Risk Factors Associated with Clinical Malaria Episodes in Bangladesh: A Longitudinal Study
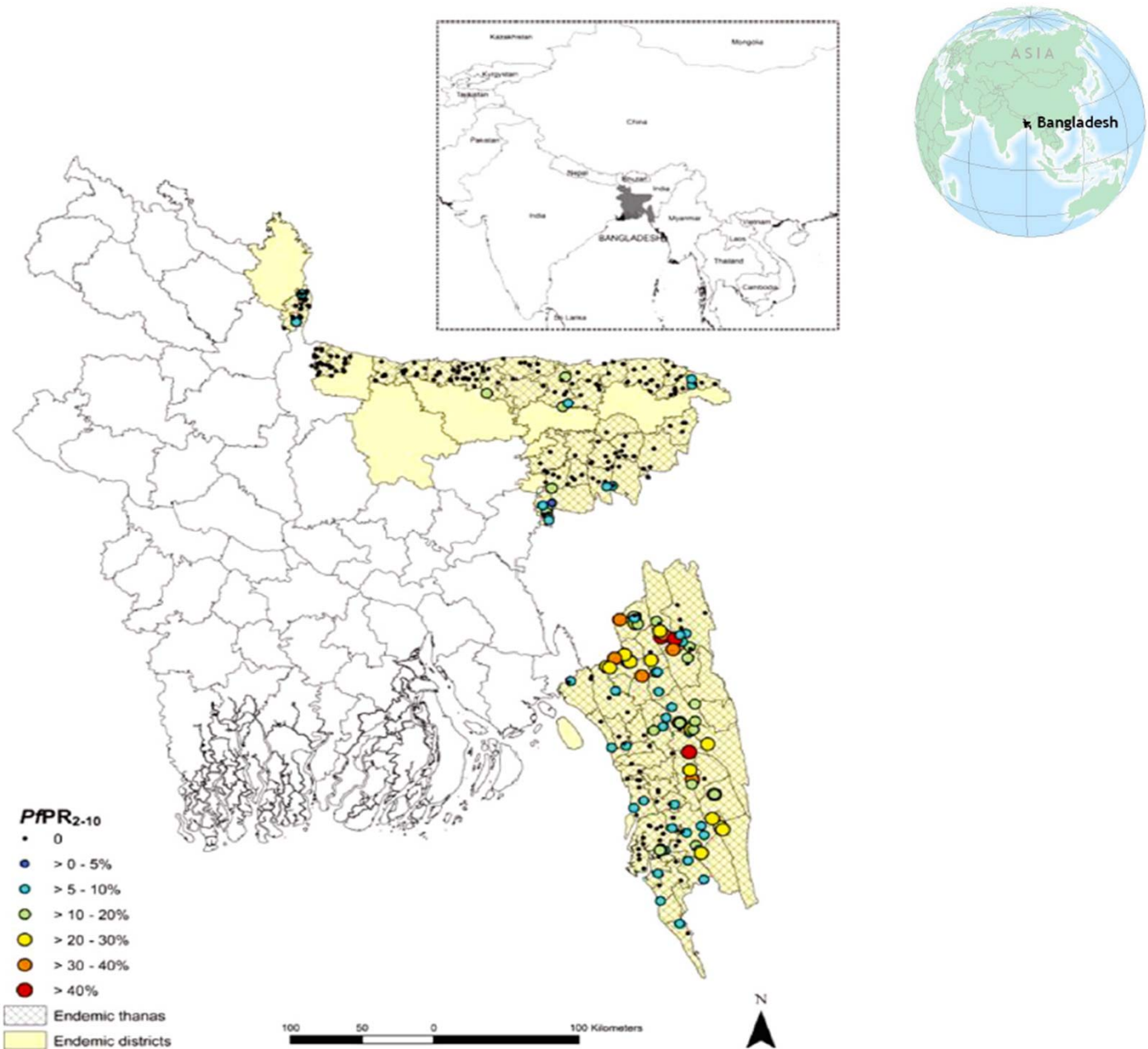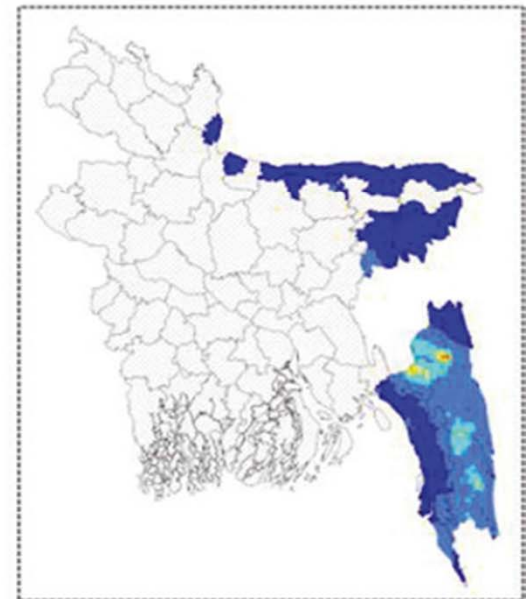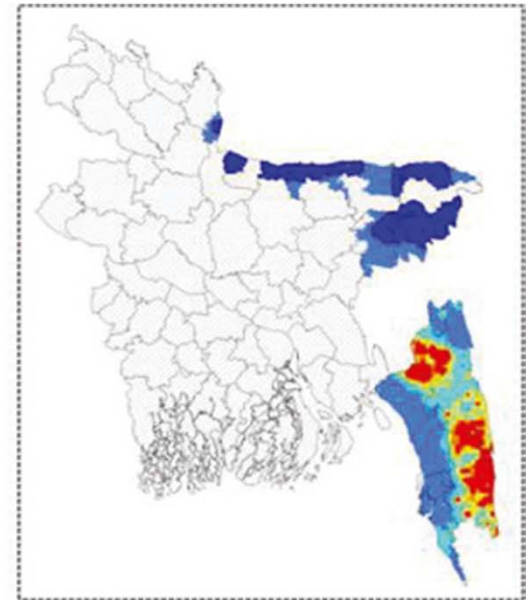
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District map of Bangladesh showing the *Pf PR$_{2-10}$ from the 354 villages geo-located and the location of Bangladesh, *Am. J. Trop. Med. Hyg., 83(4), 2010, pp. 861–867*

