.54	5.04	77.50	8.33
	2007	187,507	18983	358	39	319	10.12	1.89	89.11	1.91
	2008	189,554	21528	514	70	444	11.36	2.39	86.38	2.71
	2009	228,674	37990	1163	159	1004	16.61	3.06	86.33	5.09
	2010	241689	55320	895	216	679	22.89	1.62	75.87	3.70
Dotma	2001	138,155	13650	662	56	606	9.88	4.85	91.54	4.79
	2002	139,393	11757	462	41	421	8.43	3.93	91.13	3.31
	2003	140,516	9042	417	83	334	6.43	4.61	80.10	2.97
	2004	141,680	9989	336	72	264	7.05	3.36	78.57	2.37
	2005	143,088	10745	263	47	216	7.51	2.45	82.13	1.84
	2006	150,528	18955	890	168	722	12.59	4.70	81.12	5.91
	2007	152,720	13046	769	65	704	8.54	5.89	91.55	5.04
	2008	153,478	16280	474	76	398	10.61	2.91	83.97	3.09
	2009	157,143	22314	367	66	301	14.20	1.64	82.02	2.34
	2010	157286	37987	572	123	449	24.15	1.51	78.50	3.64
Balajan	2001	777,869	87176	4706	796	3910	11.21	5.40	83.09	6.05
	2002	793,757	83803	7488	1643	5845	10.56	8.94	78.06	9.43
	2003	309,380	26974	1138	220	918	8.72	4.22	80.67	3.68
	2004	322,943	23941	1052	240	812	7.41	4.39	77.19	3.26
	2005	334,682	29045	1525	236	1289	8.68	5.25	84.52	4.56
	2006	338,873	39798	2531	424	2107	11.74	6.36	83.25	7.47
	2007	344,618	35724	1674	207	1467	10.37	4.69	87.63	4.86
	2008	349,159	26140	1380	134	1246	7.49	5.28	90.29	3.95
	2009	261,752	25316	1464	119	1345	9.67	5.78	91.87	5.59
	2010	265148	47244	1417	224	1193	17.82	3.00	84.19	5.34

been a reason behind changes in malaria transmission in the highlands of Kenya [17]. In present days Kokrajhar district is facing a massive deforestation. During the last eight years, from 1999 to 2007, there has been a deforestation of an area of 467 sq km [18]. This may have played a role in accelerating malaria prevalence in the district. Furthermore, poor socioeconomic condition of the people is a determinant of malaria prevalence [17]. Majority of the people residing in the forest area are living below the poverty line and they are educationally backward. This condition is facilitating higher malaria in the forest area.

The policy for controlling malaria in the country undertaken by National Vector Borne Disease Control Program is homogeneous for all people and areas. So it implies that the

Table 5: Epidemiologic situation of malaria in forest area, nonforest area and whole district during the period 2001–2010.