Legend:

PfPR$_{2-10}$
- • 0
- > 0 - 5%
- > 5 - 10%
- > 10 - 20%
- > 20 - 30%
- > 30 - 40%
- > 40%
- Endemic thanas
- Endemic districts

Predicted PfPR₂₋₁₀
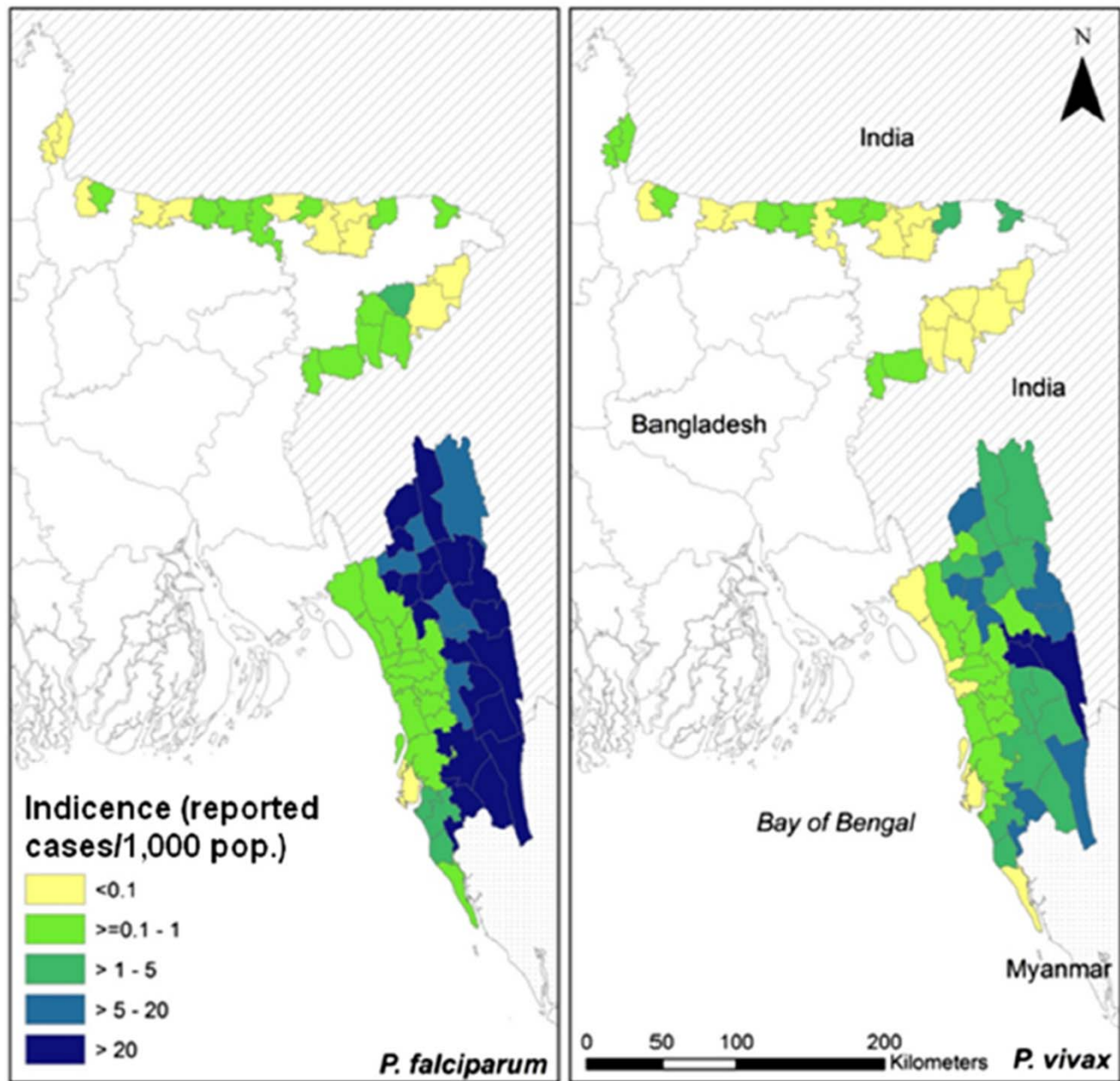
- $< 0.5\%$
- $0.5 - 5\%$
- $5 - 10\%$
- $10 - 15\%$
- $15 - 20\%$
- $20 - 25\%$
- $> 25\%$