Name of Area	Year	Population	BSE	POS	PV	PF	ABER	SPR	PF%	API
Forest area (Kachugaon BPHC)	2001	171,278	9859	1152	134	1018	5.76	11.68	88.37	6.73
	2002	180,471	11885	2478	529	1949	6.59	20.85	78.65	13.73
	2003	174,276	9053	1117	213	904	5.19	12.34	80.93	6.41
	2004	175,422	11639	1503	133	1370	6.63	12.91	91.15	8.57
	2005	177,615	15600	3049	463	2586	8.78	19.54	84.81	17.17
	2006	181,100	22261	3751	1220	2531	12.29	16.85	67.48	20.71
	2007	189,218	11935	2516	1282	1234	6.31	21.08	49.05	13.30
	2008	193,225	25708	2220	922	1298	13.30	8.64	58.47	11.49
	2009	204,840	30750	2889	966	1923	15.01	9.40	66.56	14.10
	2010	204850	48505	2809	730	2079	23.68	5.79	74.01	13.71
Nonforest area (mean of Gossaigaon, Dotma, and Balajan BPHCs)	2001	360,766	43,351	2,302	446	1,856	12.02	5.31	80.63	6.38
	2002	366,579	40,782	3,528	851	2,677	11.13	8.65	75.87	9.62
	2003	207,146	19,038	1,241	275	966	9.19	6.52	77.85	5.99
	2004	214,286	17,338	966	267	698	8.09	5.57	72.32	4.51
	2005	217,723	18,480	972	202	770	8.49	5.26	79.21	4.46
	2006	225,025	29,820	1,656	313	1,343	13.25	5.55	81.08	7.36
	2007	228,282	22,584	934	104	830	9.89	4.13	88.90	4.09
	2008	230,730	21,316	789	93	696	9.24	3.70	88.18	3.42
	2009	215,856	28,540	998	115	883	13.22	3.50	88.51	4.62
	2010	221,374	46,850	961	188	774	21.16	2.05	80.48	4.34
Whole district	2001	1,253,576	139912	8059	1472	6587	11.16	5.76	81.73	6.43
	2002	1,280,208	134231	13062	3083	9979	10.49	9.73	76.40	10.20
	2003	795,715	66168	4841	1038	3803	8.32	7.32	78.56	6.08
	2004	818,279	63654	4400	935	3465	7.78	6.91	78.75	5.38
	2005	830,785	71040	5964	1069	4895	8.55	8.40	82.08	7.18
	2006	856,175	111720	8719	2160	6559	13.05	7.80	75.23	10.18
	2007	874,063	79688	5317	1593	3724	9.12	6.67	70.04	6.08
	2008	885,416	89656	4588	1202	3386	10.13	5.12	73.80	5.18
	2009	852,409	116370	5883	1310	4573	13.65	5.06	77.73	6.90
	2010	868,973	189,056	5,693	1293	4,400	21.76	3.01	77.29	6.55

different malaria situation in the forest and nonforest areas of the district is not due to policy, but rather it is due to the forest condition. The practical malaria situation prevailing in forest and nonforest areas of the district suggests that there is a necessity of separate policies for these two areas in regard to containment of malaria.

There has been a notable improvement in controlling malaria after NRHM became fully functional in the district from 2007. It made efforts to contain malaria in the forest area and accordingly from 2008 the ABER of forest area rose above that of nonforest area. Distribution of insecticide treated bed nets in the malaria-prone areas of the district started in the later part of 2007 and following this a sudden decline in malaria prevalence from 21.08 in 2007 to 8.64 in 2008 was observed in the forest area.

Accredited Social Health Activist of NRHM has been able to bridge the gap between common people and health facilities available to them. Through ASHA health department can now explain the health situation to the villagers in their own language and persuade them to avail of the health facilities available to them. The ASHA Kit has been able to change the attitude of the people who are socially, demographically, and educationally backward that prevent them from seeking modern medicine to alleviate their plight. Earlier, tribal people used to approach their traditional *Oja* (medicine man) or *Gonok* (event teller) for their treatment as they were the only accessible and approachable healers for them. For treating malaria the local communities of the district used some medicinal plants available in the forests in their vicinity as other local communities of Assam used to do [19]. But now ASHA is more easily approachable to them for their health issues and since medicines for preliminary treatment of different diseases are available to them through ASHA, the tribal villagers have started to choose modern medicines as a reliable option for their treatment. Thus the ASHA kit has been able to change even their health-seeking behavior, making them more dependent on modern medicine rather than on superstitions and traditional treatments.

7. Conclusion

The analysis of malaria data of ten years in Kokrajhar district for observing trends reveals that malaria situation in the district still persists casting a gloomy picture in the district in general and the forest area in particular. Despite the malaria department's improved control measures such as comprehensive programs of vector control, surveillance and treatment and services of NRHM, there is still a preponderance of the disease in the district and the situation is under par when compared to the state situation. As forest area is the main donor to district malaria, a more rigorous measure is needed to combat malaria in the forest area. Since it is the pattern of the disease to decline for some years and then rise up again, there should be enough preparation during remission period so that the health departments can combat the disease when it takes to rise again in the following years.

Appendix

For more details see Tables 4 and 5.

Abbreviations, Acronyms and Definitions

PV: *Plasmodium vivax*
PF: *Plasmodium falciparum*
BSE: Blood slides examined (number of blood slides examined tested for presence of malaria parasite)
POS: Positive (number of confirmed malaria positive cases)
SFR: Slide falciparum rate = (PF/BSE) × 100
SPR: Slide positivity rate = (POS/BSE) × 100
ABER: Annual blood examination rate = (BSE/Population) × 100
API: Annual parasite incidence = (POS/Population) × 1000.

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