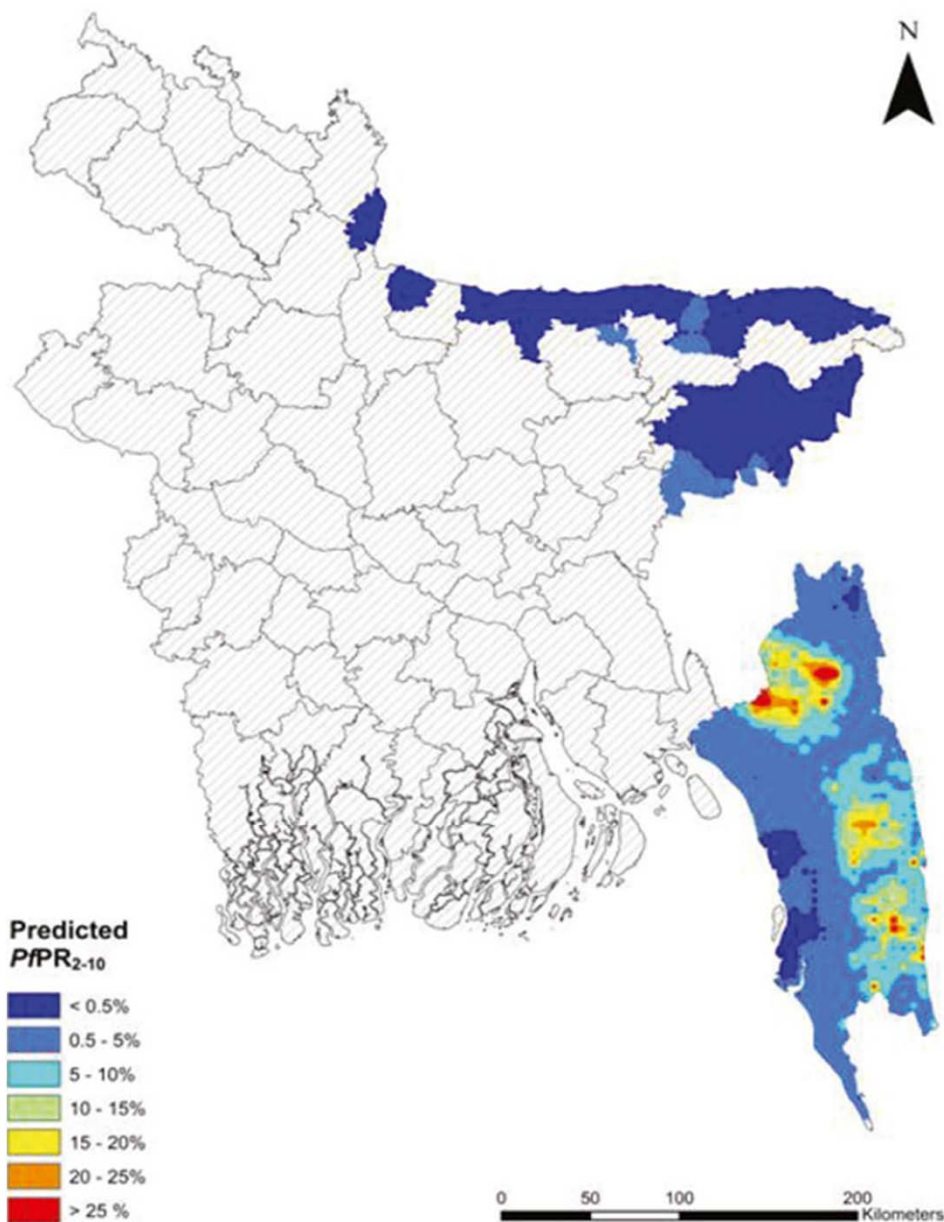
Median predicted spatial distribution of *Pf PR 2–10 across the endemic thanas of Bangladesh at 1- × 1-km resolution, upper 75% predicted prevalence (Upper Inset), and lower 25% predicted prevalence (Lower Inset), Am. J. Trop. Med. Hyg., 83(4), 2010, pp. 861–867*

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Indicence (reported cases/1,000 pop.)

- <0.1
- >=0.1 - 1
- > 1 - 5
- > 5 - 20
- > 20

P. falciparum

P. vivax

India

India

Bangladesh

Bay of Bengal

Myanmar

0   50   100   200 Kilometers

Incidence of reported cases of *Plasmodium falciparum* and *Plasmodium vivax* per 1,000 people across the endemic sub-districts in Bangladesh, 2007. *Malaria Journal 2012, 11:170*

Study area

Objective

This study investigates bed net ratio per household, housing construction materials (wall), hydrologic and topographic risk factors of malaria, and spatial patterns of the disease over two years in the same population.

Data collection

- Malaria episodes of 1634 households (all age groups) in 2009 and 2010

- Diagnosis

- Socioeconomic

- Geographic

- Household density calculation

- Remote sensing data

Analysis

Examine individual and household level analyses with malaria incidence by spatial and statistical analysis.

Multivariate negative binomial regression model

• Association between malaria incidence with socioeconomic, topographic and hydrological risk factors.

Spatial analysis

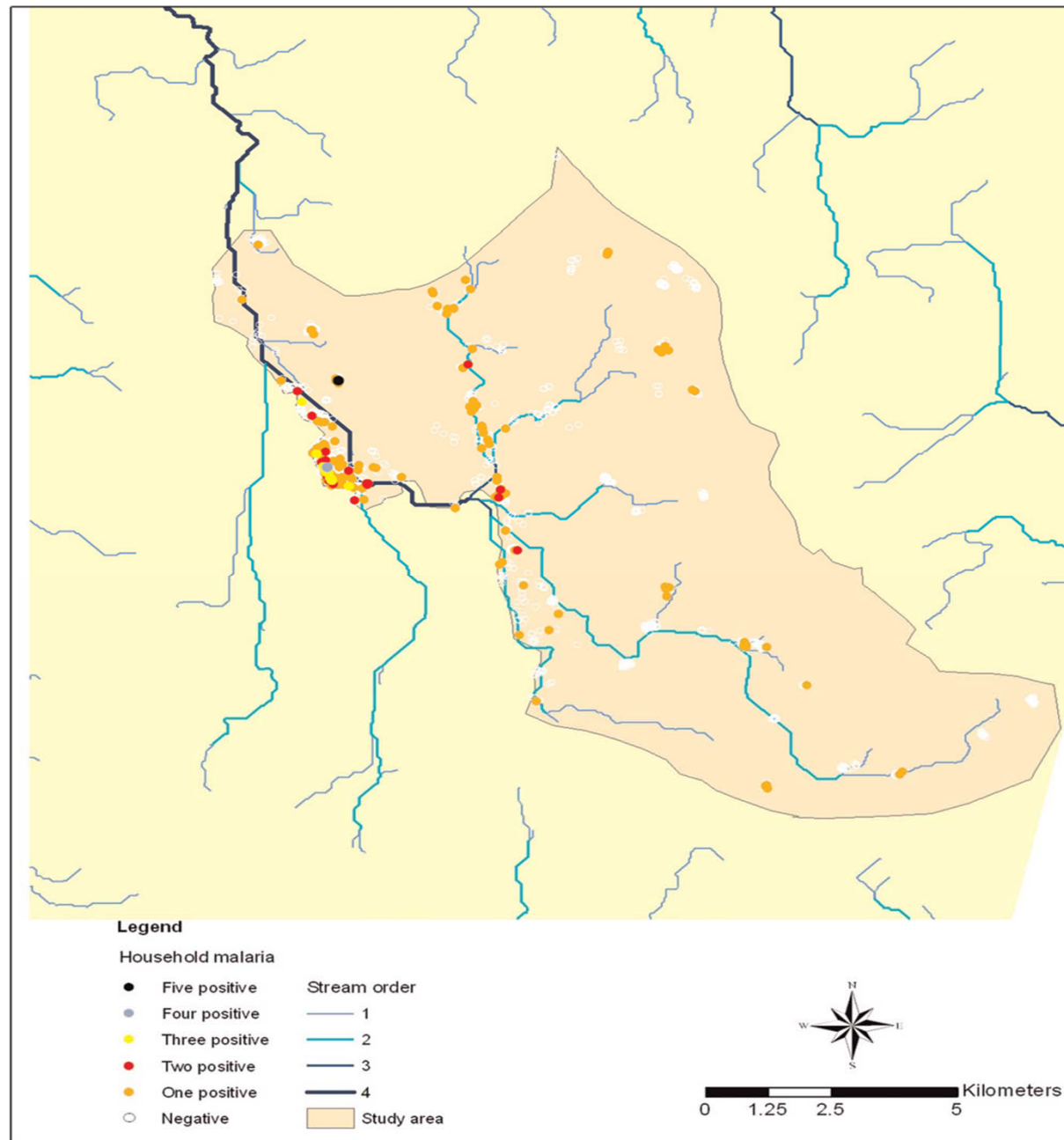• Detect spatial clusters of malaria episodes

Results – Overall Patterns

Malaria incidence

• There were 497 (6.3%) episodes of malaria recorded from 7,922 individuals during the study period.

• 78% households did not experience any malaria, 252 households (15%) had one single malaria case and 104 households (6.4%) had multiple infections, i.e. two to five infections.

Individual level risk factors:

• Using children <5 years as reference (Incidence rate ratio, IRR: 1) the risk of malaria infection decreased with increasing age.

• Malaria was equally distributed among males and females in the population.

Legend

Household malaria

- ● Five positive
- ● Four positive
- ● Three positive
- ● Two positive
- ● One positive
- ○ Negative

Stream order
- —— 1
- —— 2
- —— 3
- —— 4
- Study area

Kilometers
0   1.25   2.5   5

Stream order network in the study area, Bangladesh

Malaria risk increased in households having lower bed net coverage, poor housing materials and high house density

Risk factors for malaria*

Factor	Adjusted IRR (95% CI)	*P*
Bed net ratio (per person/per household)	IRR (95% CI)	IRR (95% CI)
0–0.5	1	
> 0.5–1	0.71 (0.56–0.91)	0.006
> 1	0.42 (0.28–0.62)	0.0001
Wall		
Jute stick/bamboo	1	
Tin/concrete	1.63 (0.94–2.82)	0.081
Mud	2.17 (1.45–3.26)	0.0001
House density (no.)		
1–200	**1**	
201–500	1.80 (1.09–3.00)	0.022
501–1,000	1.43 (0.70–2.92)	0.326
> 1,000	2.79 (1.70–4.56)	0.0001

*IRR = incidence rate ratio; CI = confidence interval. IRR for the reference category is 1.00. **Only significant risk factors are shown**
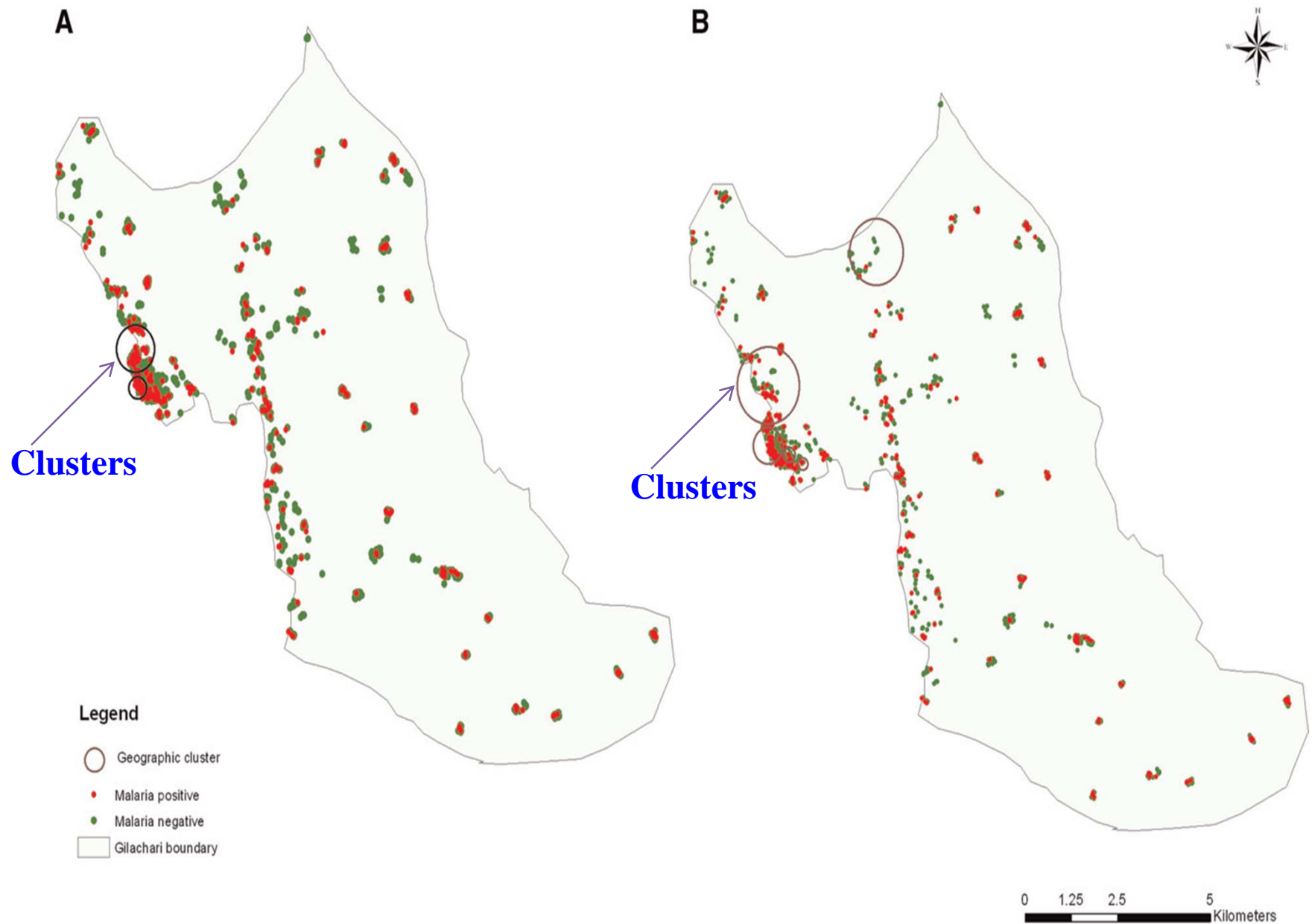
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Figure. A, Spatial distribution of malaria clusters in 2009. B, Spatial distribution of malaria clusters in 2010.

Geographic cluster of malaria cases (adjusted Poisson model for 2009 and 2010), Bangladesh*

Year and cluster	Population	No. observed cases	No. expected cases	Relative risk	P
2009					
1	378	44	12.08	4.20	0.00001
2	535	44	17.10	2.90	0.00001
2010					
1	118	20	3.63	5.90	0.00001
2	151	22	4.65	5.10	0.00001
3	76	14	2.34	6.28	0.0007
4	48	11	1.48	7.74	0.0019
5	619	41	19.07	2.38	0.0170

*Only significant clusters are shown.

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Limitations

- Thirteen confirmed cases were excluded because their names and households did not match with our records.

- There could have been false-positive or false-negative results in microscopic tests or RDTs

- Missed some malaria-positive cases, e.g., if persons bought antimalarial drugs directly from drug vendors and/or preferred self treatment

Conclusion

- This longitudinal study provides some novel findings about stability of hot spots and multiple infections among households and individuals.

- Further, the areas that require expanded malaria control efforts based on malaria foci have been identified.

- The location of households in villages is an independent and important factor for variation in malaria incidence.

- This study also confirmed the existence of some malaria risk factors (bed net ratio, poor housing construction materials and house density)

- Mass screening can be conducted in stable hotspots to identify asymptomatic reservoirs and providing treatment

- For targeted interventions, detail risk mapping using GIS, remote sensing, and DEM may be important for policy implementation.